Natural Disasters in Nepal

- An Introduction to Mitigation Efforts through Academic and Research Activities -

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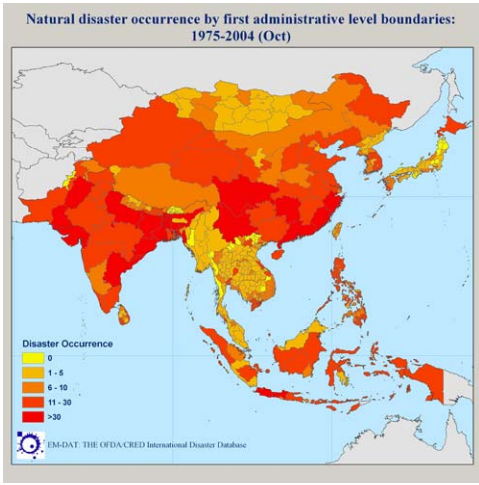
Natural Disasters in South, East, and Southeast Asia

(1975 - 2005)

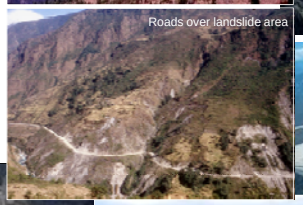


Natural Disasters in Nepal

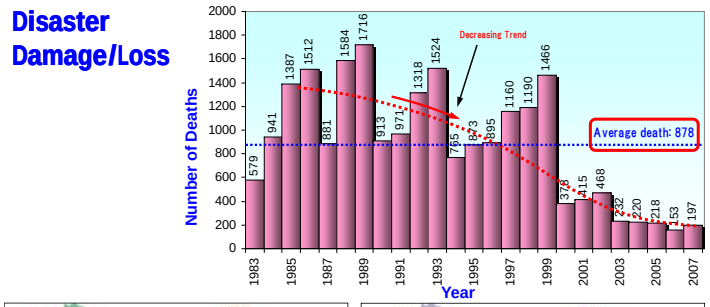
- Landslides)
- Floods)
- Earthquake)
- GLOF (Glacier Lake Outburst Flood)

Others: Drought, Epidemics, Fire, etc.

Weak Geological and Gemorphological Formations



Disaster Damage/Loss



Hazard loss with respect to GDP and development expenditure, 1983-1995

Year	Real GDP (million NRs.)	Development Expenditure (million NRs.)	Total Hazard Loss (million NRs.)	% Real GDP	% Development expenditure
1983	19,624	4,982	240	1.22	4.82
1984	21,390	5,163	48	0.23	0.94
1985	22,600	5,488	71	0.32	1.31
1986	23,753	6,213	23	0.1	0.37
1987	24,077	7,378	2,004	8.33	27.17
1988	25,749	9,428	6,099	23.69	64.69
1989	27,201	12,328	4,171	15.34	33.84
1990	28,661	12,997	139	0.49	1.07
1991	30,249	15,979	42	0.14	0.27
1992	31,376	16,512	52	0.17	0.32
1993	32,081	19,413	5,188	16.17	26.73
1994	34,251	21,482	185	0.54	0.86
1995	35,401	19794.9	930	2.63	4.70
Avg.	27,416	12,089	1,476	5.39	12.9

CBS Statistical Yearbook 1995 and Economic Survey, the Ministry of Finance, 1995

Human deaths in Asian Region due to Natural Disasters (1995~2004)

Table 2 Total number of people reported killed, by continent and by year (1995 to 2004)

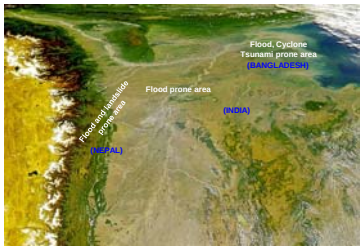
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Africa	7,902	3,484	4,064	7,006	2,688	5,756	4,462	8,272	5,810	4,308	48,812
Americas	2,628	2,541	3,069	21,865	33,989	1,820	3,460	2,285	2,026	8,269	81,952
Asia	75,590	49,706	71,033	82,373	75,899	11,608	29,255	13,338	27,990	226,102	702,775
Europe	3,366	1,204	1,166	1,434	19,448	1,627	2,196	1,699	31,045	1,182	64,368
Oceania	24	111	388	2,227	116	265	9	91	64	35	3,270
High human development	8,223	2,170	2,435	3,070	5,420	2,221	2,136	2,115	31,606	1,248	60,644
Medium human development	19,493	17,146	18,157	42,635	70,163	13,279	33,349	15,169	41,743	239,904	511,031
Low human development	56,854	57,730	59,128	69,200	56,548	5,523	3,897	8,421	3,457	8,774	329,502
Total	84,570	77,046	79,720	114,905	132,131	21,016	39,382	25,705	76,806	249,896	901,177

Source: EM-DAT, CRED, University of Louvain, Belgium

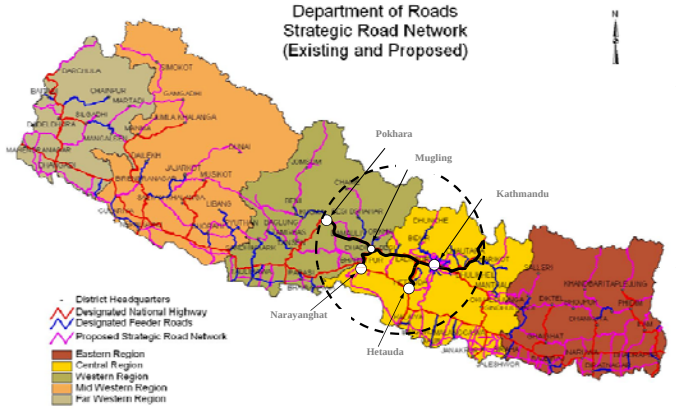
S. Asia

Country	Number of affected people vs. persons killed (based on data from 1985-2004)	Deaths of persons per million/ per year (based on data from 1985-2004)
Sri Lanka	1:321	94
Bangladesh	1:1661	63
Nepal	1:144	39
Afghanistan	1:593	21
China	1:5754	13
Bhutan	1:278	12
India	1:9531	6
Pakistan	1:2448	4
Maldives	1:360	2

Nepal: High Human Death !

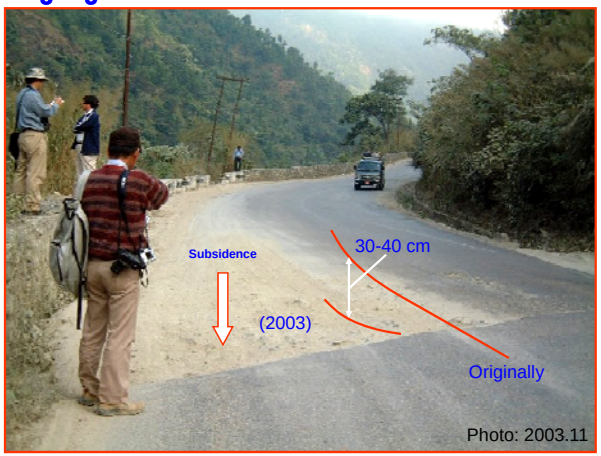


Strategic Road Network of Nepal

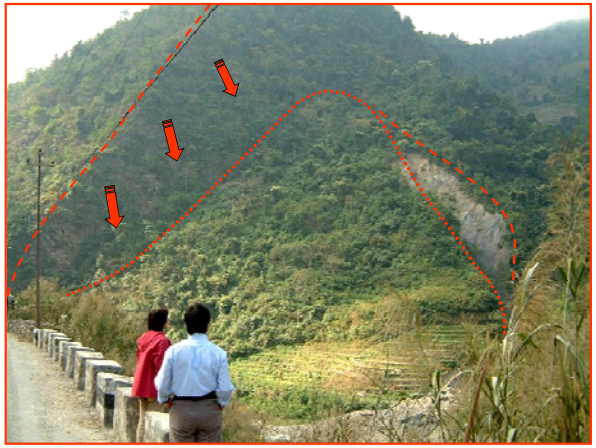


Typical Slope Failure Alongside Prithvi Highway (Krishnabhir)

Damaged Portion of Prithvi Highway near Mugling

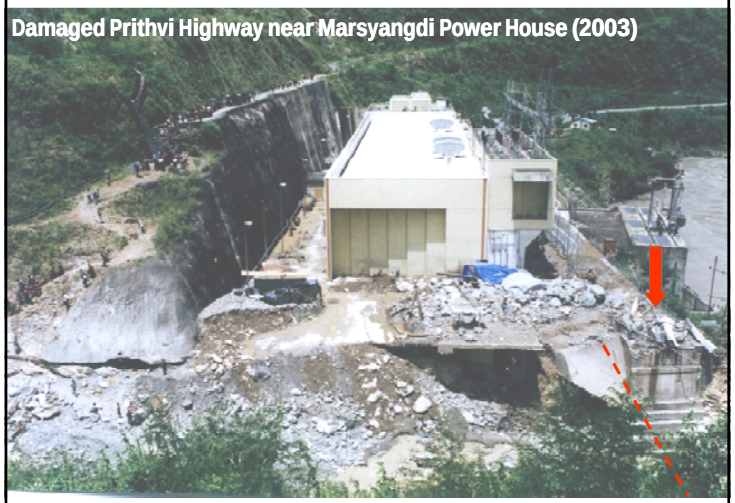


Typical Old Landslide Deposit



Way to Pokhara (near Damauli)

Damaged Prithvi Highway near Marsyangdi Power House (2003)



Debris Flow Alongside Narayanghat-Mugling Highway (2003)

Typical Failure Site Alongside Tribhuvan Highway (2004)

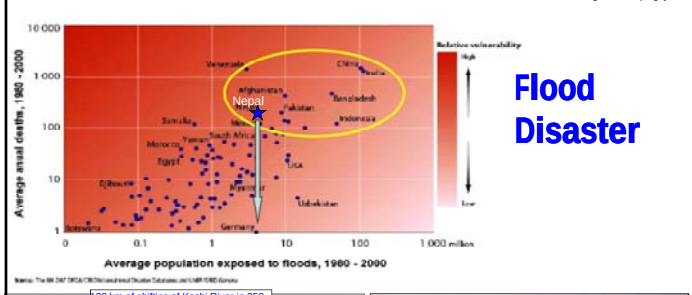
Living with Landslides

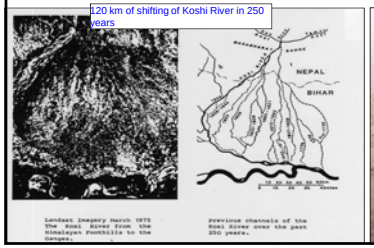
Landslide in Khotang, 2002 in which over 20 people died

Living with Landslides

Debris Flow in Bagarchhapp village, Manang district which killed many people including tourists

Flood Disaster



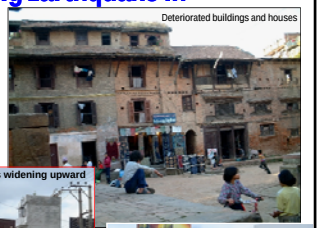


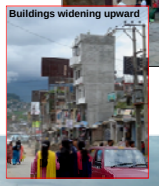
Flooding of rivers in the plains

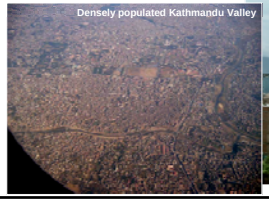
Estimated Loss/Damage in Next Big Earthquake in Kathmandu Valley *(JICA 2002)*

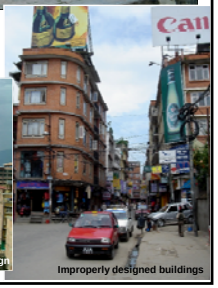
Potential Impact due to scenario EQ in KV
(KVERMP estimated for IX MMI)

Impact	Extent
Death	>40,000
Injuries	>95,000
Buildings destroyed/collapsed	>60%
Homeless population	>700,000
Bridges impassable	>50%
Road length damaged	>10%
Water supply pipes damaged	>95%
Telephone exchange buildings	most
Telephone lines	>60%
Electric substations	most
Electric lines	40%

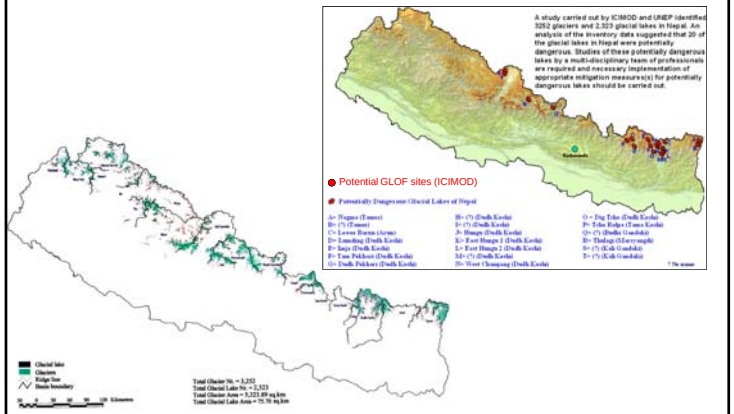








Glaciers and Glacier Lakes in the Nepal Himalaya

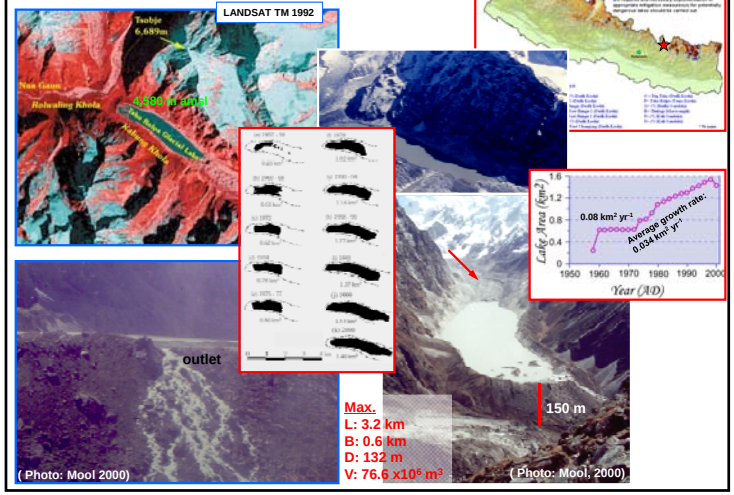


Climate Change → Glacier Lake Outburst

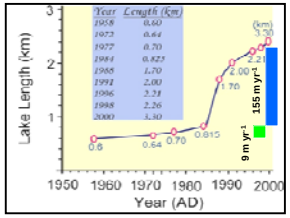
Imja Glacier, Nepal - 1956. © Fritz Mueller

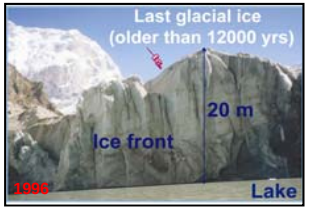
Imja Glacier, Nepal - 2006. © Giovanni Kappenberger

Tsho Rolpa Glacier Lake



Thulagi Glacier Lake



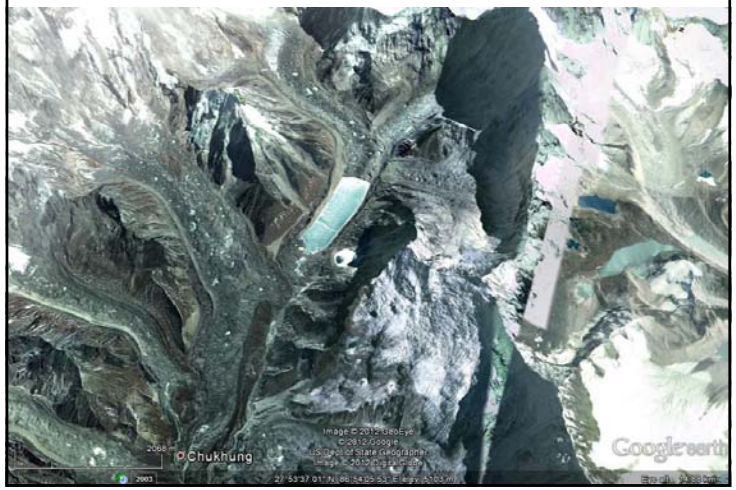


(Photographs: Adhikari 1996)

The Nepal Himalaya

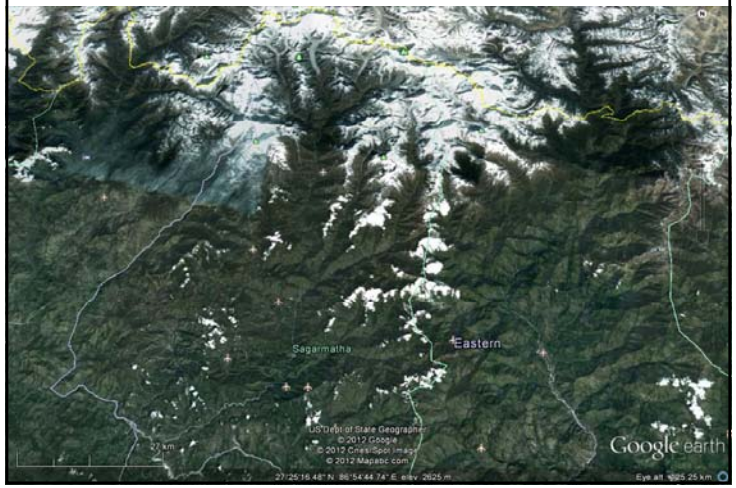
Himalaya and Glaciers

Himalayan Glacier Lakes and Impact of Climate Change



Glacier Lakes in the Nepal Himalaya

Glacier Lake Outburst Flood Hazard



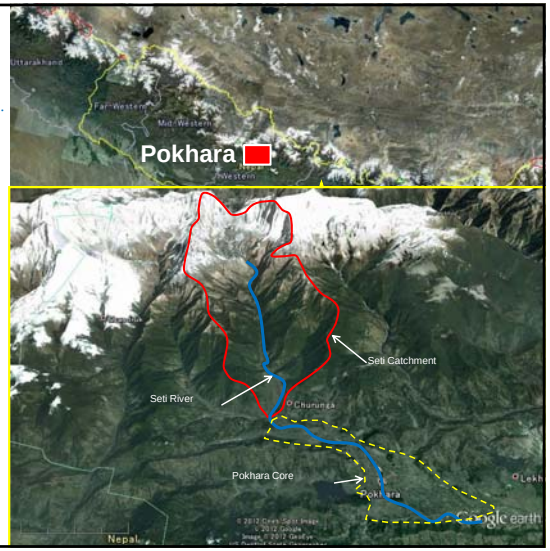
Outline of Recent Debris-Flood Disaster in Pokhara

Disaster Outline

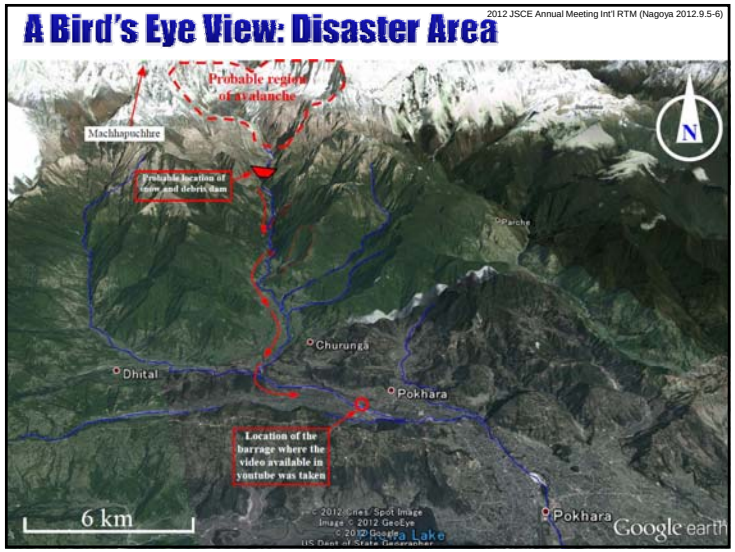
- Date: 5 May 2012
- Time: 9:00AM – 2:00PM
- Total 8 Flood Waves
- Dead: 31
- Missing: 40 (?)
- Bridges (Suspension): 2
- Buses and Trucks: 4
- Tractor: 1
- Property damage: 100 million rupees
- Clear weather (no rain!)
- No seismic effect (?)

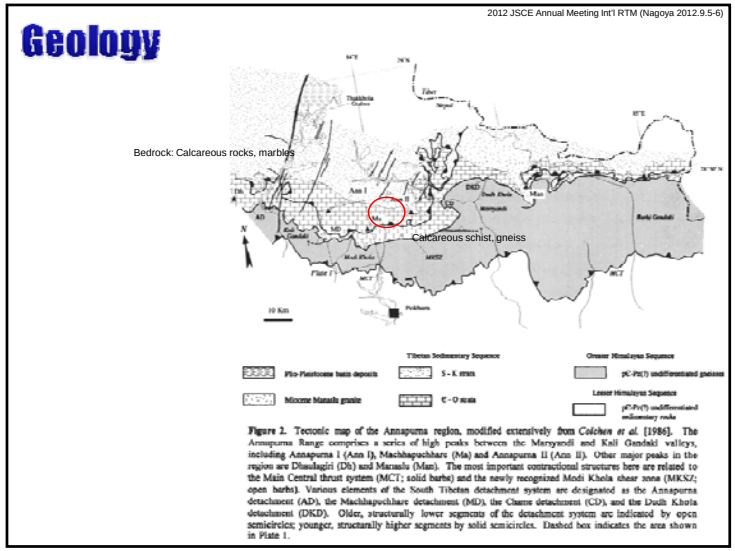
Location

- Population: 0.5 mil.
- City altitude: 800m
- Seti Source Elevation: 3500 m




Importance of Pokhara
Macchapuchhre (6993 m)
Annapurna IV (7525m)
Annapurna II (7037m)


2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
A Bird's Eye View: Disaster Area
Probable region of avalanche
Machhapuchhre
Probable location of snow and debris dam
Parche
Churunga
Dhital
Pokhara
Location of the barrage where the video available in youtube was taken
6 km
Phewa Lake
Pokhara
Google earth


2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
Geology
Bedrock: Calcareous rocks, marbles
Calcareous schist, gneiss
Figure 2. Tectonic map of the Annapurna region, modified extensively from Colchen et al. [1986]. The Annapurna Range comprises a series of high peaks between the Marsyandi and Kali Gandaki valleys, including Annapurna I (Ann I), Machhapuchhare (Ma) and Annapurna II (Ann II). Other major peaks in the region are Dhaulagiri (Dh) and Manaslu (Man). The most important contractional structures here are related to the Main Central thrust system (MCT; solid barbs) and the newly recognized Modi Khola shear zone (MKSZ; open barbs). Various elements of the South Tibetan detachment system are designated as the Annapurna detachment (AD), the Machhapuchhare detachment (MD), the Chame detachment (CD), and the Dudh Khola detachment (DKD). Older, structurally lower segments of the detachment system are indicated by open semicircles; younger, structurally higher segments by solid semicircles. Dashed box indicates the area shown in Plate 1.

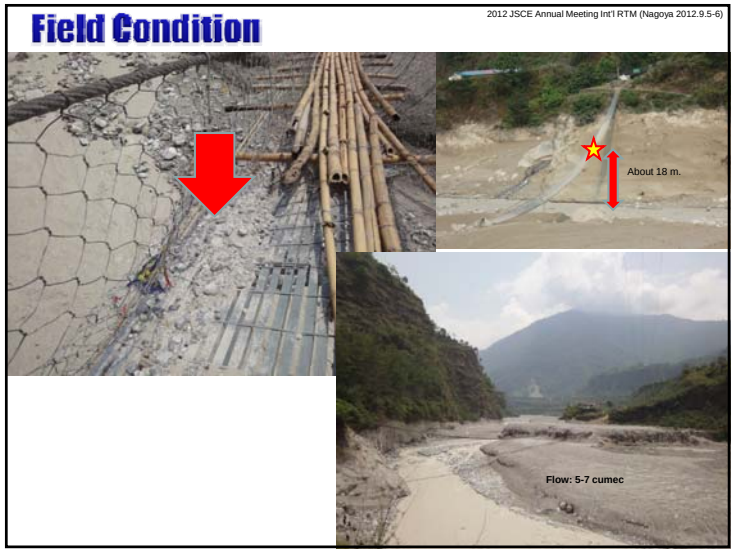

Debris Flow

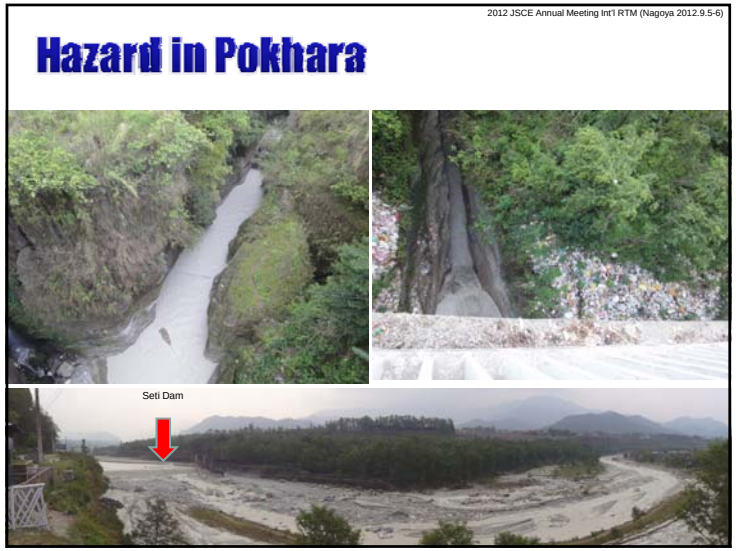
Media Reports

Media Reports

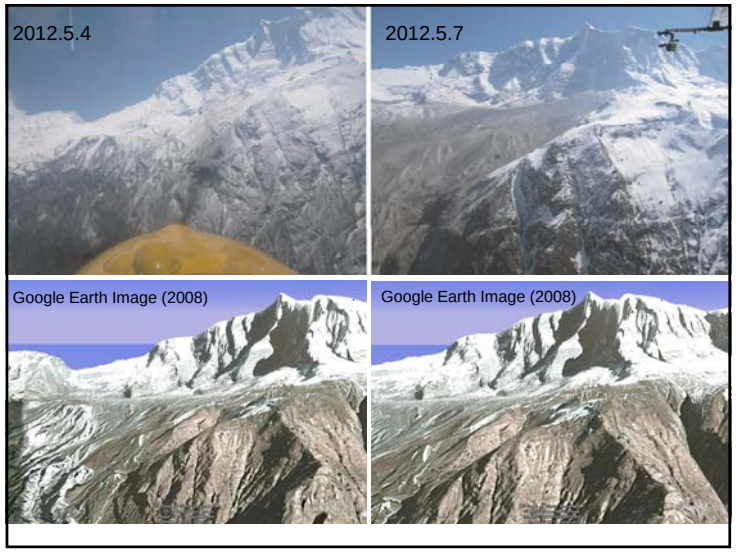
Debris Flow at 20km from Source Point

Field Visit


Field Condition
2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
About 18 m.
Flow: 5-7 cumec


2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
Hazard in Pokhara
Seti Dam

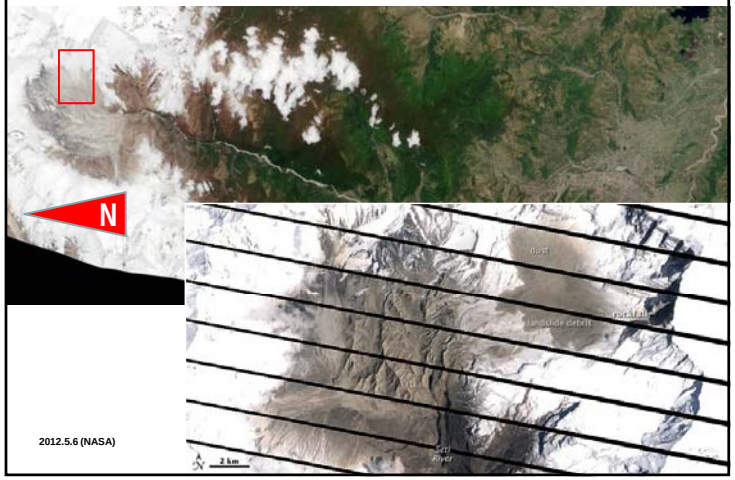

2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
Aerial Survey



Mechanism Interpretation

- Landslide Failure?
- Rock Avalanche/Failure?
- Landslide Damming?
- Snow-Debris Avalanche and Immediate Slurrification?

A Post-disaster NASA Image



Why all this in Nepal?

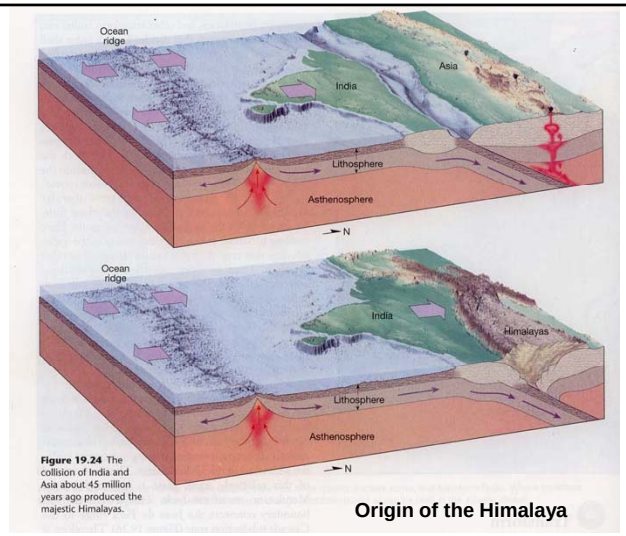
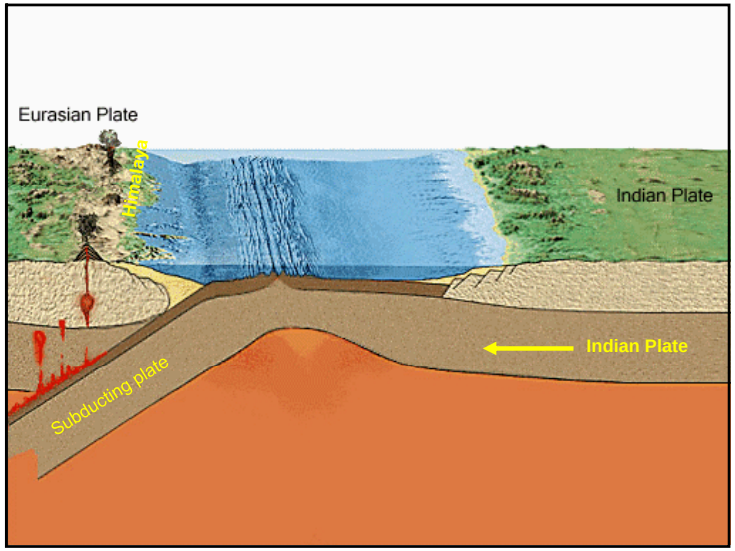
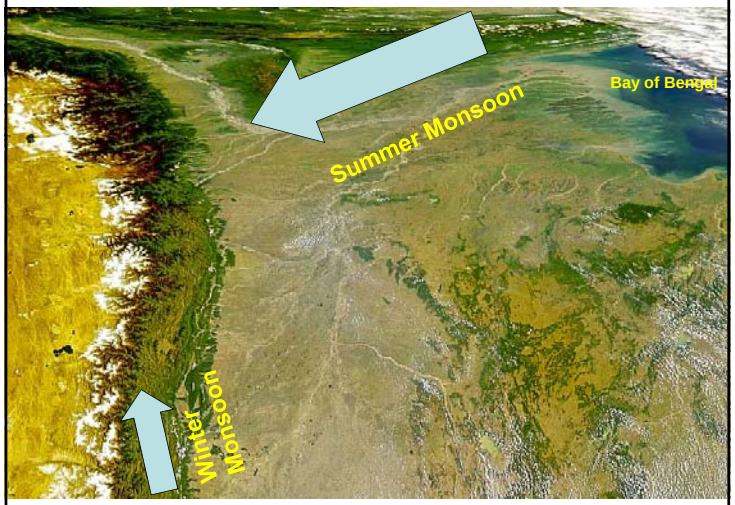


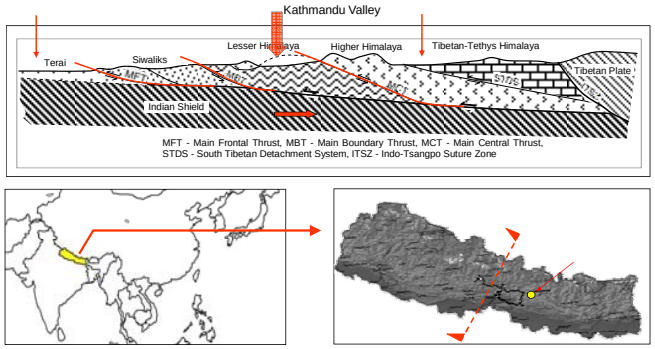
Figure 19.24 The collision of India and Asia about 45 million years ago produced the majestic Himalayas.

Origin of the Himalaya

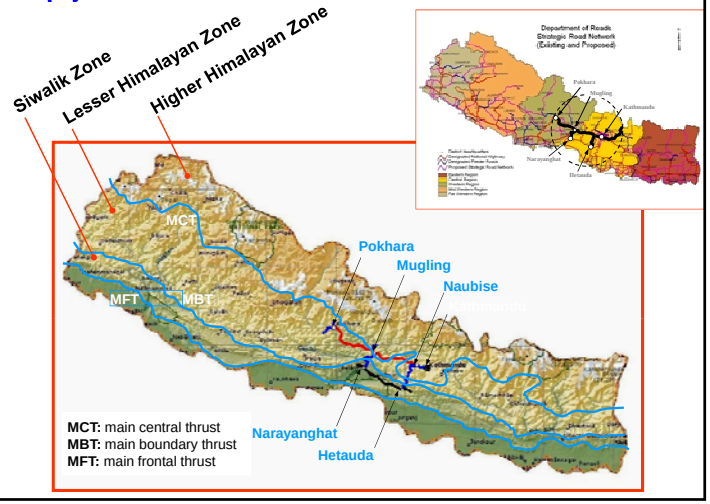




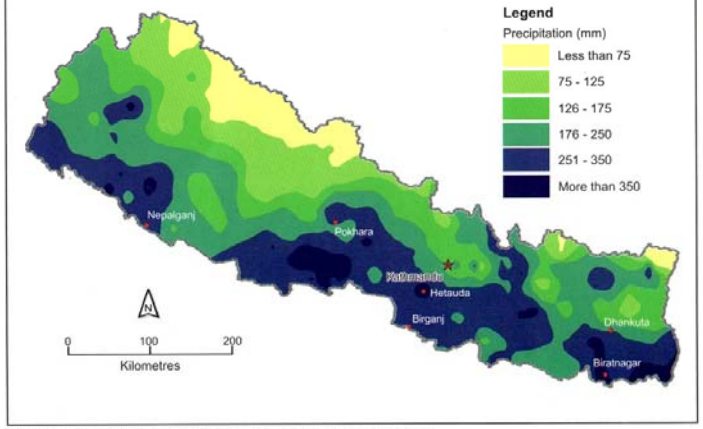
Generalized cross section of Himalayas across mid Nepal showing major thrust planes and continental subduction



Geophysical Division and Tectonic Thrust Lines

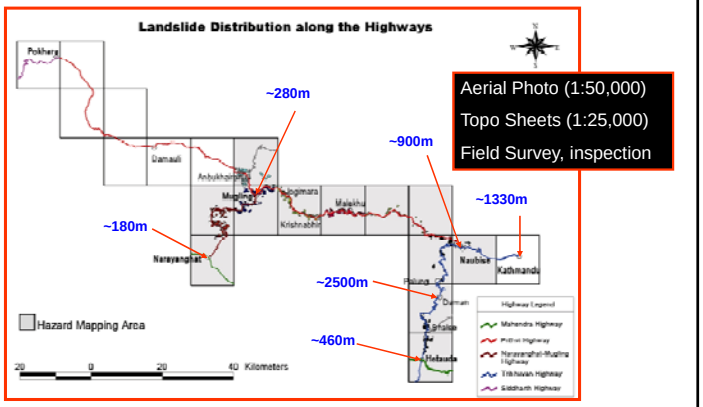


NEPAL: Highest 24 Hour Precipitation

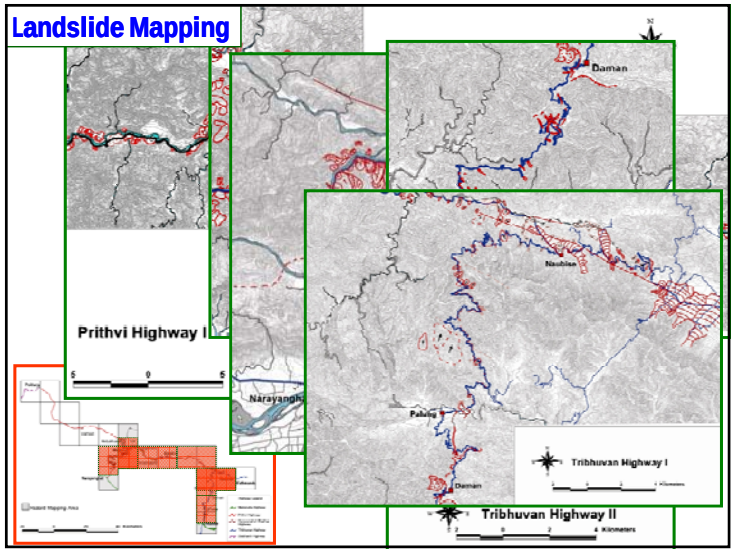


Sourc: ICIMOD, 1996. Climatic and Hydrological Atlas of Nepal. Kathmandu: ICIMOD

Roadside Landslide Hazard Mapping

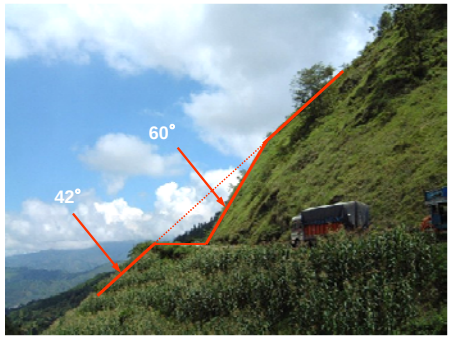


Landslide Mapping

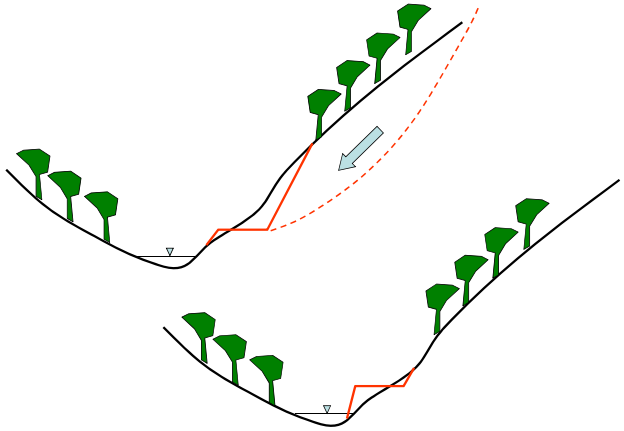


A TYPICAL EXAMPLE OF MAKING NATURAL SLOPES PRONE TO FAILURE

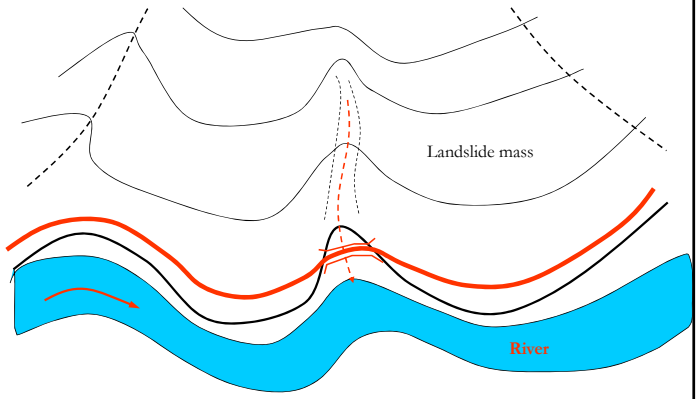
(Common Practice in Road Construction)



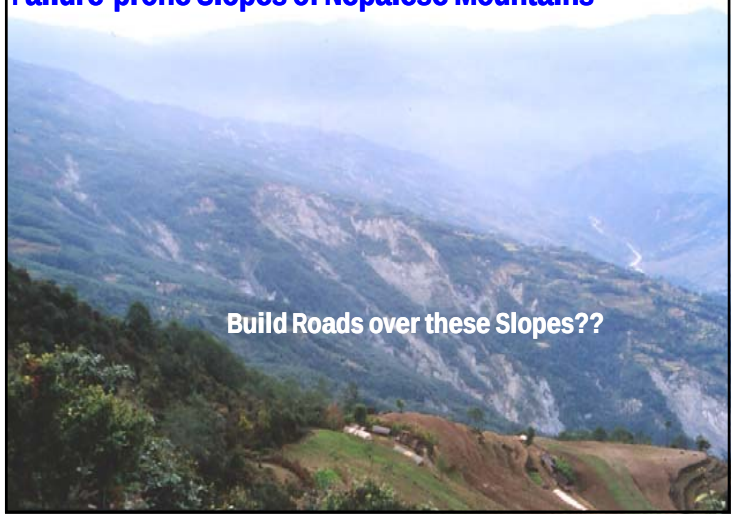
Road Building: Slope Cutting, River Bank Encroachment



Building Roads over Landslide Mass



Failure-prone Slopes of Nepalese Mountains



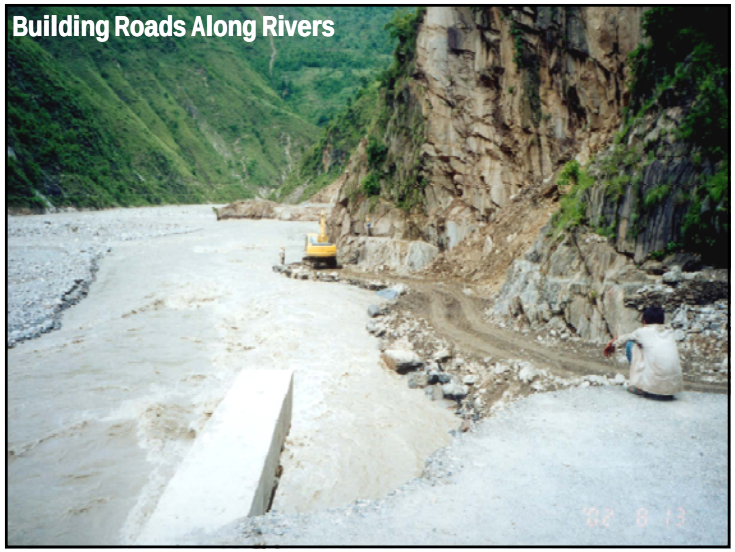
Typical Road Alignment on Nepalese Mountains

A series of landslide on the left bank of the Bhotekoshi River. Location: north of Barabishe near Daklang

Building Roads Along Rivers (Encroaching River Bank)

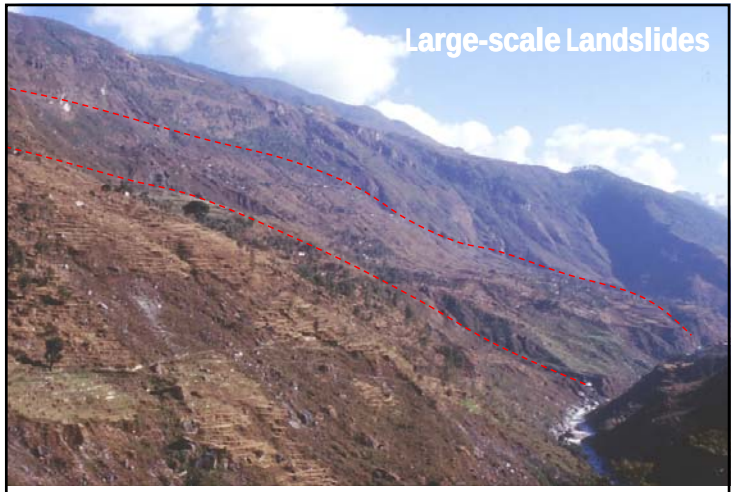
Banepa-Sindhuli Highway

Building Roads Along Rivers



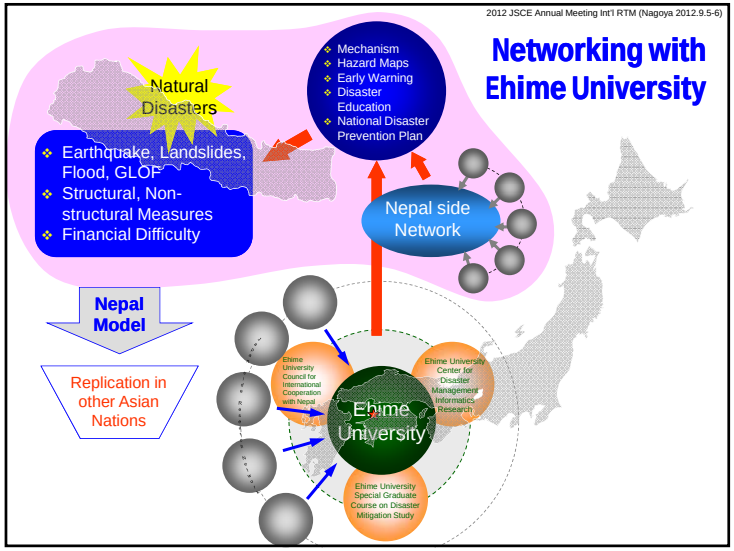
Building Roads Along Rivers

Large-scale Landslides

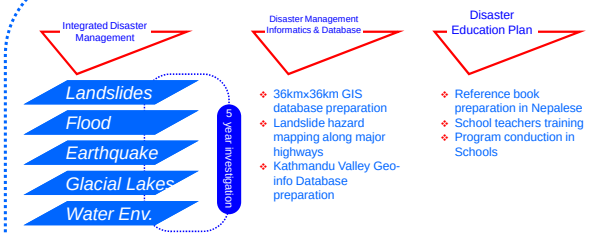


Landslide on the right bank of the Bhotekoshi River.
Location: north of Barabise

Networking with Ehime University



Integrated Disaster Mitigation Plan



Method

- ☐ International Students (Master, Doctor), Visiting Research Fellows
- ☐ Field Survey (Investigation)
- ☐ Research Meetings (Symposiums, Conferences, Seminars, Talk Programs, etc.)
- ☐ Collaborative Programs with Government and Non-Government Agencies
- ☐ Contribution to State Disaster Plan

Research Base Consolidation in Nepal (2001 onwards)

- 10-year investigation with the support of Japan Government
- 12-time international seminars and conferences including institutional and individual network building
- Four-time Letters of Appreciation from Nepal Government
- Memorandum of Understanding with five major Nepalese Academic Institutions
- Placement of Ehime University Satellite Office in Kathmandu (2006.5)
- Beginning of Special Graduate Course on Disaster Prevention Study at Ehime University (2007.10)
- Joint programs with Japanese University Alumni (JUAAN) in Nepal (more than 200 members)
- Collaborative research initiatives with Nepal Engineering College (focusing on Landslides and Earthquake)
- Beginning of Master Course in Disaster Management with Nepal Engineering College (talks in progress)
- Many-time Nepal programs at Ehime University

MOU Signing Ceremony (2006.5.28)

Satellite Office Launching Ceremony (2006.5.28)

Reporting of the Activities to Nepal Government

Environment Minister participating in an International Conference

Education Minister participating in a Seminar with JU Alumni

Media Support

NTV programs on landslide issues in Nepal

Achievements

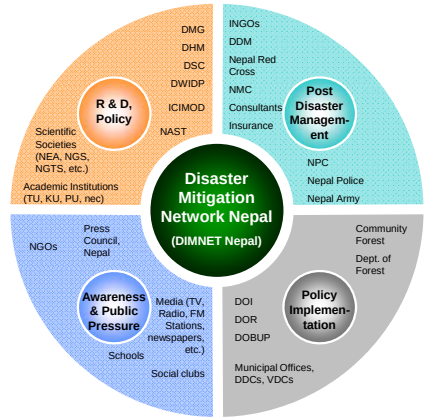
Books・Proceedings: 10

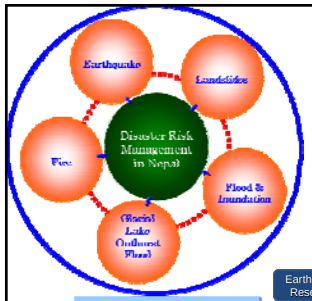
Research papers : About 30

Appreciation Letters (DG, DOR, Nepal)

Planned Network for Integrated Disaster Management in Nepal

DMG: Department of Mines and Geology
DHM: Department of Hydrology and Meteorology
DSC: Department of Soil Conservation
DWIDP: Department of Water Induced Disaster Prevention
ICIMOD: Int'l Center for Integrated Moutnain Development
NAST: Nepal Academy of Science and Technology
NEA: Nepal Engineers' Association
NGS: Nepal Geological Society
NGTS: Nepal Geotechnical Society
TU: Tribhuvan University
KU: Kathmandu University
PU: Pokhara University
nec: Nepal Engineering College
NGOs: Non-Governmental Organizations
INGOs: International Non-Governmental Organizations
DDM: Department of Disaster Management
NMC: Nepal Medical Council
NPC:
DOI: Department of Irrigation
DOR: Department of Roads
DOBUP: Department of Buildings and Urban Planning





Research Plan

Proposed Fields of Research

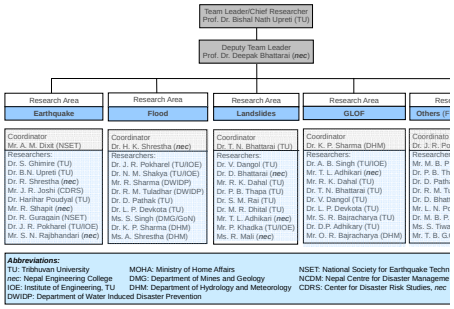
Earthquake Research	Landslide Research	Flood Research	GLOF Research	Fire/ Training/ Demonstration
• MFT Trench Investigation • KTM Valley ground dynamics • KTM Valley ground modeling • Earthquake acceleration measurement in KTM Valley lake deposit • Liquefaction potential of Kathmandu sands	• Landslide mechanism (field measurement, stability analysis) • Landslide hazard mapping, basic data collection • Aerial photo based landslide topography identification	• Flood data collection and analysis • Basic measurements and data acquisition from radar • Flood model analysis	• Field measurement system development • Development of glacial moraine deposit failure analysis • Modeling of flow mechanism	• Develop appropriate technology for fire resistance in traditional thatched roofed house in Terai • Live demonstration for public awareness • Community based trainings • Teacher's training

Development of database for various disasters
Development of hazard assessment methodology
Development of Appropriate Technology, Manuals

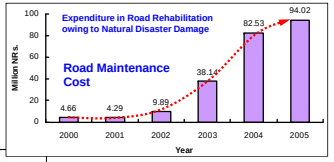
Nepal side Project Plan and Partners

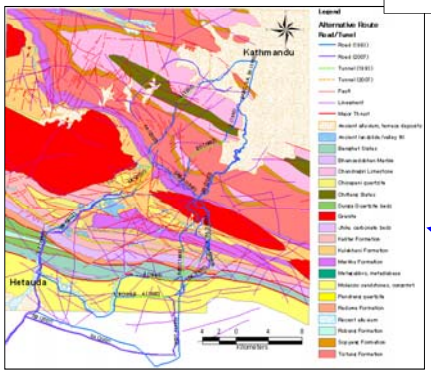
S. N	Institution	Fields of Activities					
		Landslide	Flood	Earthquake	GLOF	Fire	Training/Others
1	Department of Geology/TU	●	●	●	●		●
2	Nepal Engineering College	●	●	●			●
3	Center for Disaster Studies/TU	●	●	●		●	●
4	Department of Hydrology and Meteorology	●	●		●		●
5	Ministry of Home Affairs	●	●	●	●	●	●
6	National Society for Earthquake Technology-Nepal			●			●
7	Nepal Centre for Disaster Management	●	●	●		●	●

Organogram of the Proposed Research Project (Nepal-side)

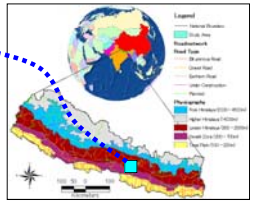


Ongoing Work

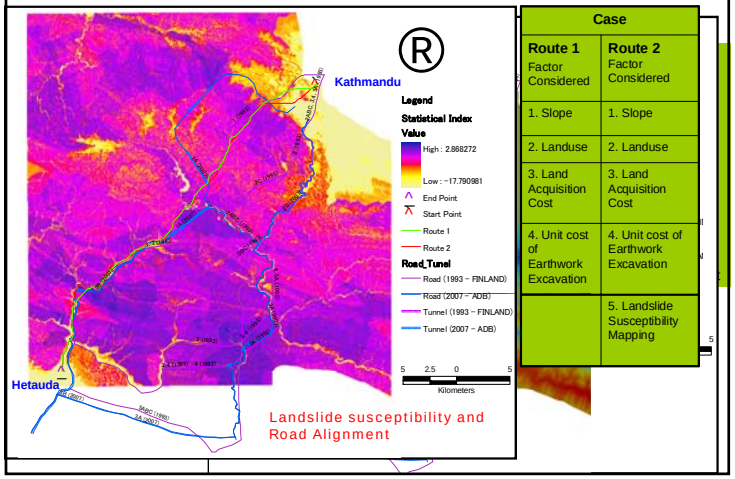




Previous Investigations and plans:
1991: JICA
1992: SWISS
1993: FINLAND
2007: ADB

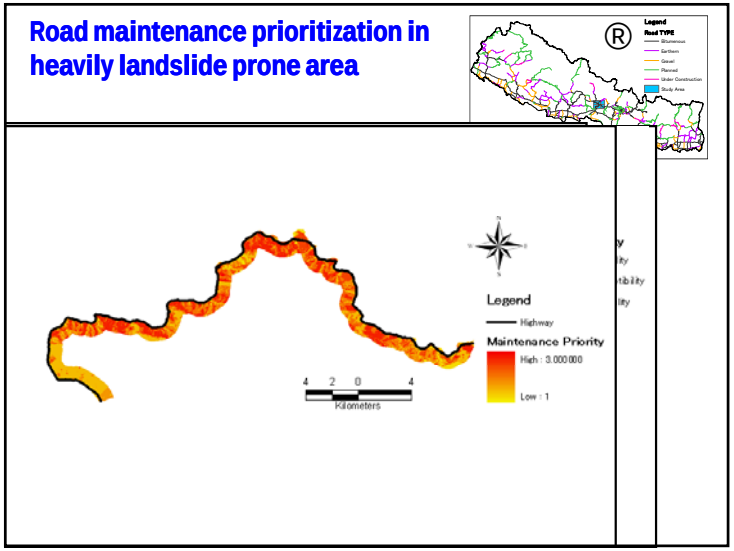


Highway Route Selection in Landslide Susceptible Area

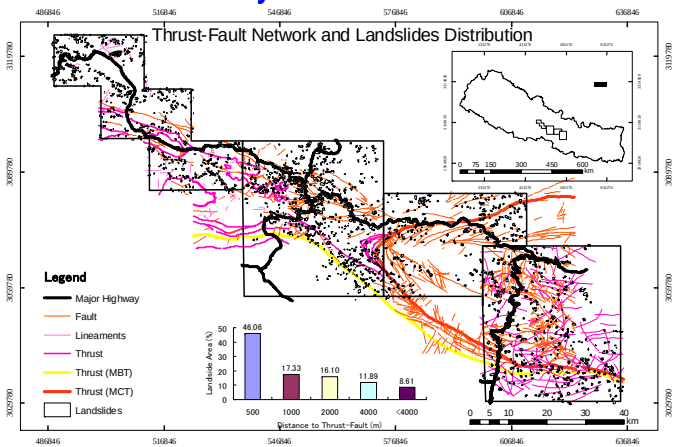


Case	
Route 1 Factor Considered	**Route 2** Factor Considered
1. Slope	1. Slope
2. Landuse	2. Landuse
3. Land Acquisition Cost	3. Land Acquisition Cost
4. Unit cost of Earthwork Excavation	4. Unit cost of Earthwork Excavation
	5. Landslide Susceptibility Mapping

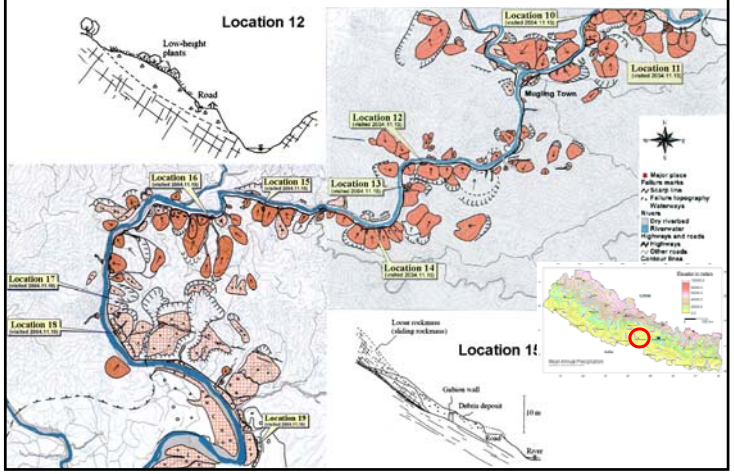
Road maintenance prioritization in heavily landslide prone area

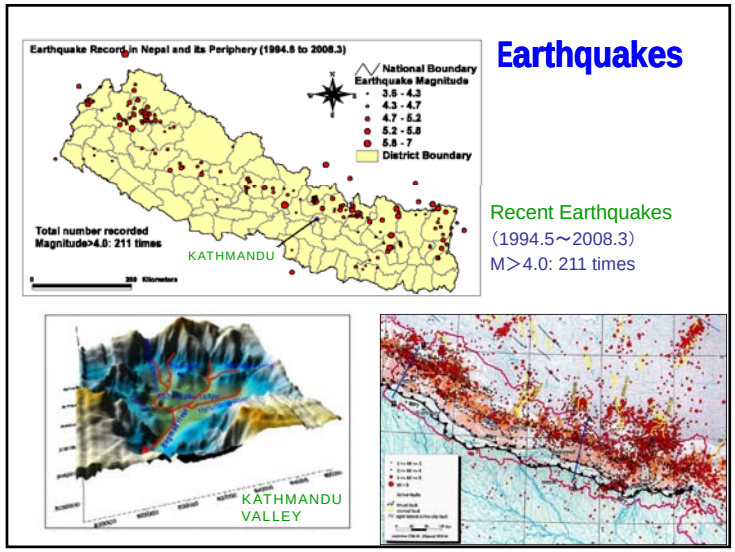


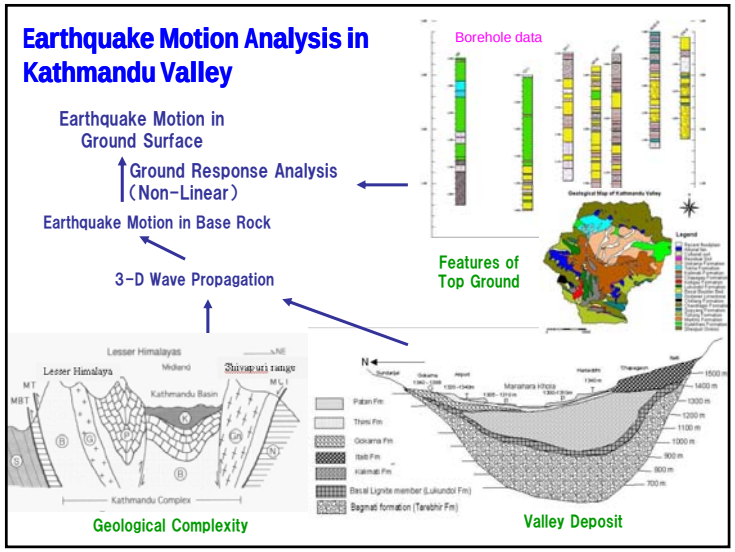
Landslide Hazard Analysis

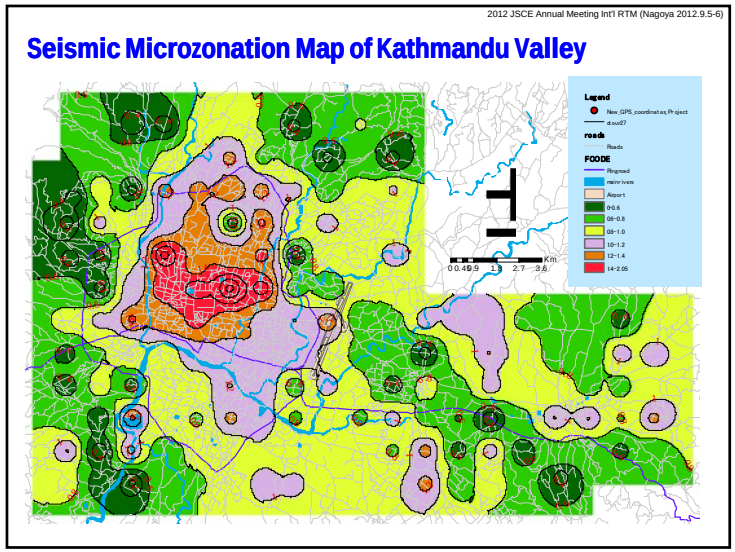


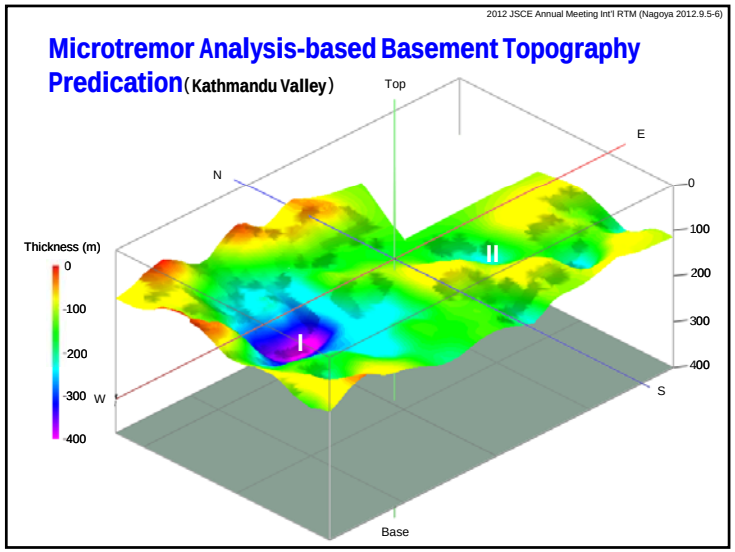
Landslide Hazard Analysis




Earthquake Record in Nepal and its Periphery (1984.5 to 2008.3)
National Boundary
Earthquake Magnitude
3.5 - 4.3
4.3 - 4.7
4.7 - 5.2
5.2 - 5.8
5.8 - 7
District Boundary
Total number recorded
Magnitude>4.0: 211 times
KATHMANDU
Earthquakes
Recent Earthquakes
(1994.5～2008.3)
M>4.0: 211 times
KATHMANDU
VALLEY


Earthquake Motion Analysis in Kathmandu Valley
Borehole data
Earthquake Motion in Ground Surface
Ground Response Analysis (Non-Linear)
Earthquake Motion in Base Rock
3-D Wave Propagation
Features of Top Ground
Lesser Himalayas
Lesser Himalaya
Siwaliks
Kathmandu Basin
Kathmandu Complex
Geological Complexity
Valley Deposit


2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
Seismic Microzonation Map of Kathmandu Valley
Legend
roads
FOODE
Km


2012 JSCE Annual Meeting Int'l RTM (Nagoya 2012.9.5-6)
Microtremor Analysis-based Basement Topography Predication (Kathmandu Valley)
Top
Base
N
E
S
W
Thickness (m)
0
100
200
300
400
I
II