Hazards Its Vulnerability in Central & Eastern Himalayas& its Response in Sikkim

Presented By:

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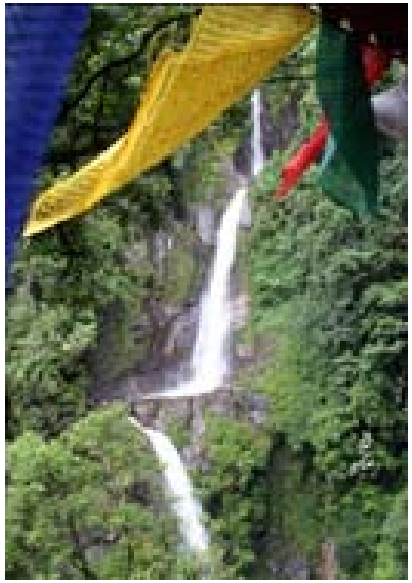
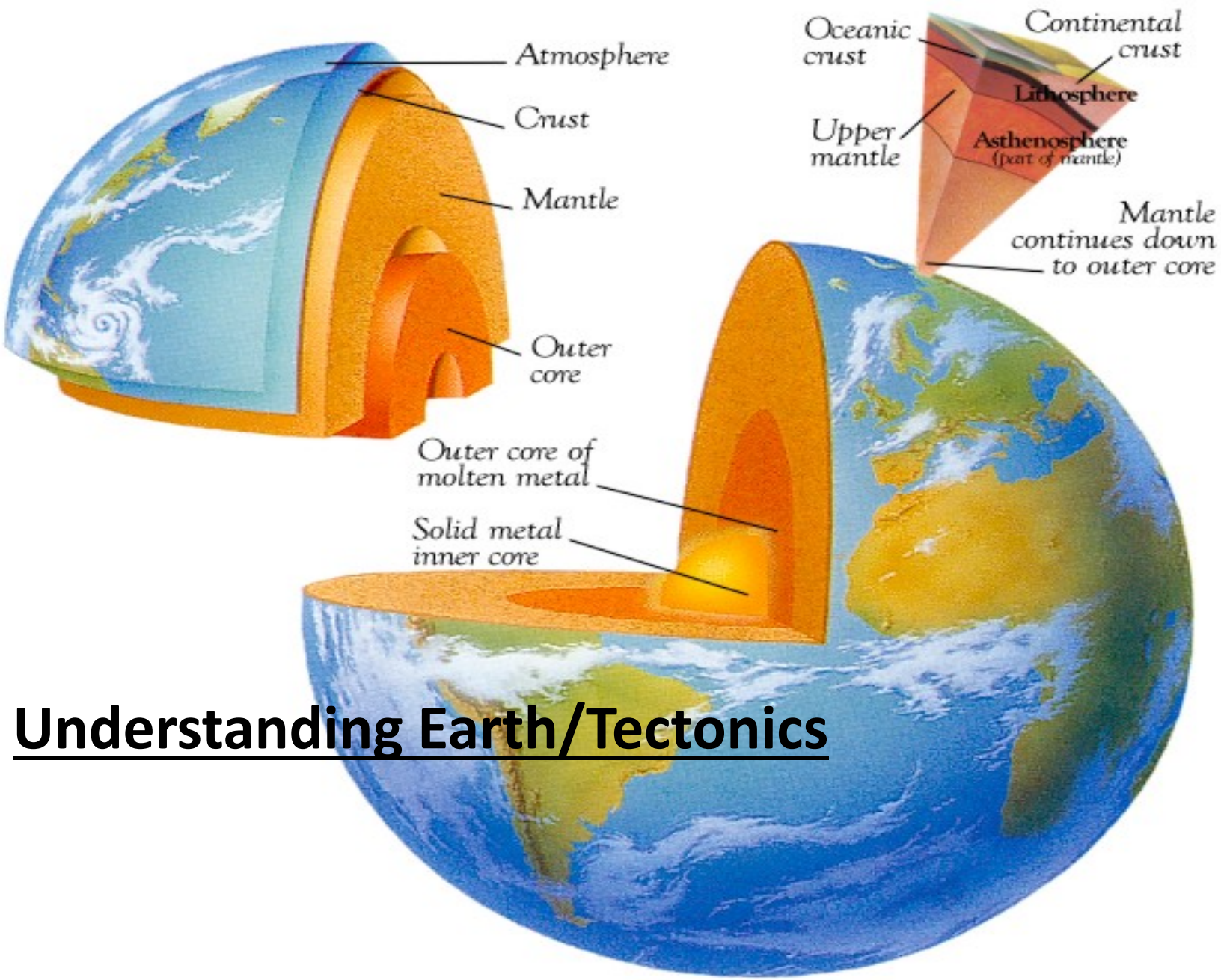
Sikkim State Disaster Management Authority, Govt. Of Sikkim.

SIKKIM,INDIA	
GEOGRAPHICAL AREA	7096 Sq.KM.
POPULATION (2011 CENCUS)	6.07 LAKHS
DISTRICTS	04 (EAST, WEST , NORTH & SOUTH)
MAIN DRAINAGES	TISTA , RANGHIT & ITS TRIBUTARIES
FOREST COVER	43% of the total area.
GEOGRAPHICAL LOCATION	27^0 00’46” to 28^0 07’48” N latitude & 88^0 00’58” to 88^0 55’25” E Longitude
ECONOMY	MAINLY TOURISM, CASH CROPS, HYDEL POWER PROJECT, Becoming an Organic province in India
LITERACY RATE(2001 CENCUS)	82%

IMPORTANT PEAKS OF SIKKIM

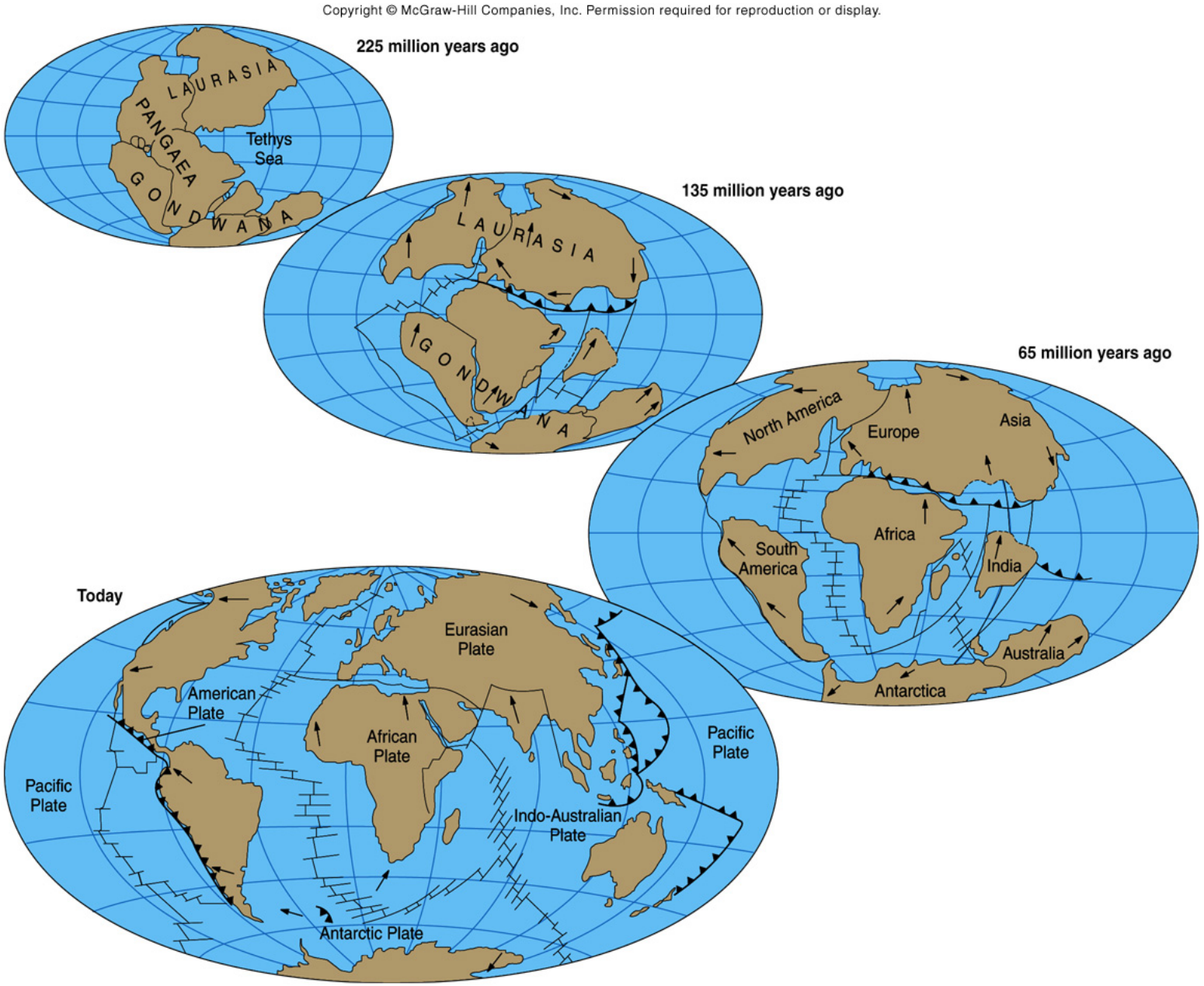
➢ Mt.Kanchendzonga	28208 ft.
➢ Mt.Kabru	24215 ft.
➢ Mt.Talung	24200 ft.
➢ Mt.Siniolchu	22600 ft.
➢ Mt.Simvo	22476 ft.
➢ Mt.Pandim	22100 ft.
➢ Mt.Rathong	22100 ft.
➢ Mt. Paunhri	22000 ft.
➢ Mt.Kokthang	20162 ft.
➢ Mt.Lamaongden	19366 ft.
➢ Mt.Masunyange	19300 ft.



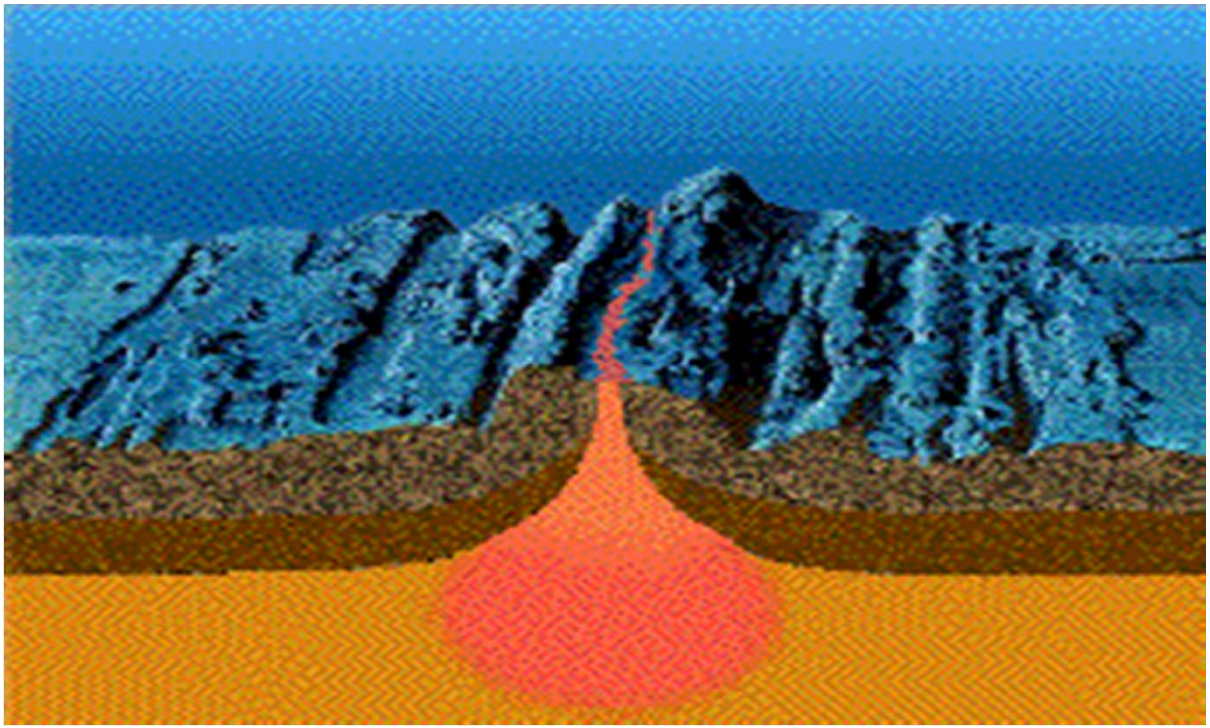


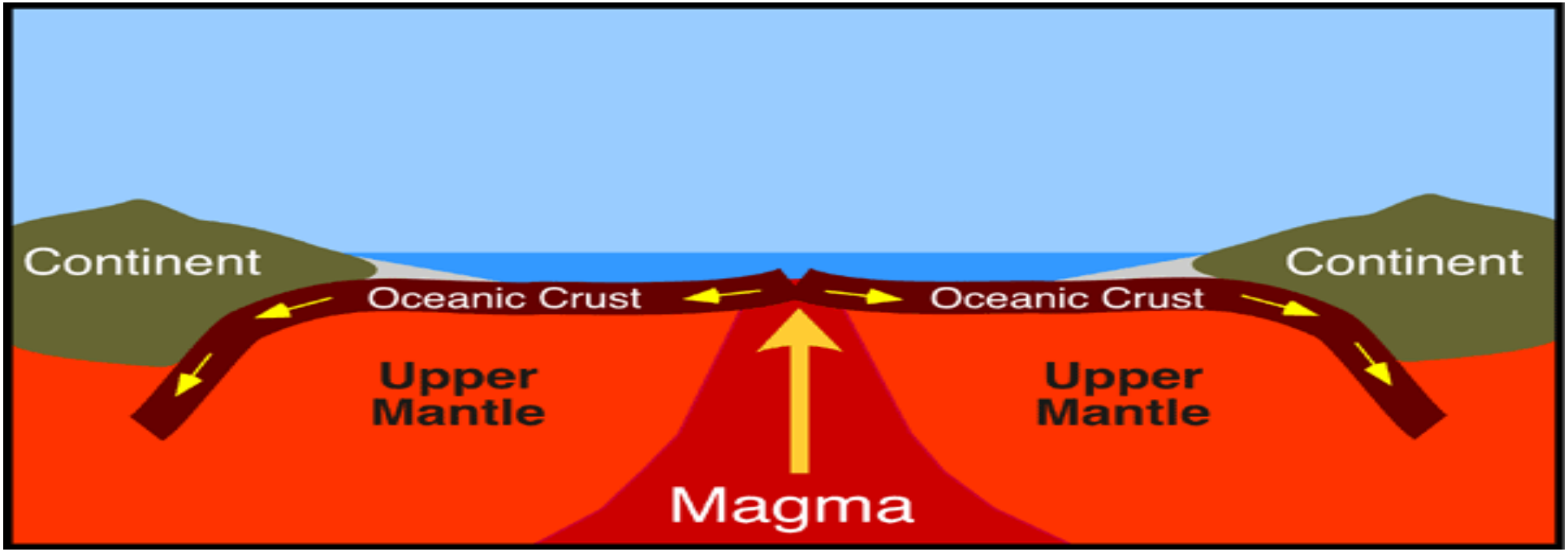
Understanding Earth/Tectonics

Break-up of Supercontinent Pangaea

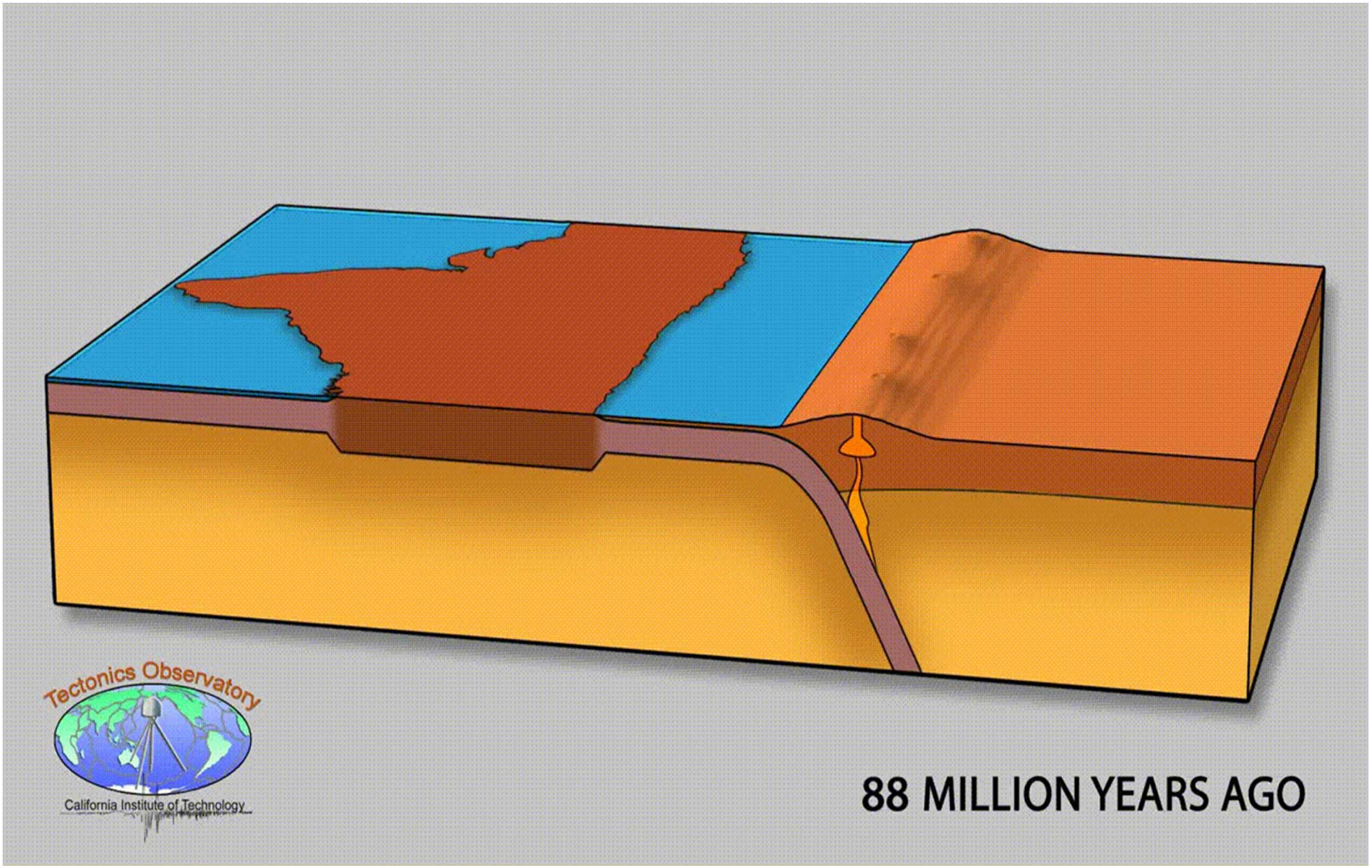


Mid-Oceanic Ridges





Mountain Building Process

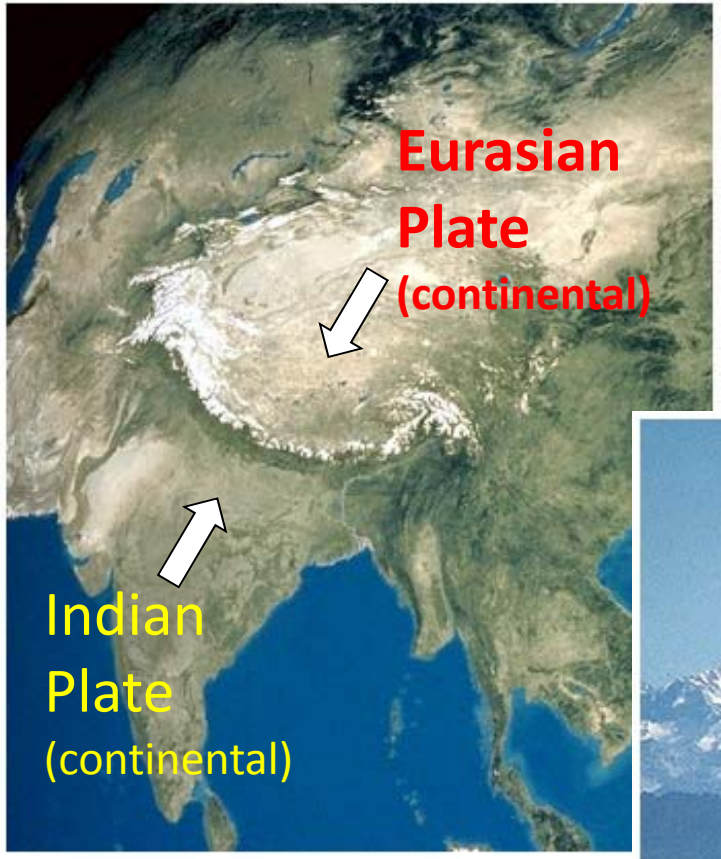


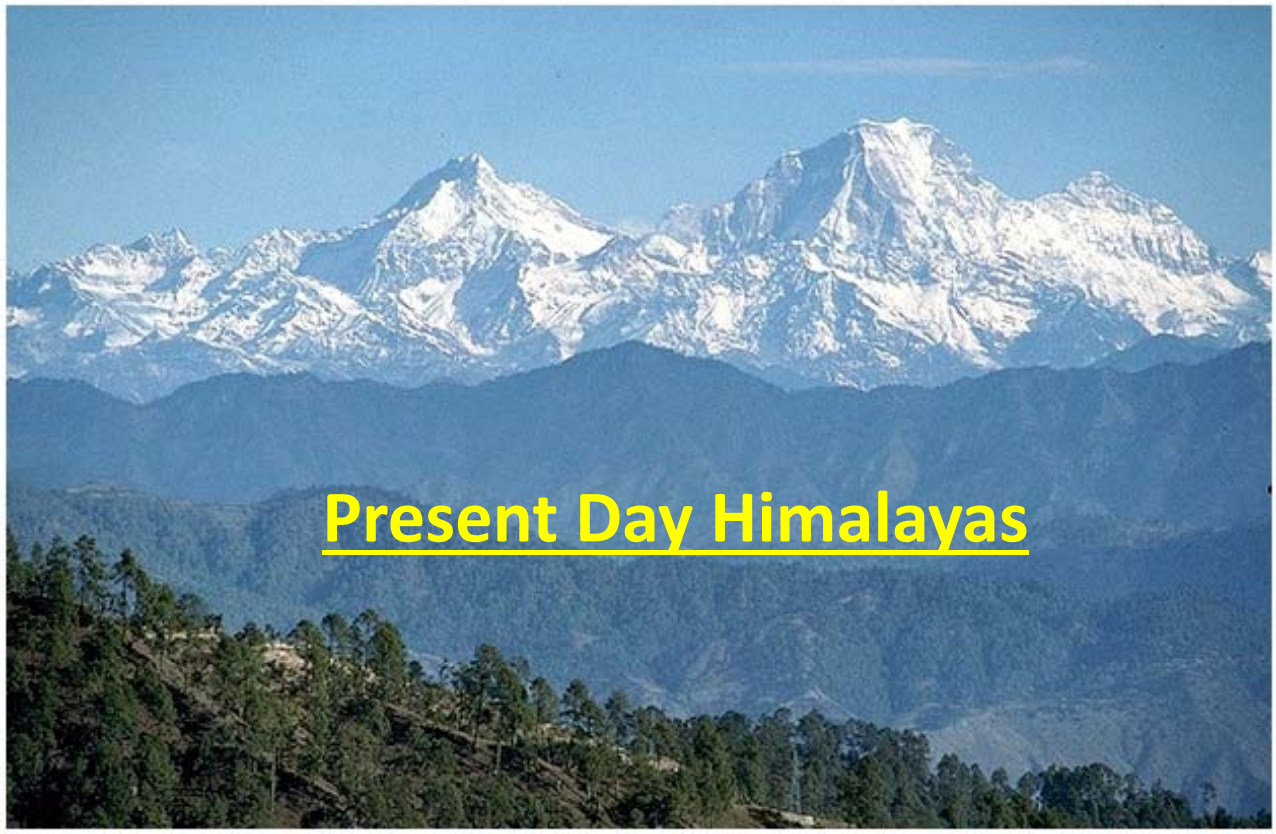
Movement of Indian Plate towards Eurasian Plates

Recommendations

Uplift of Himalaya Mountains and Tibetan Plateau

35 million years ago.





STROMATOLITIC DOLOMITE TERRAIN BEING DEVELOPED AS A GEO-TOURISM SITE, MAMLEY, SOUTH SIKKIM

The Chief Minister inspecting the site for Geo-tourism at Mamley

Disasters affecting Sikkim

- ✓ Landslide Hazards
- ✓ Earthquake Hazards
- ✓Flash Flood/Clouds burst/Hail storm
- ✓ Fire Hazards
- ✓Snow and Avalanches
- ✓ Drought Hazards
- ✓Riots / Stampede

Summary of Some Of The Major Occurrence of Disaster in Sikkim (Landslides/Flashflood)

Year	Location	Cause	No. of deceased	No. Of injured	Remarks
1983	Sikkim	Landslide	63 person dead.	---	Manul, North Sikkim
1995	Sikkim	Landslide	32 persons dead, 8 houses completely damaged.	---	Gangtok
1997	Sikkim	Landslide	43 lives lost , 1300 houses Fully / partially damaged.	---	Gangtok and vicinity
2000	Sikkim	Landslide	5 lives lost, 28 families evacuated.	---	Gyalshing, West Sikkim
2005	Sikkim	Landslide	7 lives lost, 28 families evacuated.	---	Mangzing, South Sikkim.
2011	Sikkim	Landslide	18 lives lost, 3 house fully damaged.	---	Gyalshing, West Sikkim.
2012	Sikkim	Landslide/ Flash Flood/ Rock falls	41 lives lost, 6 Missing and many houses were fully/ partially damaged	20 injured	Throughout Sikkim.

MAJOR CAUSES OF LANDSLIDES

- Weak geological, slope conditions
- Triggered due to rainfall
- Surface, sub-surface water movements
- Earthquakes
- Anthropogenic activities in form of cutting of unstable slopes

Landslide on North Sikkim Highway

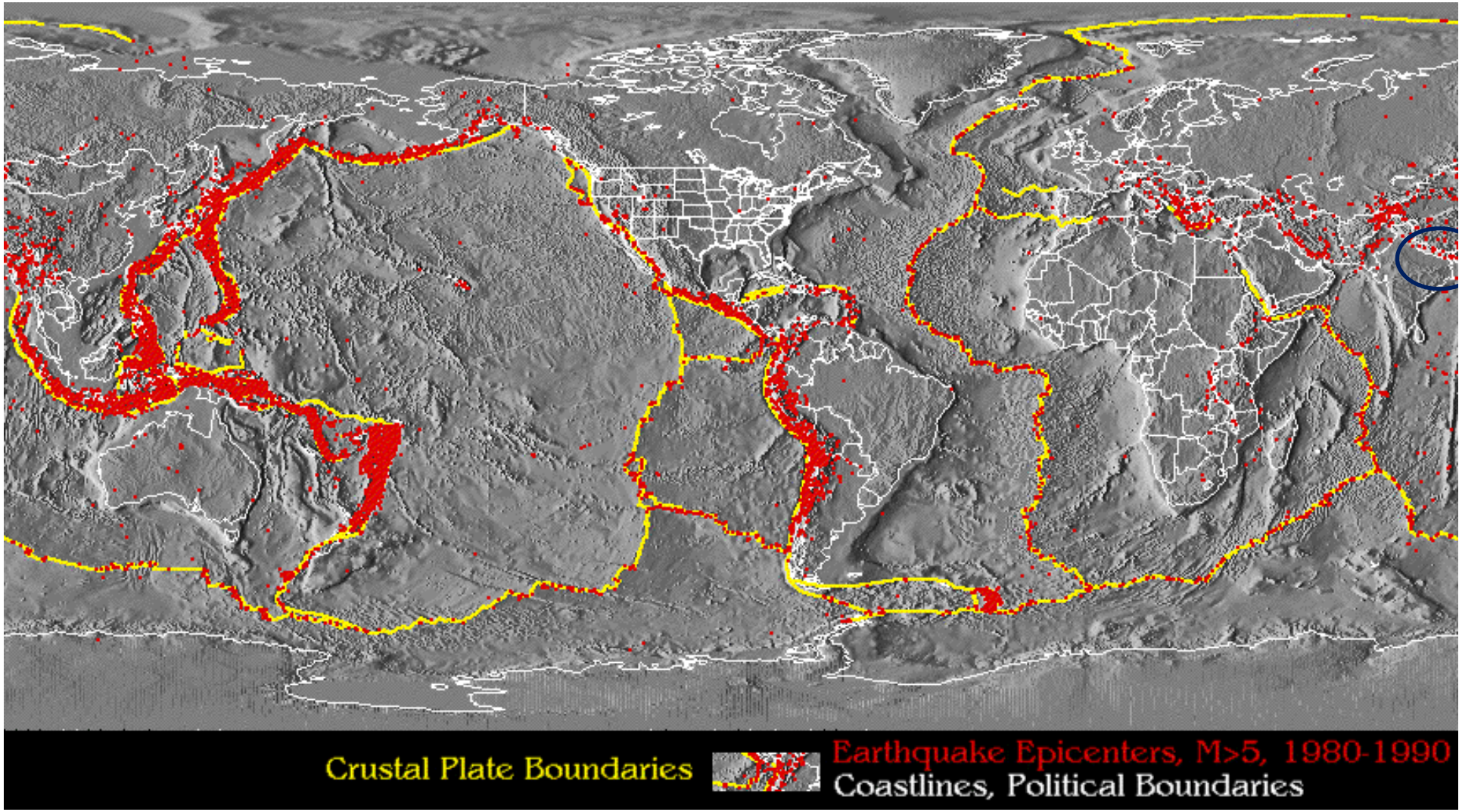
Wrong Selection of Sites

Jarong School area, South Sikkim

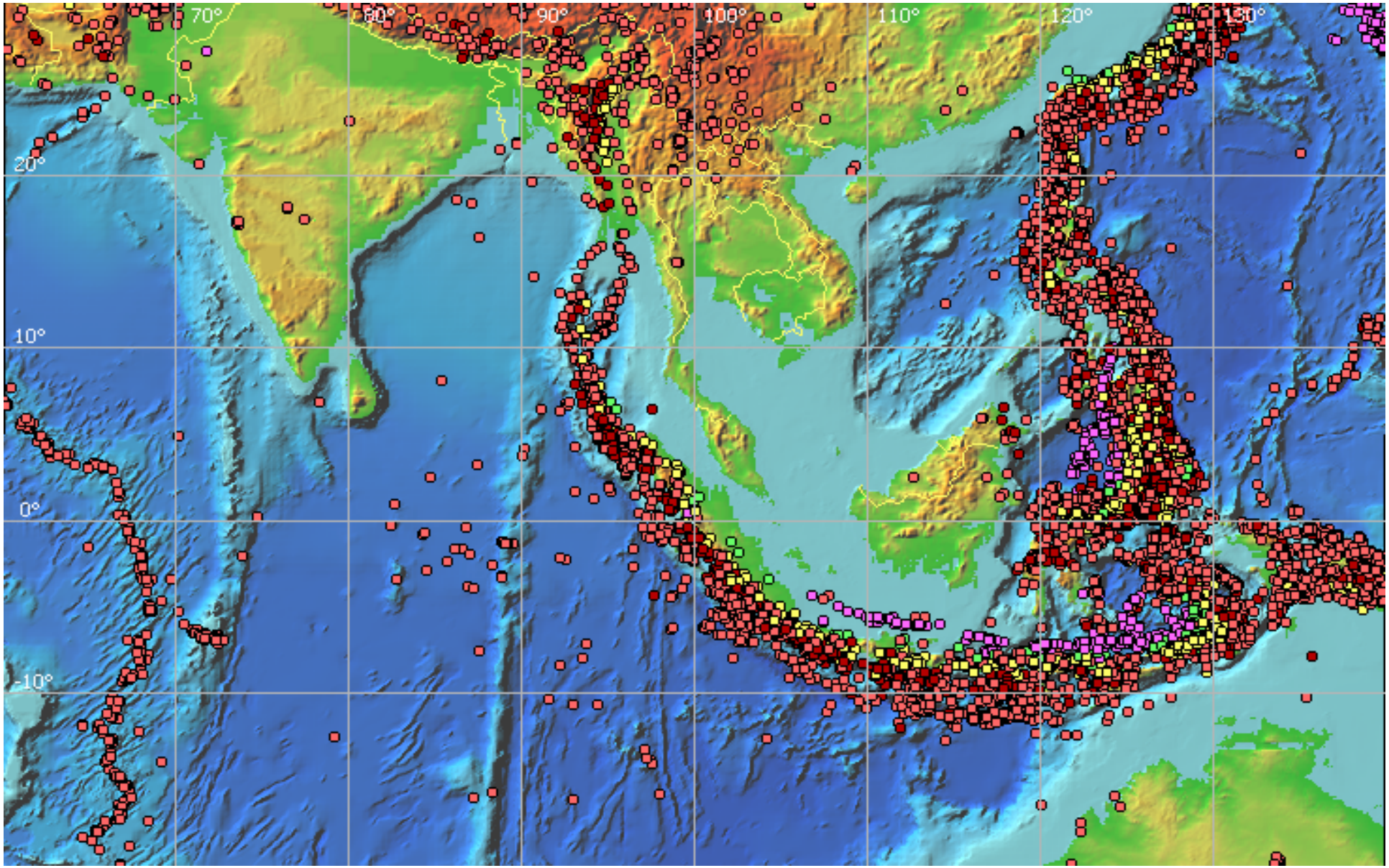

13th. MILE SUBSIDENCE ZONE
J.N.ROAD, EAST SIKKIM
08.11.2009

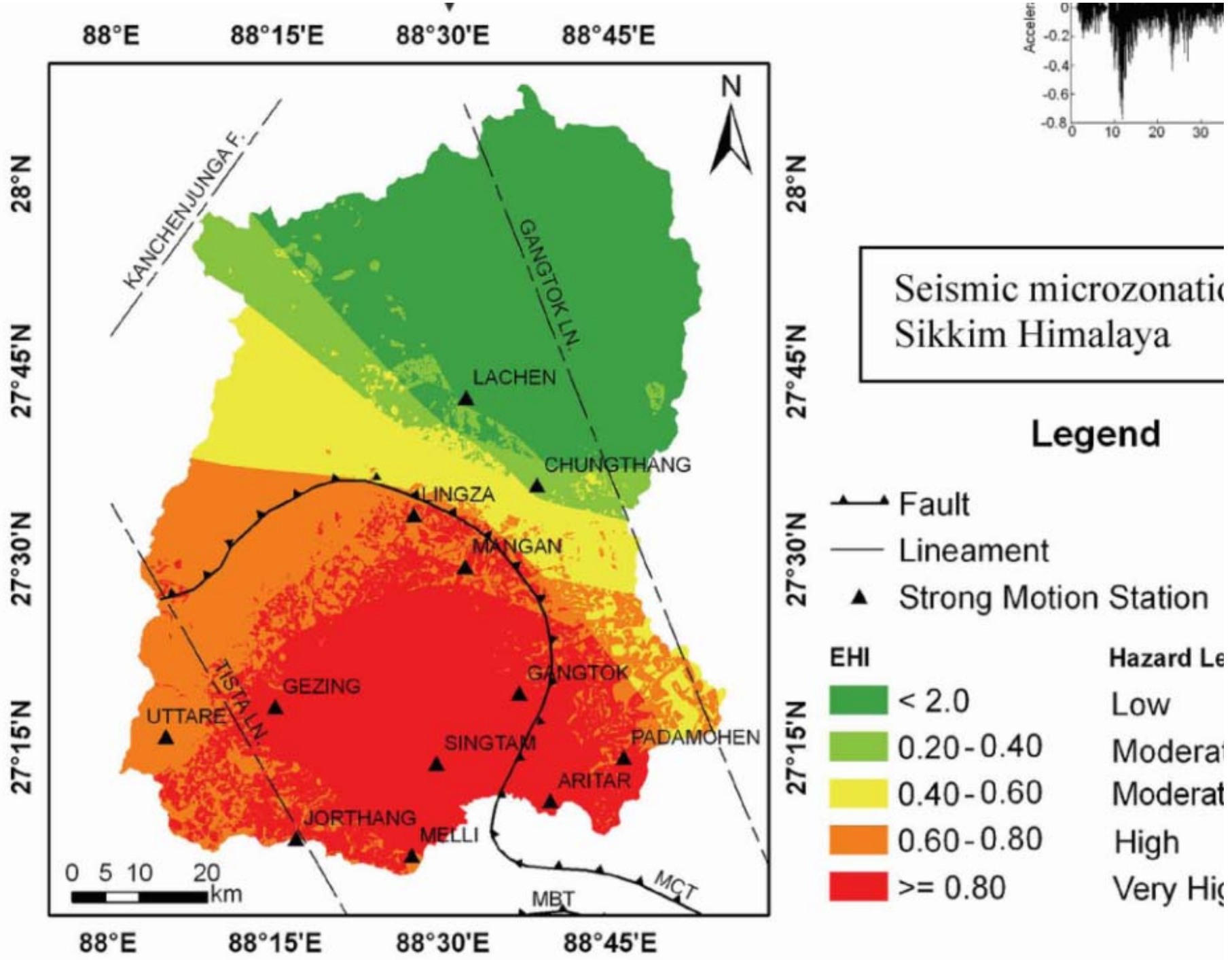

FLASH FLOOD NEAR MAKHA
EAST SIKKIM
14.06.2009

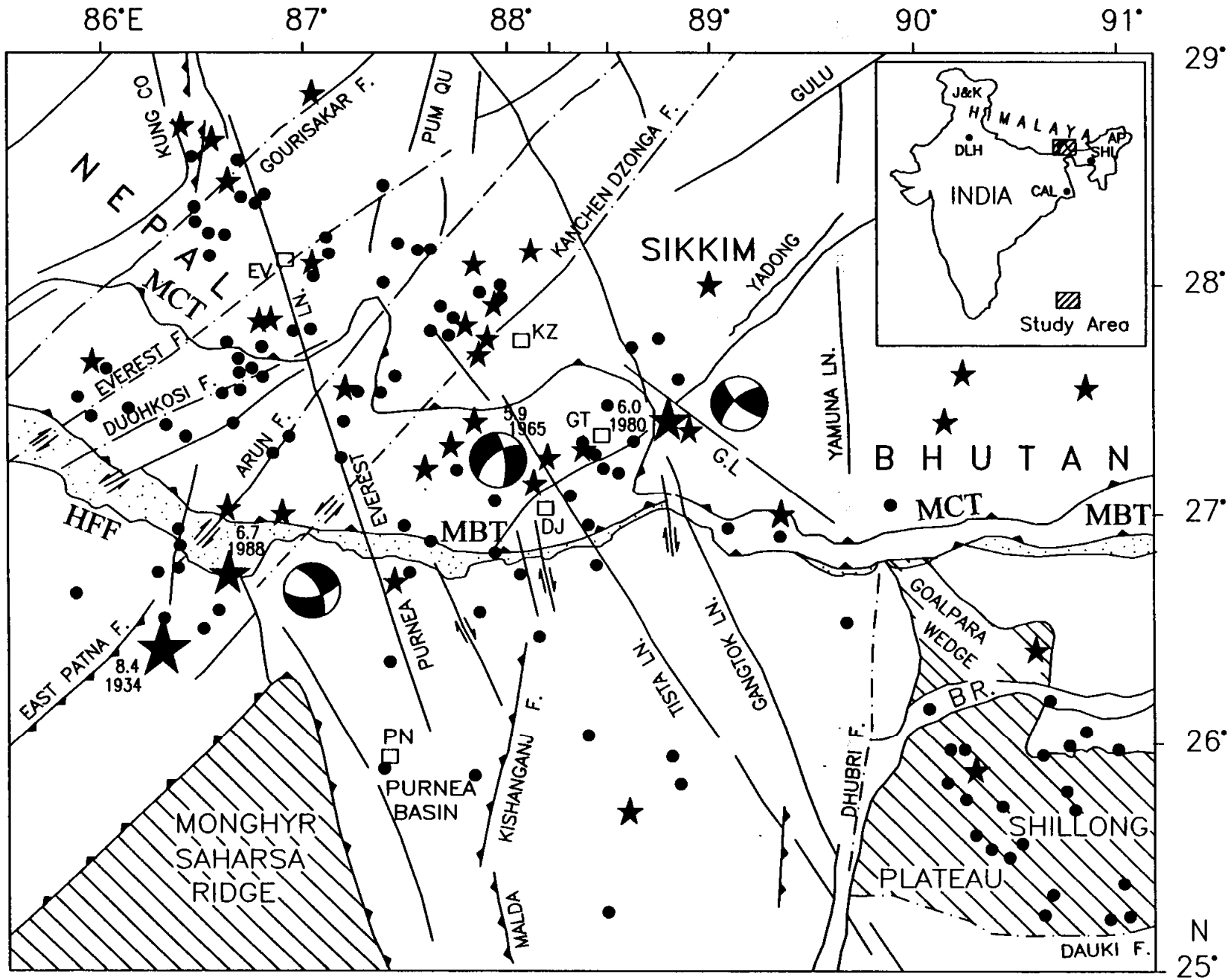
Most of the Epicenters of the Earthquakes are along the plate boundaries.



Distribution of epicenters of earthquakes greater than magnitude 5.0 for the period 1976-2000, South East Asia and Indian Ocean




88°E
88°15'E
88°30'E
88°45'E
28°N
27°45'N
27°30'N
27°15'N
N
KANCHENJUNGA F.
GANGTOK LN.
TISTA LN.
MCT
MBT
LACHEN
CHUNGTHANG
LINGZA
MANGAN
GEZING
GANGTOK
UTTARE
SINGTAM
PADAMOHEN
ARITAR
JORTHANG
MELLI
0 5 10 20
km
Seismic microzonatio
Sikkim Himalaya
Legend
Fault
Lineament
Strong Motion Station
EHI
Hazard Le
< 2.0
Low
0.20 - 0.40
Moderat
0.40 - 0.60
Moderat
0.60 - 0.80
High
>= 0.80
Very Hig


86°E
87°
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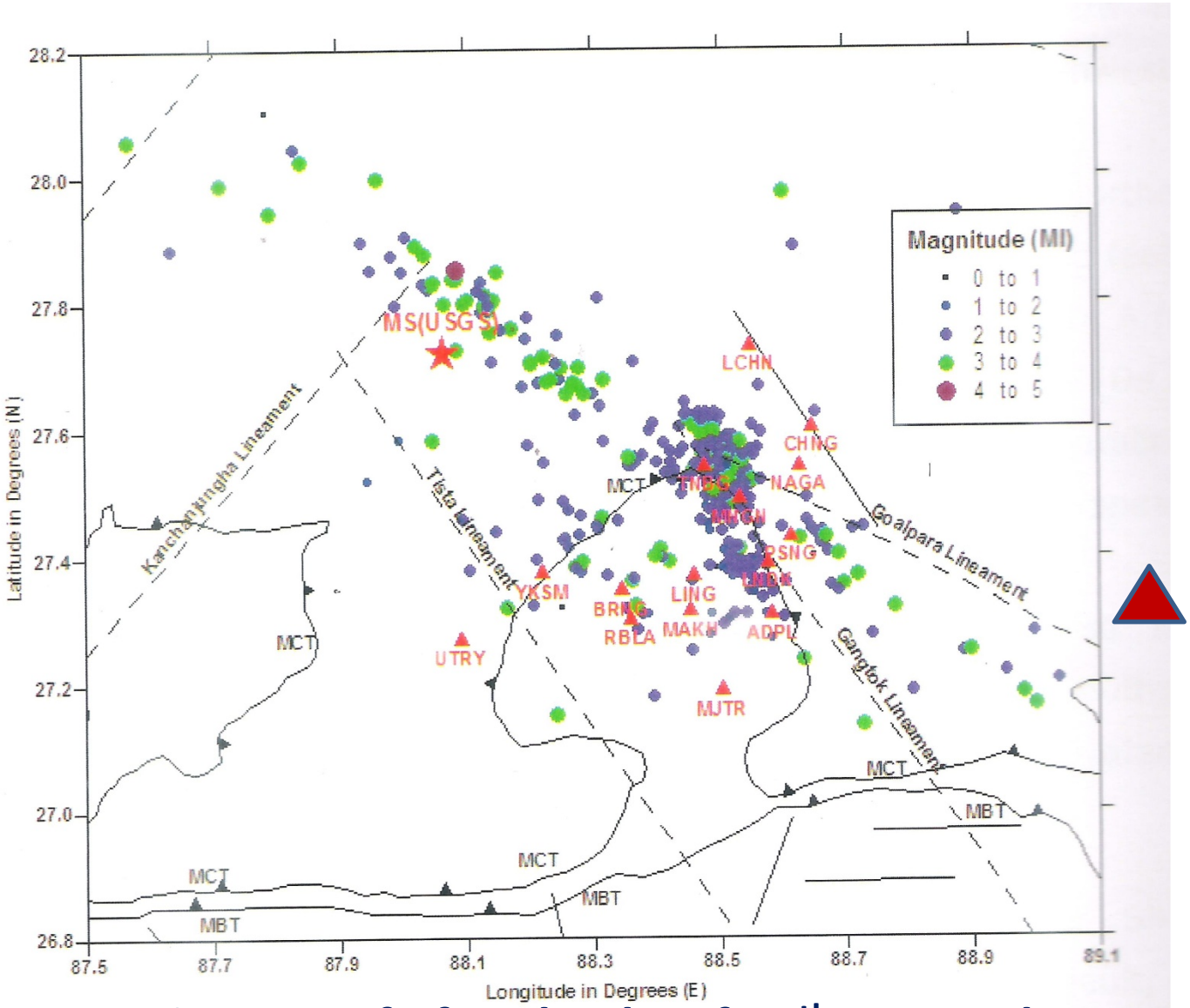
N
NEPAL
SIKKIM
BHUTAN
INDIA
J&K
HIMALAYA
DLH
AP
SHI
CAL
Study Area
KUNG CO
GOURISAKAR F.
PUM QU
KANCHEN DZONGA F.
GULU
YADONG
MCT
EV
LN
KZ
EVEREST F.
DUDHKOSI F.
ARUN F.
EVEREST
5.9
1965
GT
6.0
1980
G.L
YAMUNA LN.
HFF
6.7
1988
MBT
DJ
MCT
MBT
EAST PATNA F.
8.4
1934
PURNEA
TISTA LN.
GANGTOK LN.
GOALPARA
WEDGE
BR.
PN
PURNEA
BASIN
KISHANGANJ F.
DHUBRI F.
MONGHYR
SAHARSA
RIDGE
MALDA
SHILLONG
PLATEAU
DAUKI F.



Recording Stations

Epicentre of aftershocks of 18th September Earthquake

Source: GSI Report

Building collapse at Balwakhani, Gangtok in 18th September Earthquake

Building collapse at Lumsey, Gangtok in 18th September Earthquake.

Data showing the locations of recent Nepal earthquakes (main shock and its aftershock) Richter scale (5 and above)

Date	Time (UTC)	Latitude (deg.)	Longitude (deg.)	Depth (KM)	Magnitude	Region
25/04/2015	7:08:03	27.8°N	85.6°E	10	5	NEPAL
25/04/2015	7:47:01	27.9°N	85.5°E	10	5	NEPAL
25/04/2015	8:17:01	27.8°N	85.7°E	10	5	NEPAL
25/04/2015	8:29:28	28.1°N	84.8°E	20	5	NEPAL
25/04/2015	10:40:34	27.7°N	85.8°E	5	5	NEPAL
25/04/2015	12:44:05	28.1°N	84.5°E	10	5.3	NEPAL
25/04/2015	6:37:58	28.0°N	85.7°E	10	5.5	NEPAL
25/04/2015	8:20:48	27.6°N	84.9°E	10	5.6	NEPAL
25/04/2015	9:30:30	27.6°N	85.3°E	10	5.6	NEPAL
25/04/2015	17:42:52	28.2°N	85.8°E	10	5.6	NEPAL
25/04/2015	23:16:13	27.7°N	84.9°E	10	5.6	NEPAL
25/04/2015	6:56:35	28.0°N	85.7°E	10	5.7	NEPAL
25/04/2015	8:55:55	27.3°N	85.1°E	10	5.7	NEPAL
25/04/2015	6:45:20	28.1°N	84.8°E	10	6.6	NEPAL
25/04/2015	6:11:25	28.1°N	84.6°E	10	7.9	NEPAL
26/04/2015	7:26:03	27.7°N	85.8°E	10	5	NEPAL
26/04/2015	16:26:05	27.6°N	85.7°E	10	5.3	NEPAL
26/04/2015	7:09:08	27.6°N	85.9°E	10	6.9	NEPAL
27/04/2015	12:35:49	26.7°N	88.1°E	10	5.1	NEPAL - INDIA (WEST BENGAL)BORDER REGION
12/5/2015	8:06:06	27.6°N	86.1°E	10	5	NEPAL
12/5/2015	21:25:12	27.7°N	84.6°E	10	5.1	NEPAL
12/5/2015	7:34:23	27.6°N	86.2°E	15	5.4	NEPAL
12/5/2015	7:36:54	27.6°N	86.1°E	10	6.2	NEPAL
12/5/2015	7:05:19	27.7°N	86.0°E	10	7.3	NEPAL
15/05/2015	1:42:42	27.8°N	84.7°E	10	5	NEPAL

Forecast of August 6, 1988 Earthquake India – Myanmar boarder Region.

Earthquake parameters	Forecast	Occurrence
Epicenter	21ºN – 25½ºN 93ºE – 96ºE	25.116ºN 95.171ºE
Magnitude	8±1/2	7.3
Depth	100±40km	115km
Time	February 1986 – December 1990	August 6, 1988

The forecast match almost 80%

Source: Harsh K Gupta, Nature of Earthquake 2005

Approximate annual frequency of earthquake occurrence in the World

Descriptor	Magnitude	Annual Frequency in the World
Great	8 and higher	1
Major	7-7.9	18
Strong	6-6.9	120
Moderate	5-5.9	88
Light	4-4.9	6200
Minor	3-3.9	49000
Very minor (micro)	2 – 2.9	About 1000per day
Micro	1-1.9	About 8000 per day

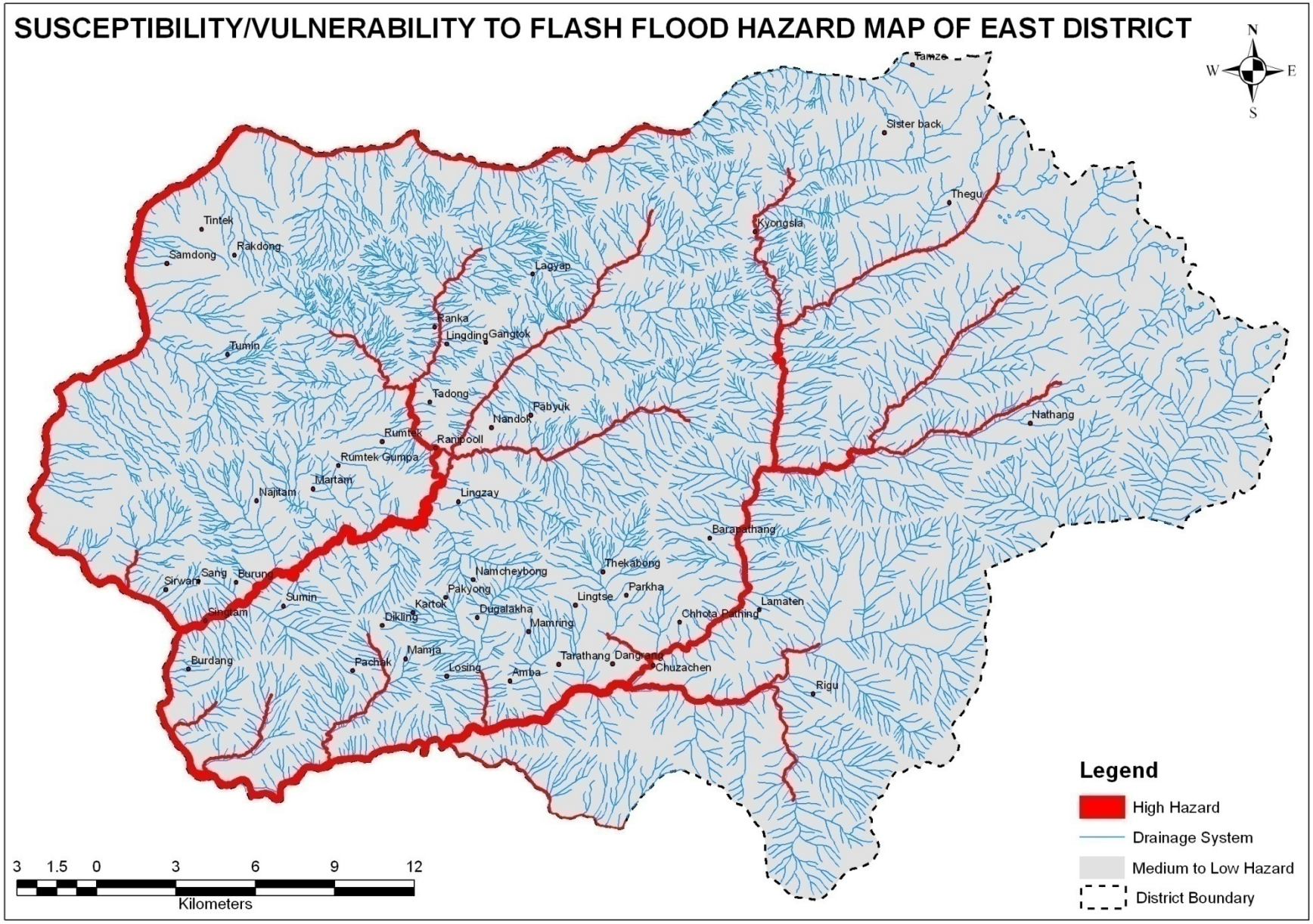
Source: Harsh K Gupta, Nature of Earthquake 2005

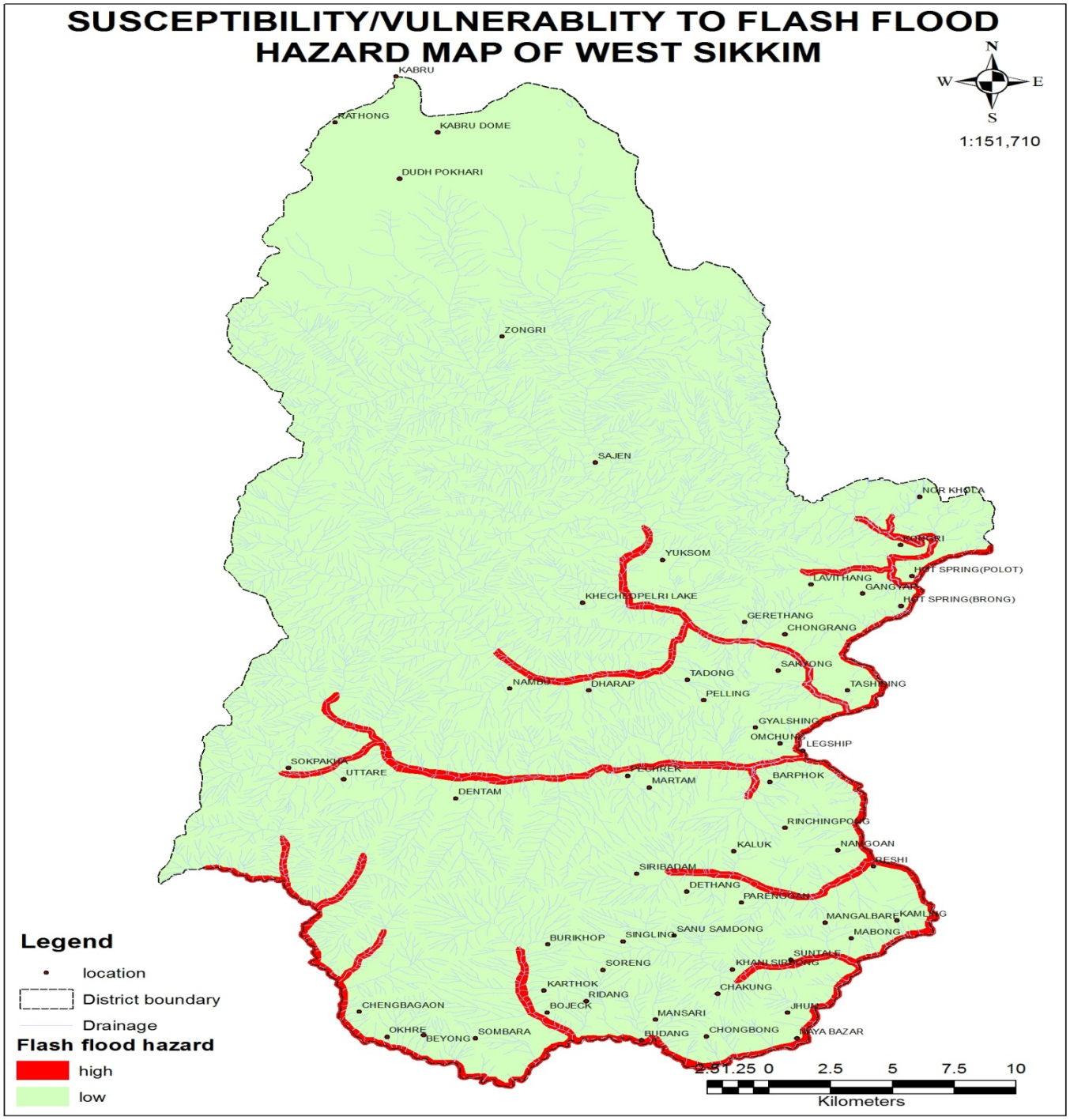
Estimates on Human Loss in case 1897 earthquake repeats

S.No	State	Injuries	Deaths
1.	Assam	≅ 40,00,000	≅6,00,000
2.	Manipur	≅2,10,000	≅38,000
3.	Meghalaya	≅4,80,000	≅68,000
4.	Nagaland	≅1,80,000	≅30,000
5.	Sikkim	≅84,000	≅12,000
6.	Tripura	≅4,32,000	≅66,000
7.	Arunachal Pradesh	≅76,000	≅12,000
8.	Mizoram	≅1,10,000	≅17,000
	Total =	**≅55,72,000**	**≅8,43,000**

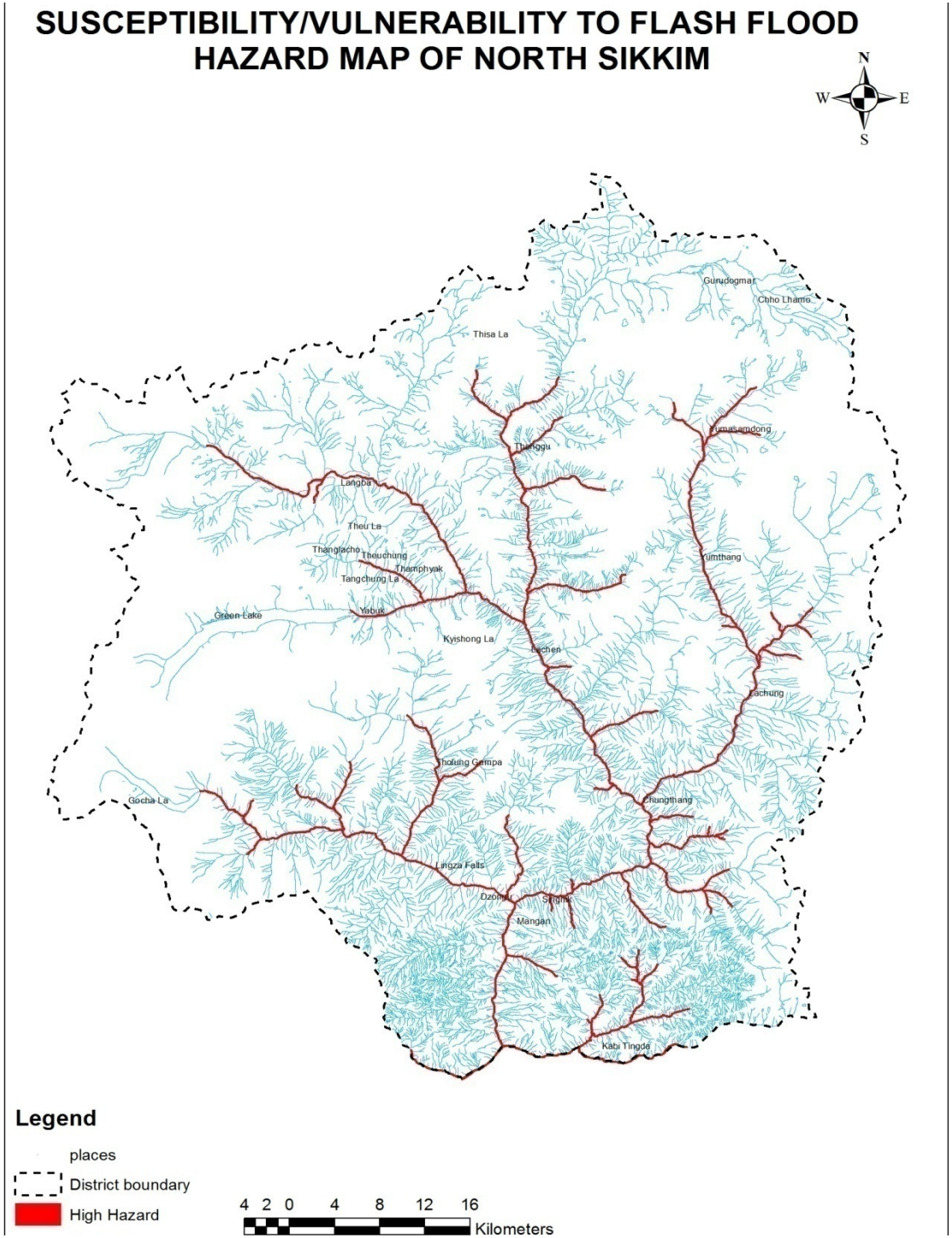
Source: Harsh K Gupta, Nature of Earthquake 2005

Flashfloods prone areas in Sikkim

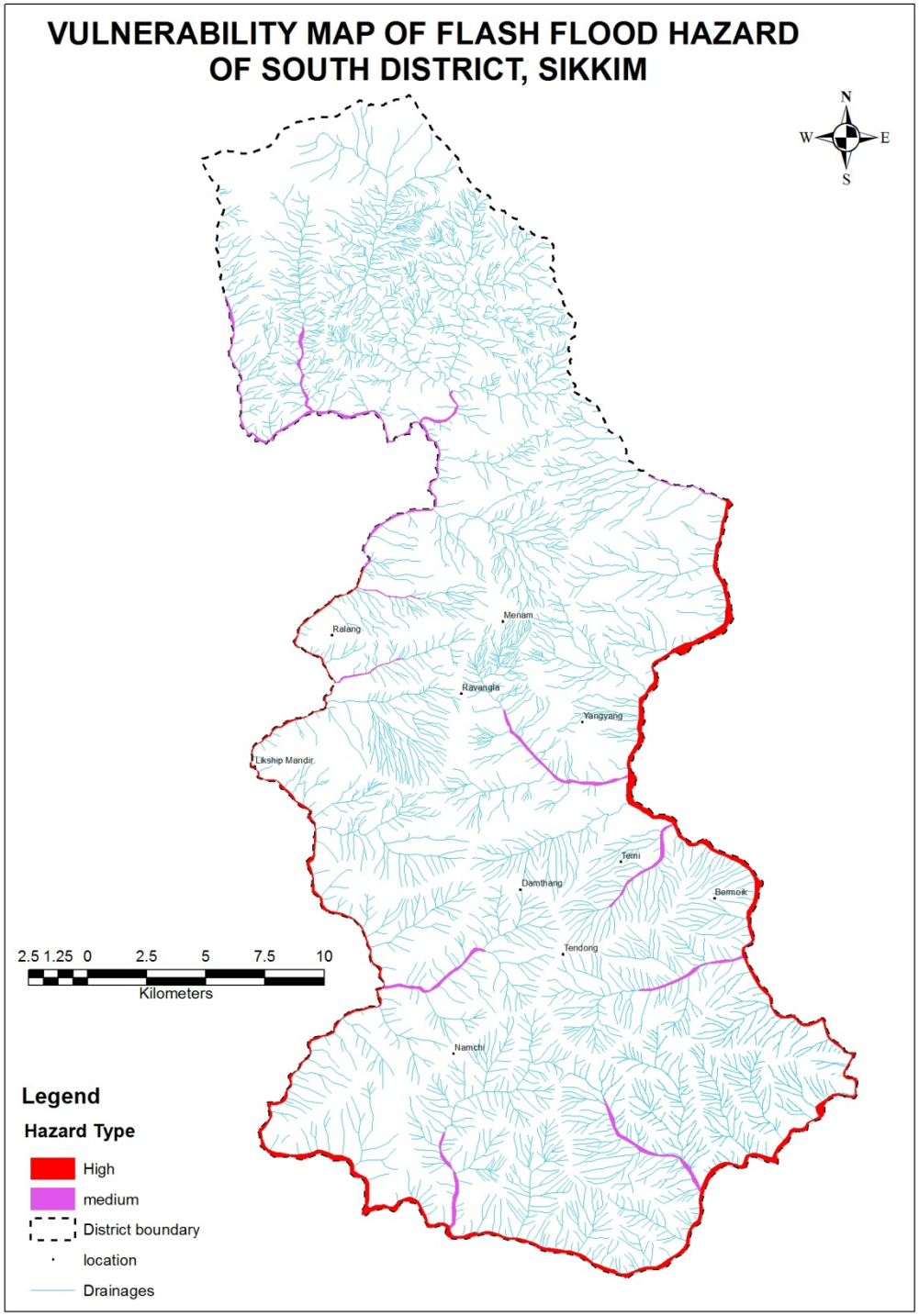




Flashfloods prone areas in Sikkim



Flashfloods prone areas in Sikkim



Flashfloods prone areas in Sikkim

ENDANGERED URBAN AREAS

- SINGTAM
- RANGPO
- RONGLI
- RORATHANG
- MELLI
- JORETHANG
- RESHI
- LEGSHIP
- LACHUNG
- CHUNGTHANG
- DICKHU

Dharakham kholse slide claim five lives at Rolep, East Sikkim(JUNE 2012) 7 PEOPLE KILLED


ank of India
BMB
airtel
SK01
P8271
L I C OF INDIA


SK 01 G 0845
POLICE

Pictures from Uttrey lake, West Sikkim

Piping

Muck dumped over seepage point

Spring water sources are drying up

Mostly in subtropical zone of the State (500 to 1500 meters)

Dec – March is the dry season

Activities of SSDMA

- **Initiated Amendment of Building Bye laws**
- **Conducted GIS based Multi Hazard Risk & Vulnerability Assessment (MHRVA) for four districts of Sikkim**
- **Conducted GIS based MHRVA for Gangtok Municipal Corporation**
- **Developed website for SSDMA www.ssdma.in**
- **Establishment of Emergency Operation Centres in the four districts**
- **IEC campaigns, mock drills, rallies, mass awareness, sensitization and training programmes in schools, market places and amongst various stakeholders (NGO, PRI, NYK, govt officials, masons, engineers, taxi drivers and others)**

Activities of SSDMA

- **Formation of Disaster Management Plans/Teams and Committees at State, District and Village level.**

- **State Disaster Management Plan (SDMP) was formulated which is followed by District Disaster Management Plans and SOPs which are under process.**

- **Nodal officers from Army, Para Military Organization, Departments and Organizations have been appointed under SSDMA for disaster management activities in the state.**

- **Civil Defense Corps is established in East district and Notification for its establishment in other districts have been brought out and formation of corps is in process**

Preparedness Measures in the State

- **Disaster Management Plans**

  1. **Review and rework on Disaster Management Plans for practical applicability**
  2. **Departments are now requested to formulate Department Disaster Management Plan**
  3. **Health Sector Disaster Management Plans have been finalized**

- **Training and Capacity Building**

  1. **Master trainers have been created amongst teachers in school safety**
  2. **IEC campaigns, mock drills, street plays, skits, talk shows, rallies, mass awareness, sensitization and training programmes conducted across the state**
  3. **Trainings being imparted to various stakeholders in disaster management (engineers, architects, masons, NGOs, PRIs, Home Guard & Civil Defence, Police, Sikkim State Disaster Response Force, Quick Response Team and others)**

Future Plans

1. **Mock exercise on earthquake and other disasters will be conducted throughout the State for better preparedness.**
2. **Setting up of fully functional Incident Response System across various levels in the State.**
3. **Provide Training & conduct Rapid Visual Survey for critical and lifeline buildings.**
4. **Retrofitting of the critical and lifeline buildings.**
5. **Prepare evacuation plans for towns & Govt. offices to response emergency & conduct mock exercises.**
6. **Capacity building of different stakeholders in disaster management.**
7. **Provide awareness/ sensitization programmes, mock exercises to the stakeholders, Students and the community for disaster preparedness, response and mitigation.**

Reconstruction of Earthquake Damaged Rural Houses (REDRH)

Before (2011)

After (2013)

Mock drill in college

Release of MHRVA books by HE, Governor of Sikkim

Preparation of Building Layout in Schools

Mason training on safe construction practices

National School Safety Programme

Construction of multi purpose hall/shelter

Training conducted on Incident Response System

Amendment of Building Byelaws

Training attended on Psycho-social care

Risk Matrix Chart

Frequency /Likelihood							Frequency/ Likelihood
	EVERY YEAR	HILLSTROMS, SNOW AND AVALANCHES, FLASHFLOOD			FIRE	LAND SLIDE	
	2-10 YRS		DROUGHT*				
	11-20 YRS				RIOTS	EARTHQUAKE	
	21-30 YRS						
	31-50 YRS						

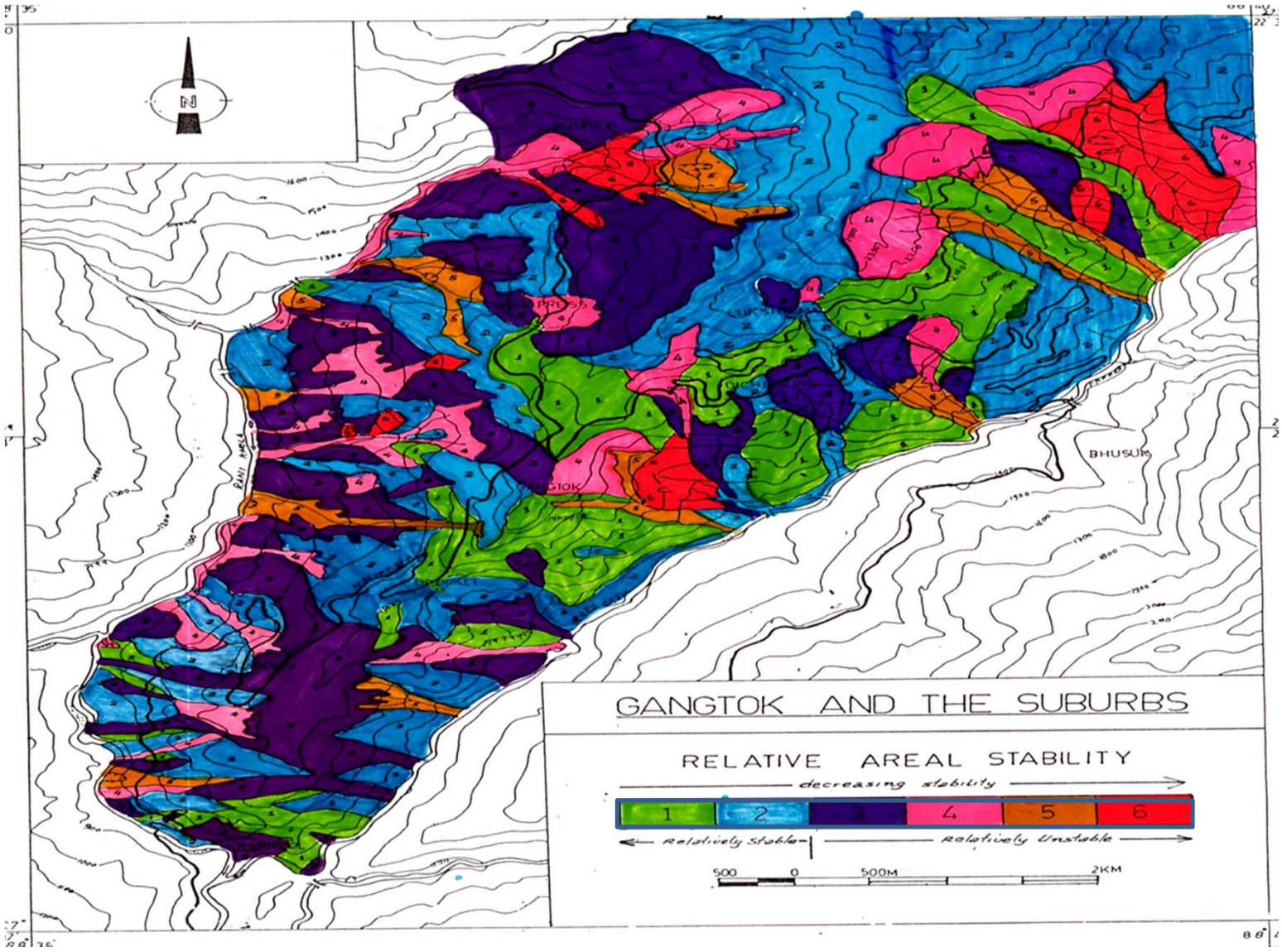
Severity/ magnitude of damage

RELATIVELY INCREASING RISK

LOW	MEDIUM LOW	MEDIUM	HIGH	VERY HIGH

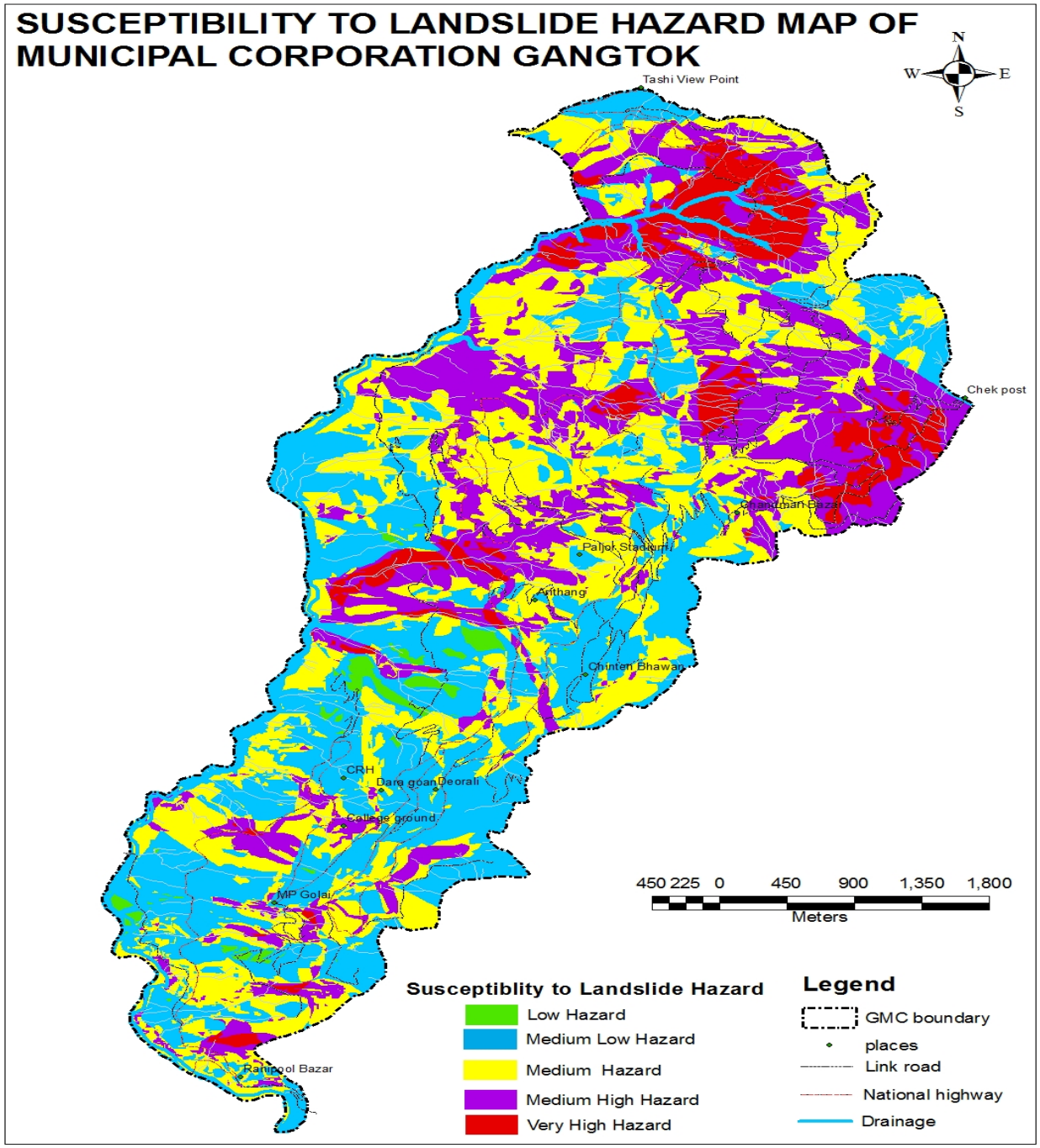
Vulnerability & Hazard Mapping In Sikkim

CONSIDERATION TO BE ADOPTED FOR DEVELOPMENTAL PROCESS

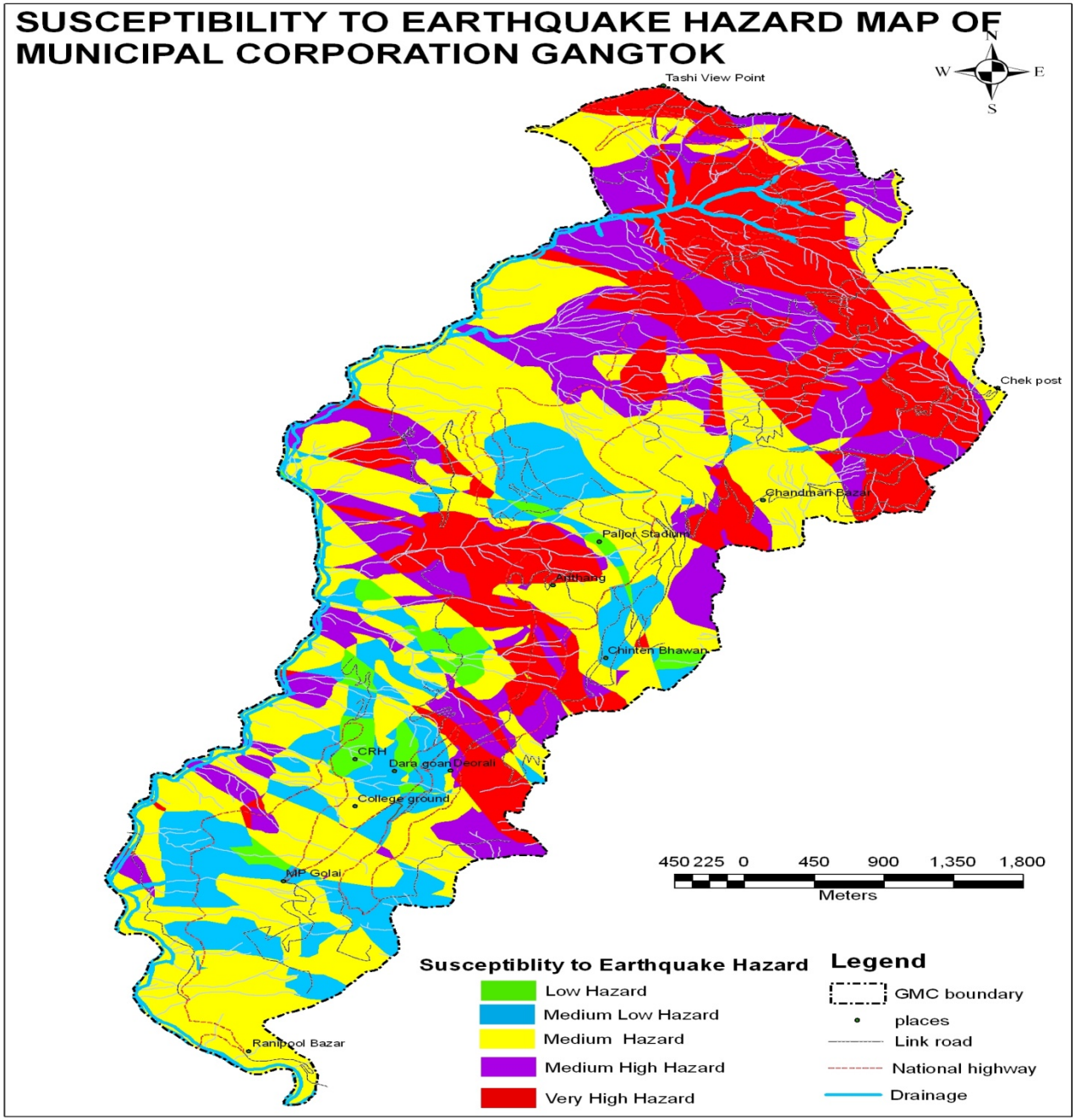


Source: Mines, Minerals & Geology, Govt. of Sikkim

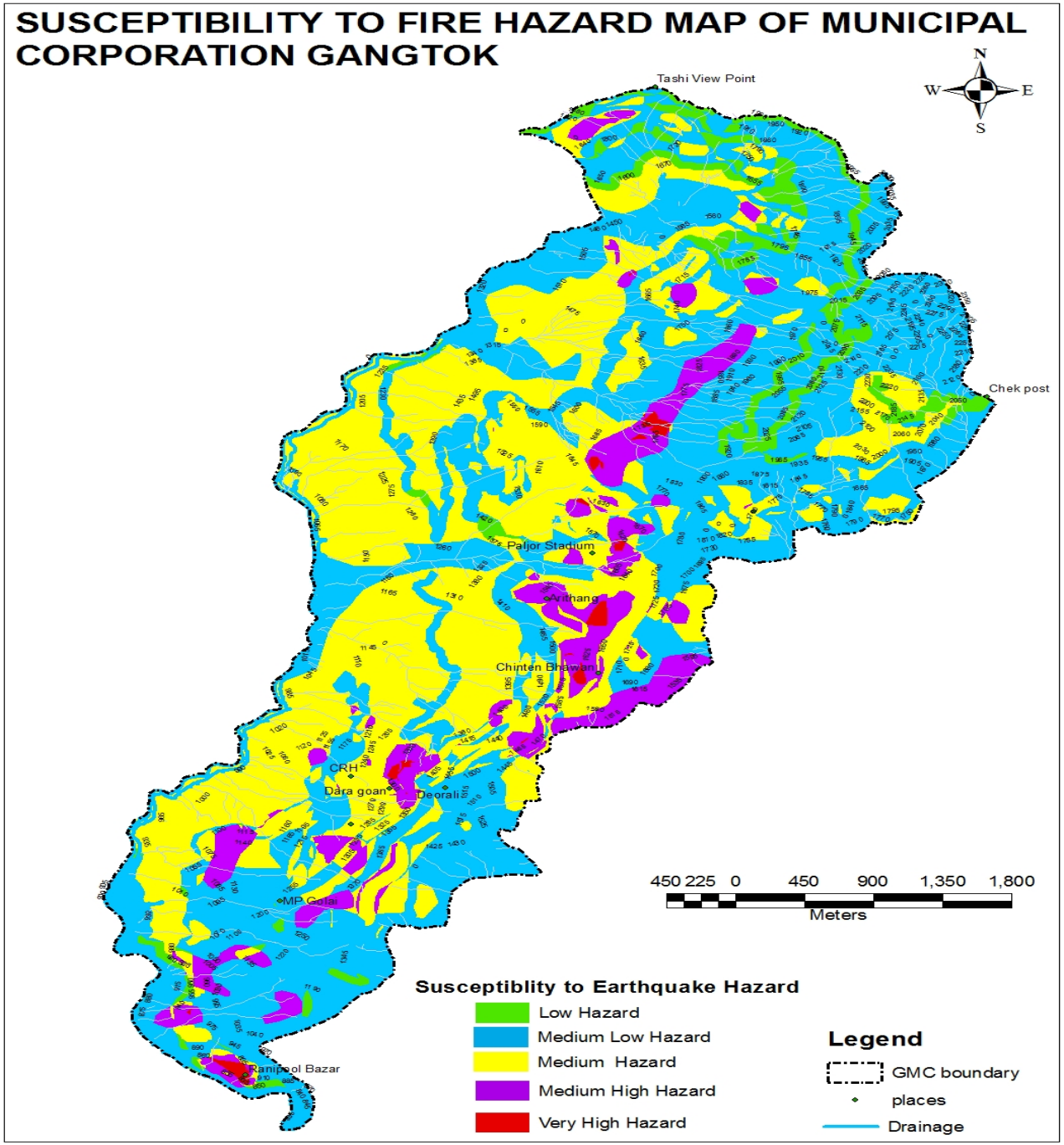
SUSCEPTIBILITY TO LANDSLIDE HAZARD MAP OF MUNICIPAL CORPORATION GANGTOK

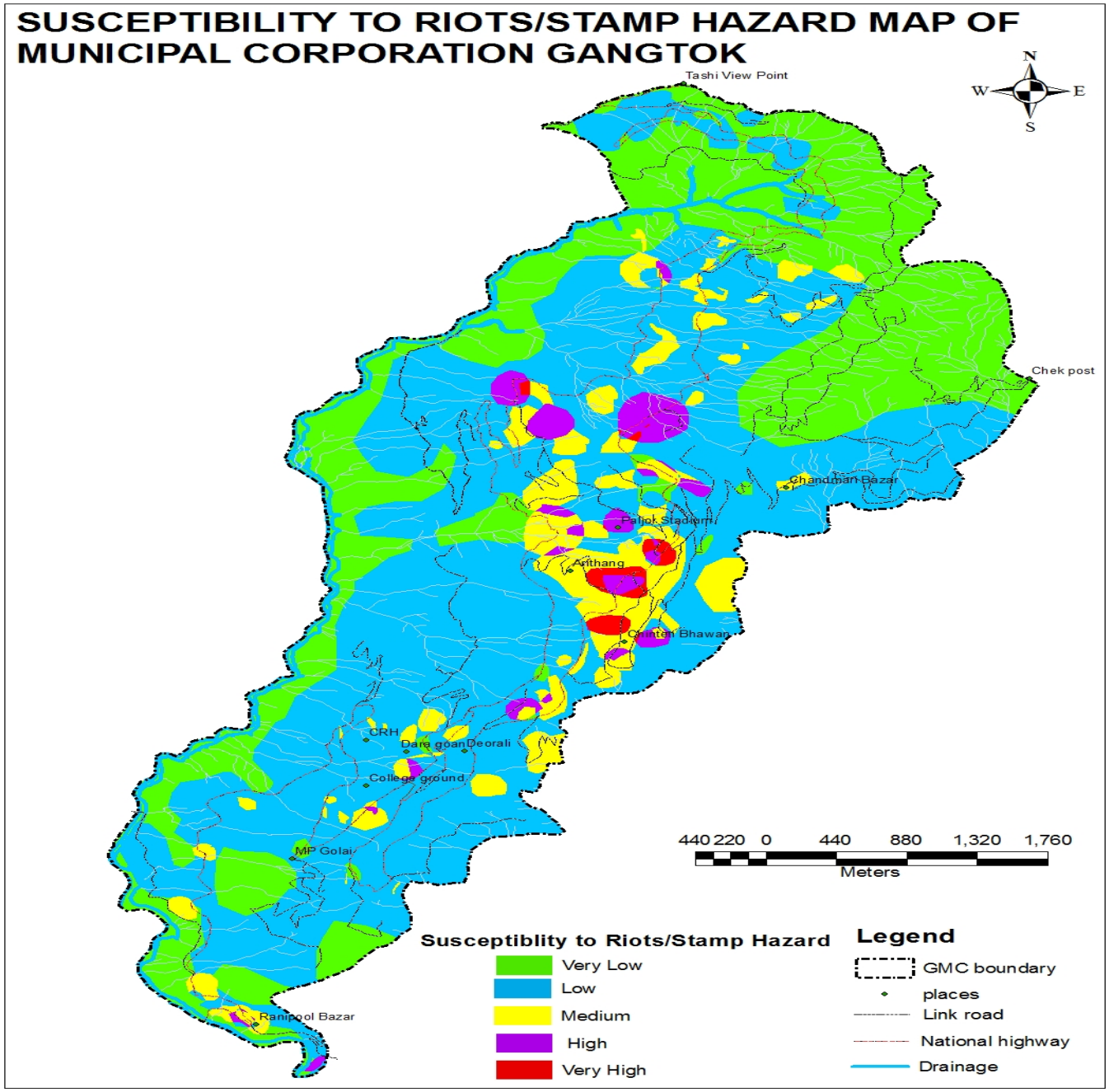


SUSCEPTIBILITY TO EARTHQUAKE HAZARD MAP OF MUNICIPAL CORPORATION GANGTOK

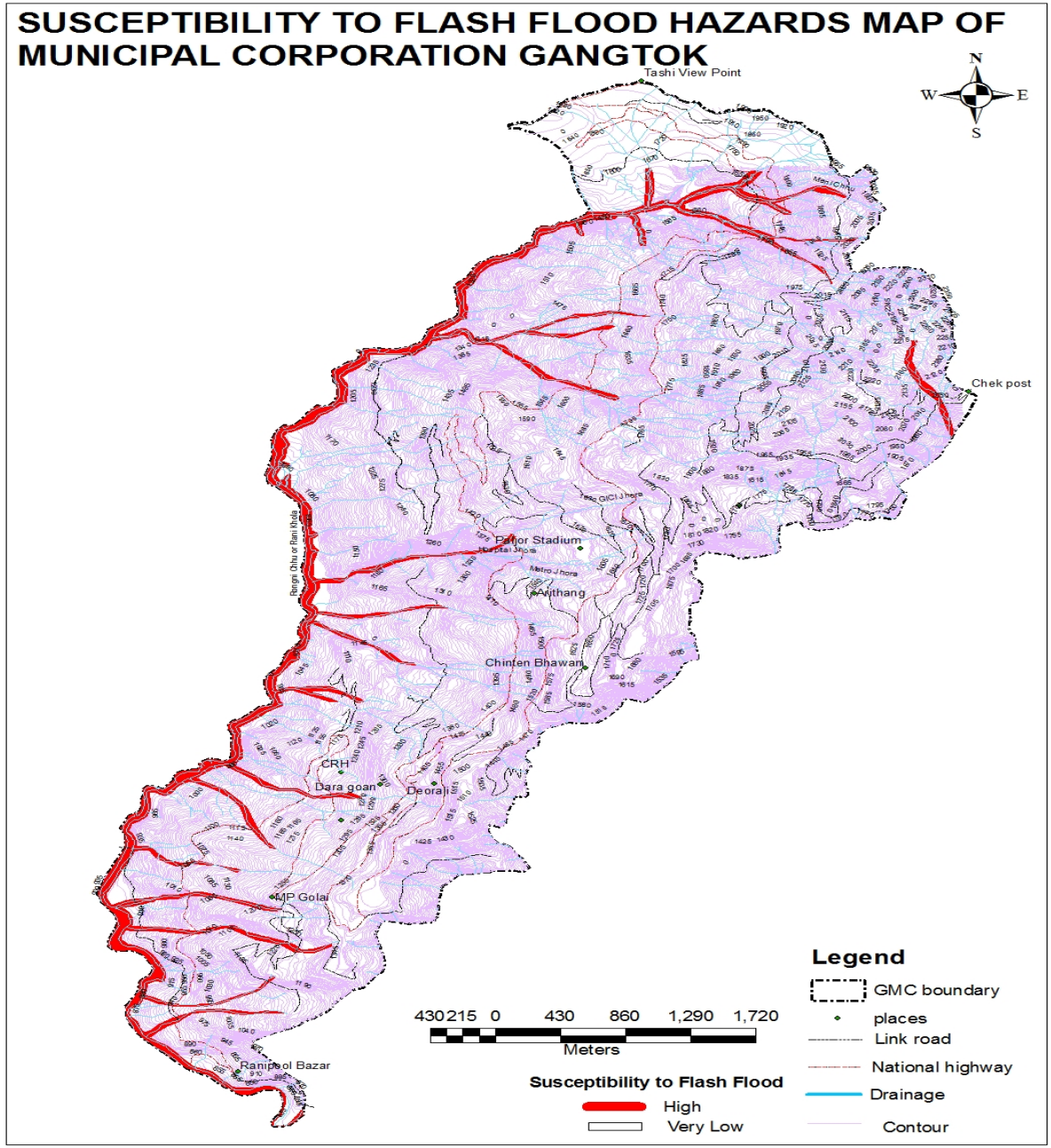


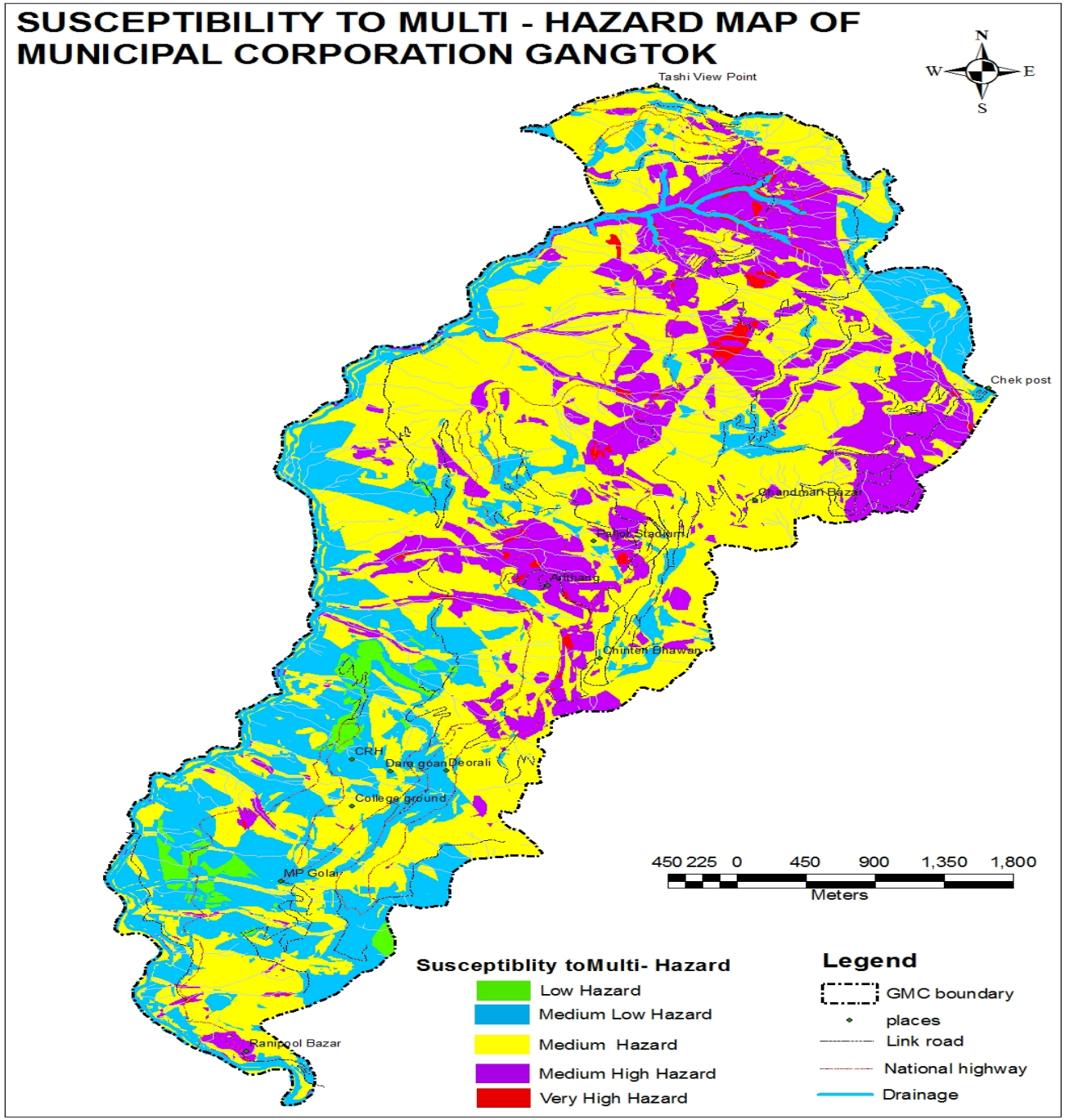
SUSCEPTIBILITY TO FIRE HAZARD MAP OF MUNICIPAL CORPORATION GANGTOK



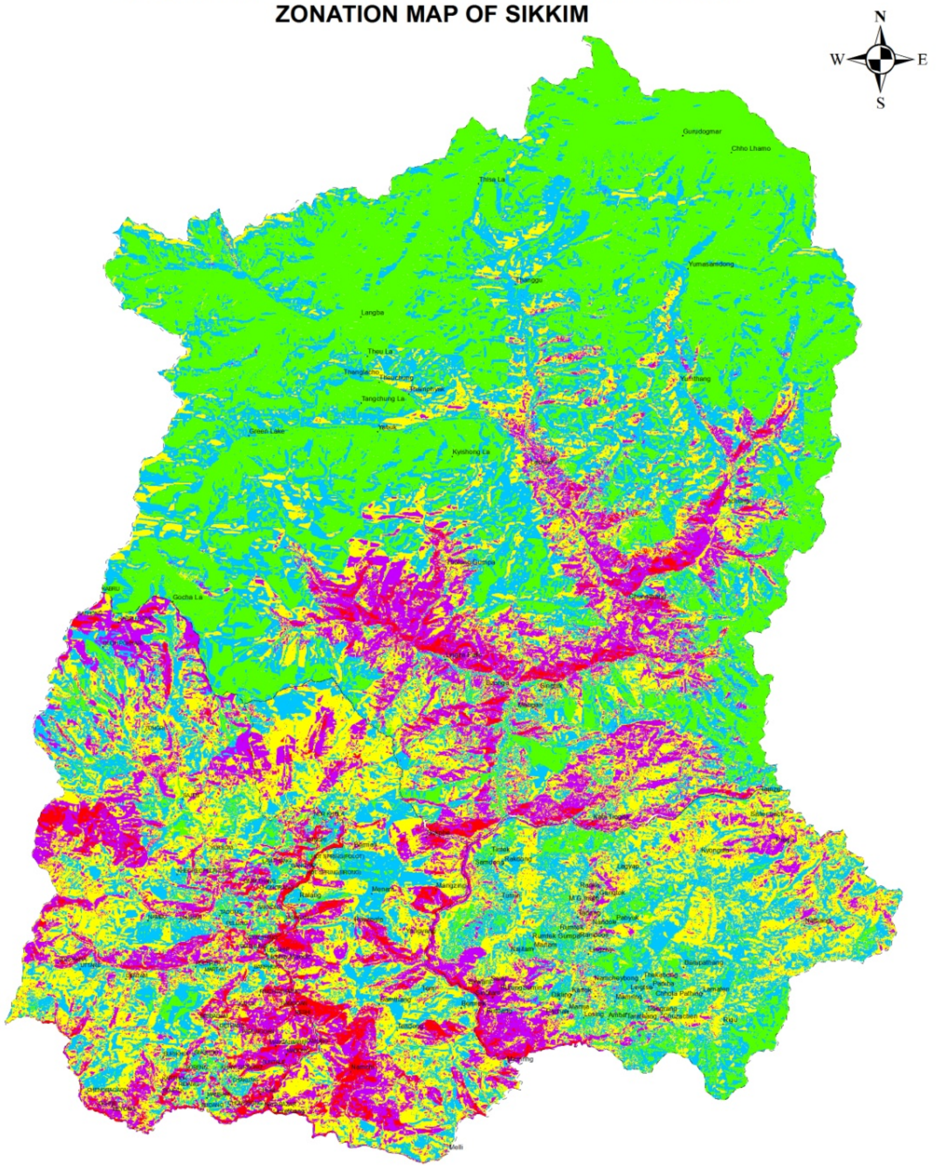

SUSCEPTIBILITY TO RIOTS/STAMP HAZARD MAP OF MUNICIPAL CORPORATION GANGTOK
N
W
E
S
Tashi View Point
Chek post
Ghandhari Bazar
Paljok Stadium
Arithang
Chintan Bhawan
CRH
Dare goan
Deorali
College ground
MP Golai
Ranipool Bazar
440 220 0 440 880 1,320 1,760
Meters
Susceptiblity to Riots/Stamp Hazard
Very Low
Low
Medium
High
Very High
Legend
GMC boundary
places
Link road
National highway
Drainage

SUSCEPTIBILITY TO FLASH FLOOD HAZARDS MAP OF MUNICIPAL CORPORATION GANGTOK




SUSCEPTIBILITY TO MULTI - HAZARD MAP OF MUNICIPAL CORPORATION GANGTOK
N
W
E
S
Tashi View Point
Chek post
Chandmari Bazar
Paljor Stadium
Ashiang
Chinten Bhawan
CRH
Dara goan
Deorali
College ground
MP Golai
Ranipool Bazar
450 225 0 450 900 1,350 1,800
Meters
Susceptiblity toMulti- Hazard
Low Hazard
Medium Low Hazard
Medium Hazard
Medium High Hazard
Very High Hazard
Legend
GMC boundary
places
Link road
National highway
Drainage

SUSCEPTIBILITY/VULNERABILITY TO MULTI- HAZARD ZONATION MAP OF SIKKIM



DISTRICT WISE HAZARDS STATISTICS

HAZARD TYPE

- Very High Hazard
- Medium High Hazard
- Medium Hazard
- Medium Low Hazard
- Low Hazard

EAST

Hazards Category	Multi-Hazard Hazards		
	% of Area	% of Household	Risk type
Very High Hazards	1.05	1.00	Very High
Medium High Hazards	12.53	16.81	High
Medium Hazards	38.70	48.67	Medium
Medium Low Hazards	36.20	23.77	Low
Low Hazards	10.98	9.19	Low

WEST

Hazards Category	Multi- Hazards		
	% of Area	% of Household	Risk type
Very High Hazards	2.17	1.12	Very High
Medium High Hazards	32.07	21.95	High
Medium Hazards	43.08	40.40	Medium
Medium Low Hazards	18.23	35.86	Low
Low Hazards	1.64	3.58	Low

NORTH

Hazards Category	Multi- Hazards		
	% of Area	% of Household	Risk type
Very High Hazards	5.16	2.15	Very High
Medium High Hazards	10.81	6.23	High
Medium Hazards	22.71	29.04	Medium
Medium Low Hazards	15.07	16.54	Low
Low Hazards	38.25	28.04	Low

SOUTH

Hazards Category	Multi- Hazards		
	% of Area	% of Household	Risk type
Very High Hazards	8.10	8.12	Very High
Medium High Hazards	20.40	23.50	High
Medium Hazards	46.67	43.08	Medium
Medium Low Hazards	20.71	24.38	Low
Low Hazards	1.13	0.87	Low

Now there is need for the response to various disasters

through Mock Exercises as preparedness

Since

Mitigation would take time

Best Practices

School Safety Programme

School safety programme and mock drills conducted in all secondary, senior secondary schools and colleges familiarized the students and their families on Duck-Cover-Hold theory.

Best Practices

Mass sensitization

Regular programmes on Training, Sensitization, Mock drills, Workshops related to every aspect of disaster management have been held which helped the public in large for e.g. Duck Cover Hold theory, Do's and Don'ts during disaster on Earthquake, Landslide, etc

Best Practices

Emergency and first Aid training

The emergency and first aid trainings imparted to NGOs and general public helped in providing first aid to the injured persons.

Recommendations

- Basic awareness among common people,
- Mass sensitization,
- Village level Vulnerability & Resources mapping,
- Construction of buildings as per building regulations.
- Environmental awareness etc.

Recommendations

Social awareness has to be created at all levels to educate and to bring Awareness among the people about the adverse impact of anthropogenic activities and the climate change and the benefit of conservation of natural resources.

CONCLUSIONS

- **Natural hazards in Sikkim are inevitable.**
- **Accordingly- we have to plan the development programs with disaster resilient features.**
- **For this there is need for including Disaster Risk Reduction into Planning & Development Process.**

AND

Follow adaptation, mitigation & response to hazards, disasters and climate change impact

WITH

Preparedness, Awareness & sensitization programs.

Thank You