Status of Seismic Risk Assessment in Cities of Nepal and Upcoming Initiatives

NSET

Workshop on

Collaborative Research and Development Project for Disaster Mitigation in Earthquake Prone Areas in Asia

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Kathmandu, Nepal
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Content: Sharing 5 Experiences of NSET in Risk Assessment (1997-2007)

1. KVERMP Experience (1997-2000)
2. SEDM (JICA) Experience (2001)
3. MERMP Experience (2002-2003)
4. SLARIM (ITC) Experience (2003-2006)
5. Ongoing Research with Universities Students (2007)
6. Near Future Programs (2007-)

KVERMP Experience (1997-2000)

Kathmandu Valley Intensity Map of 1934 Earthquke
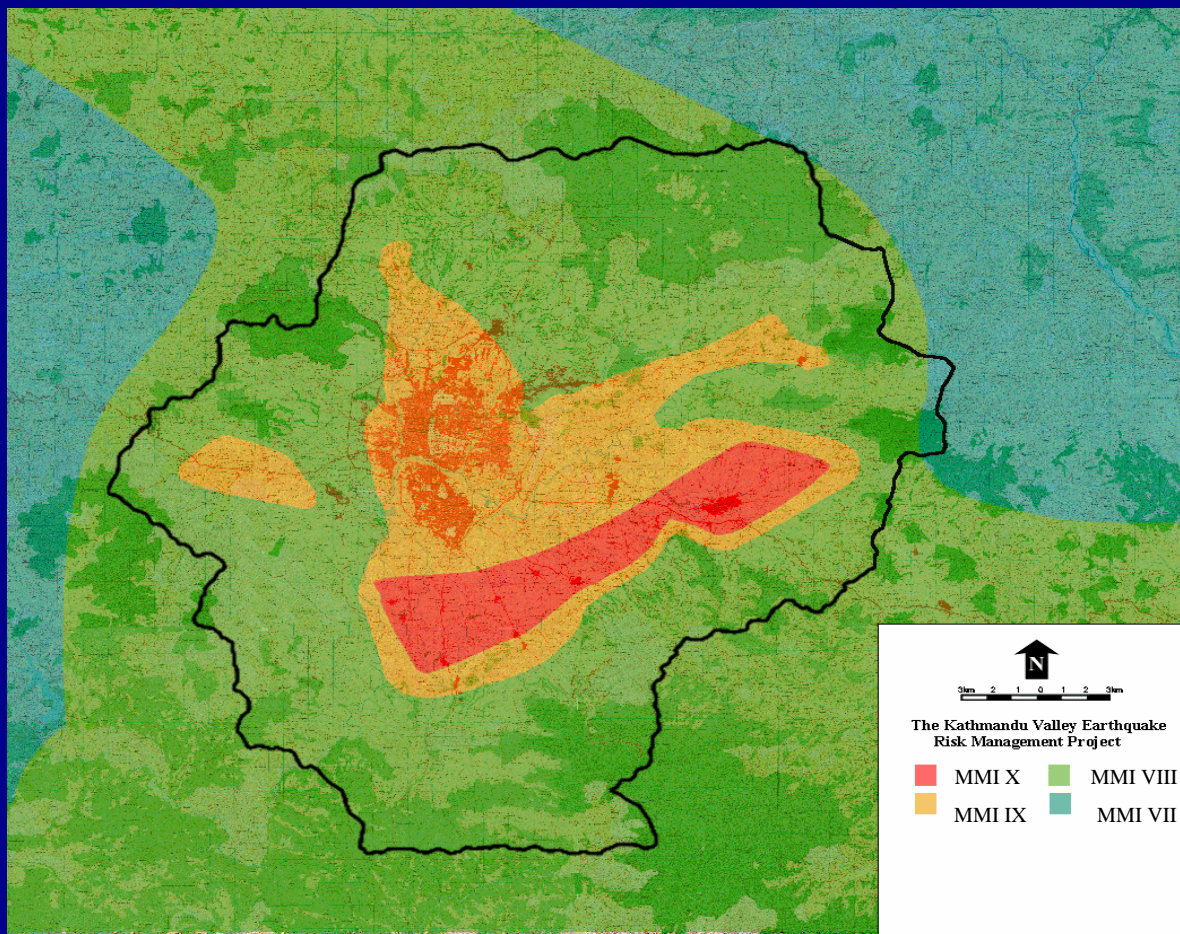
Kathmandu Valley: Earthquake Risk

- Increased Population
- Haphazard Constructions

Kathmandu Valley: Infrastructures

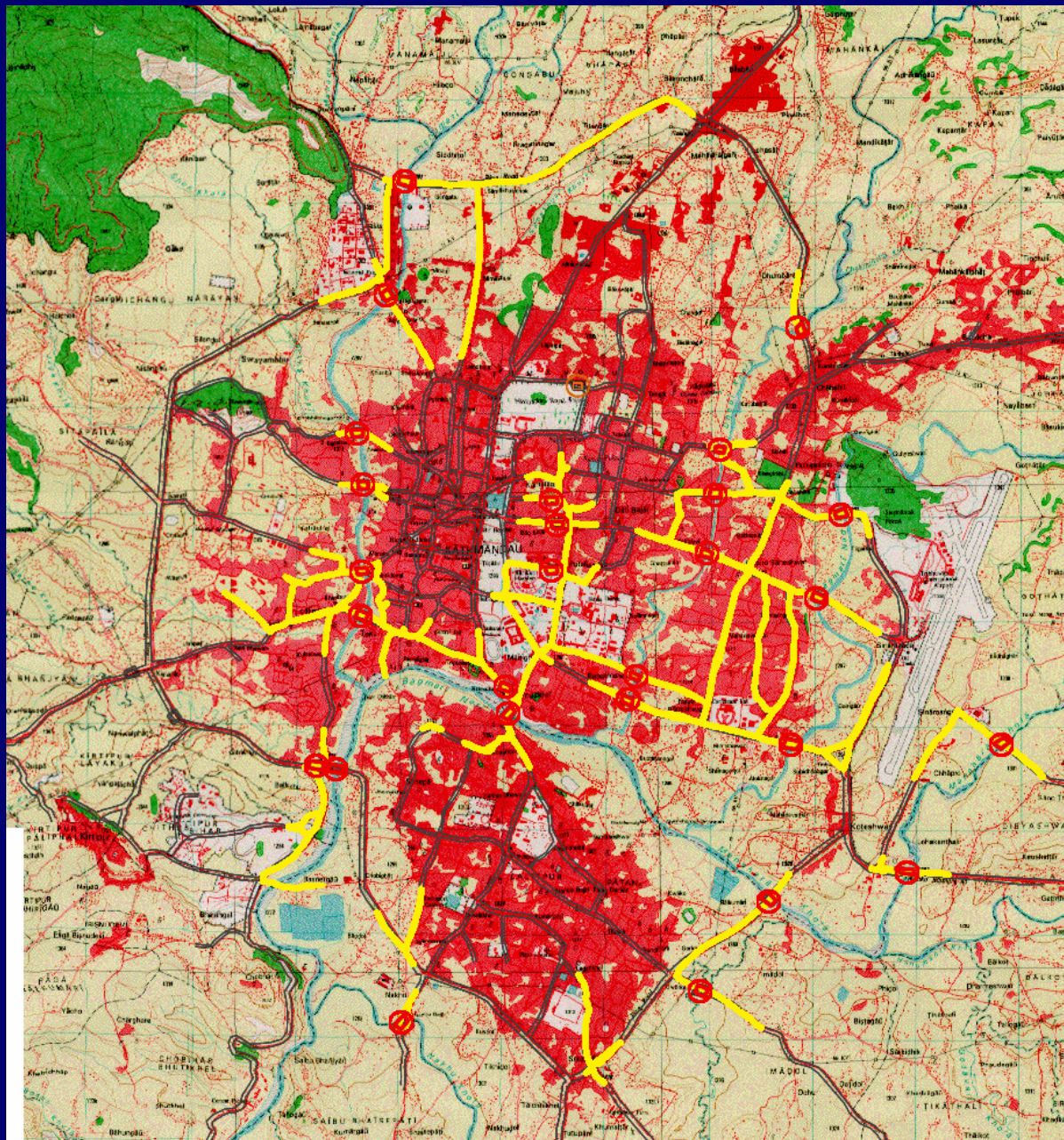- Vulnerable Buildings

- Narrow Roads

Estimated Building Damage In Kathmandu Valley

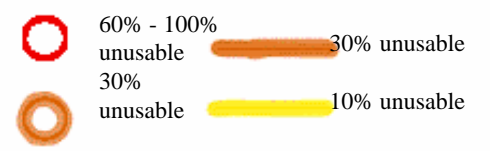**(Based on Buildings Survey during UNDP Building Code Project)**

Place	Building Stock Damaged (Beyond Repair)
Kathmandu	60%
Lalitpur	60%
Bhaktapur	75%
Entire Valley	60%

ATC-13 Methodology
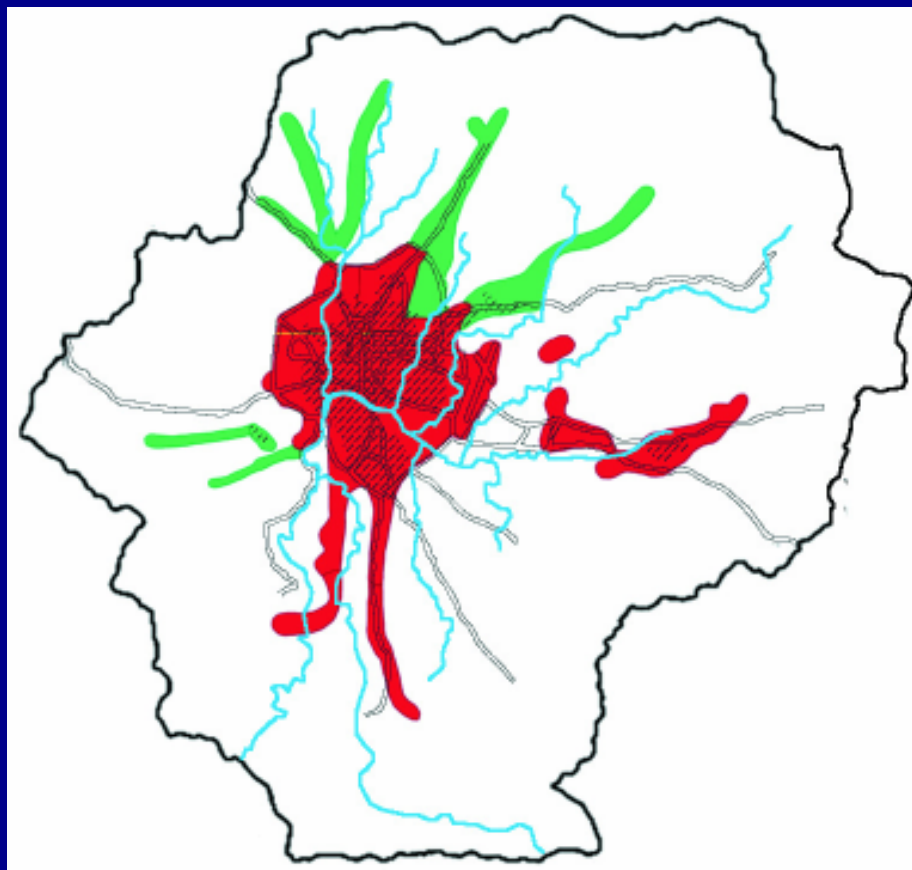
Kathmandu, Lalitpur & Kirtipur Road & Bridges Damage Maps

The Kathmandu Valley Earthquake Risk Management Project

N

3km 2 1 0 1 2 3km

Legend:
- 60% - 100% unusable
- 30% unusable
- 30% unusable
- 10% unusable

NSET - Nepal   GeoHazards International

ATC-25 Methodology

Water System Functionality: One Week after the Scenario Earthquake

ATC-25 Methodology

+ Interpretation

- <30% users served
- 30% to 60% users served
- 60% to 100% users served
- 100% users served

Potential Impact due to scenario EQ in KV
(KVERMP estimates 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%

SEDM (JICA Study) Experience (2001)

Legend

- Study area
- Municipality & District
- Ward & VDC

Seismic Intensity(MMI)

- IX
- VIII
- VII
- VI
- V

THE STUDY ON EARTHQUAKE DISASTER MITIGATION
IN THE KATHMANDU VALLEY, KINGDOM OF NEPAL

Ministry of Home Affairs(MOHA)
Department of Narcotics Control & Disaster Management
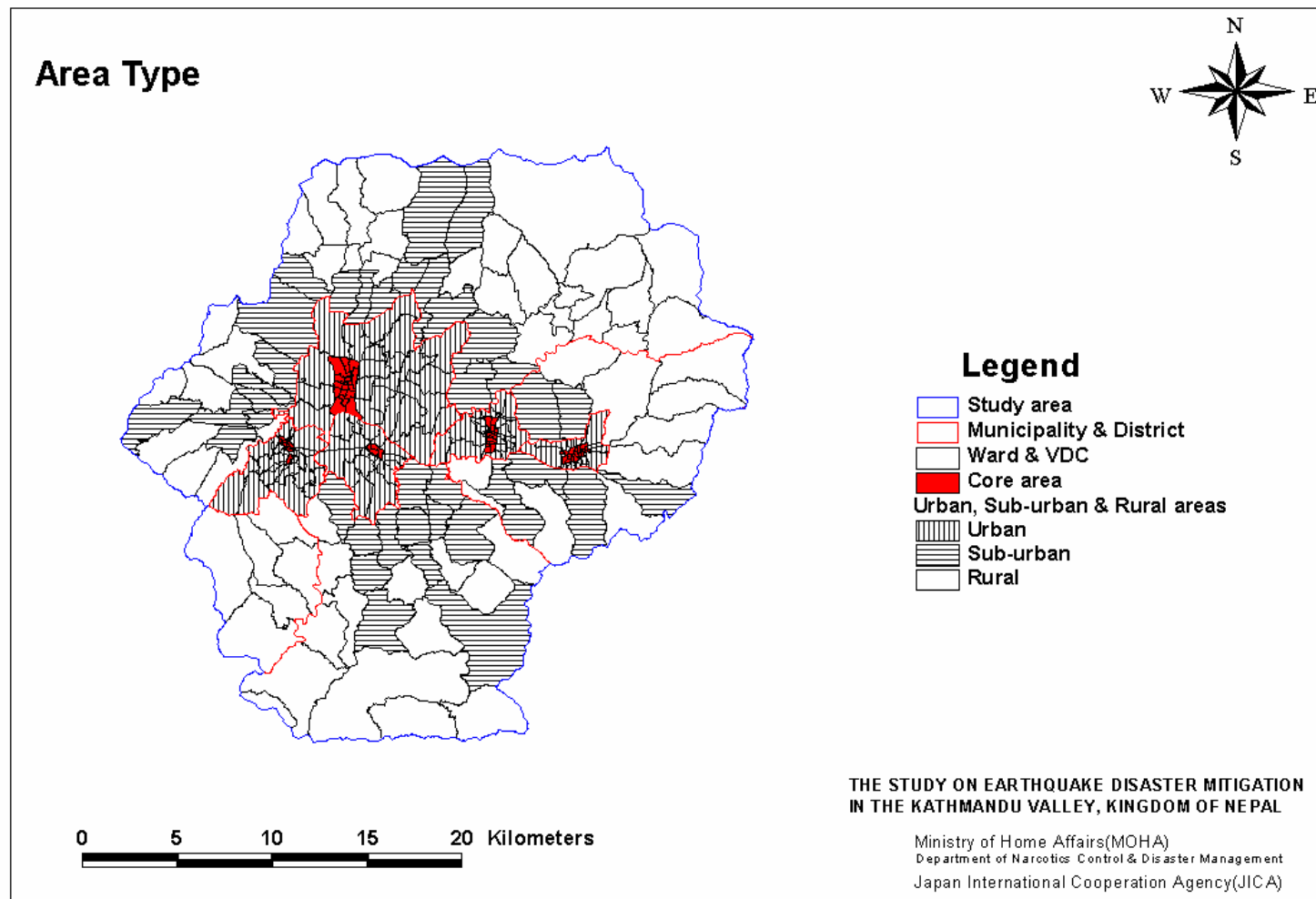Japan International Cooperation Agency(JICA)

0   5   10   Kilometers
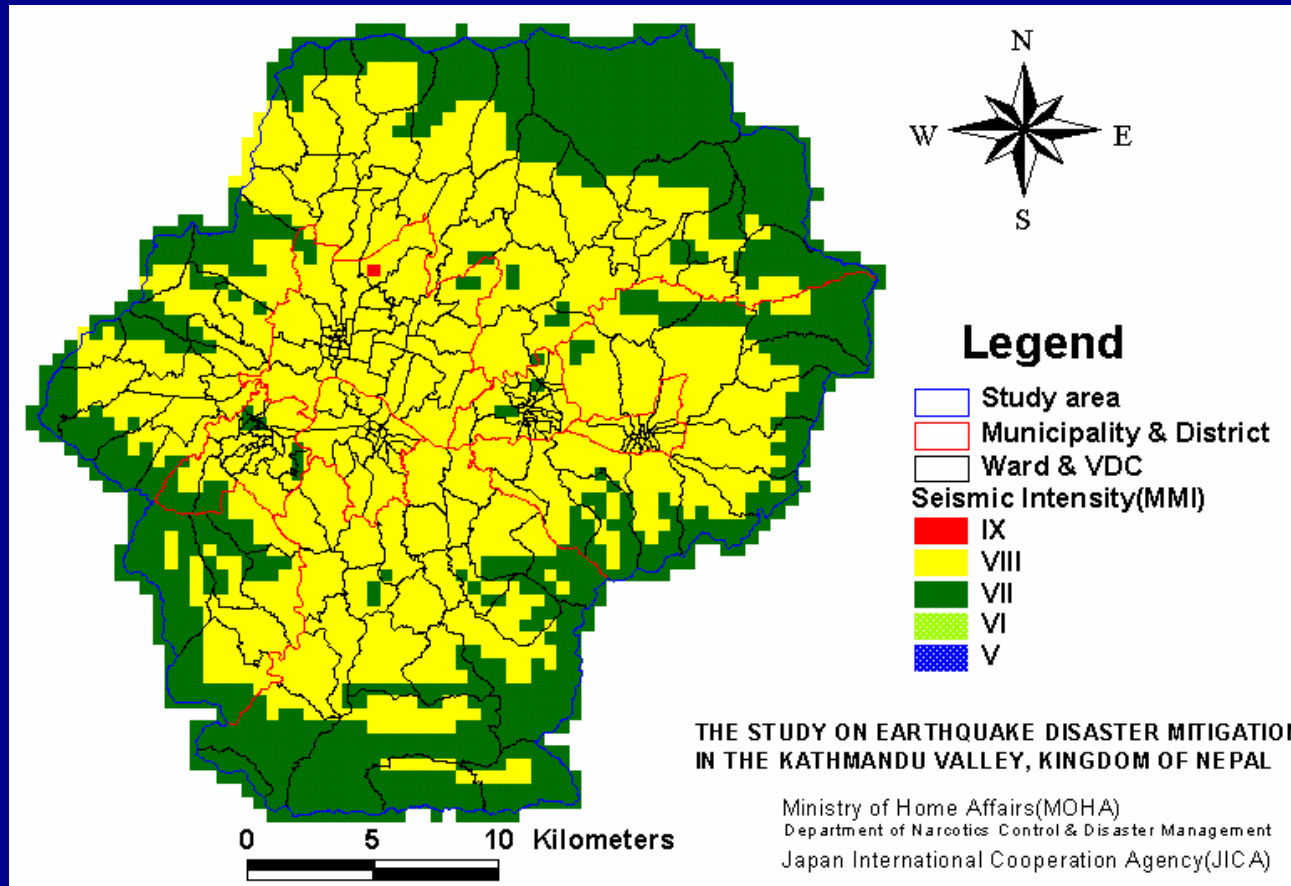
Seismic Intensity Map   **I. Mid Nepal Earthquake**

500m x 500m Grid

Building Inventory: Six Category of Area

Building Inventory: Detail Survey
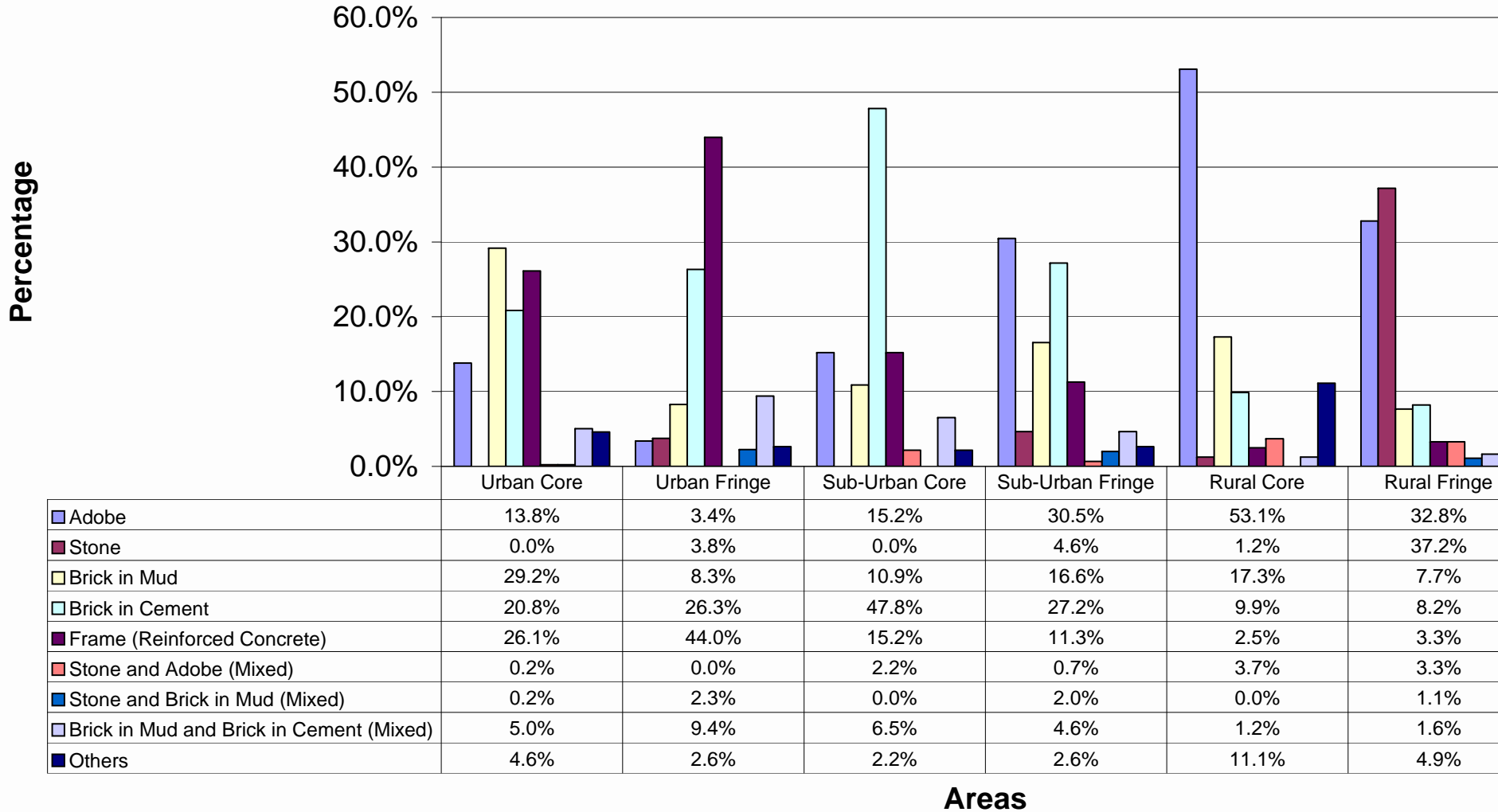
No.	Building Sample Areas	Settlement Type		No. Of areas sampled	Total Number of samples
		Main Type	Sub-type		
1	Institutional	Urban		(Schools, Hospitals, College, Cinema)	32
2	Commercial	Urban		6	150
3	Industrial (Light Industry)	Urban		4	40
4	Residential	Urban	Urban Core	19	281
			Urban Fringe	17	219
		Suburban	Suburban Core	2	46
			Suburban Fringe	7	151
		Rural	Rural Core	3	81
			Rural Fringe	7	183
5	Total				1183

Source: (NSET 2001)

Area wise Total Building Typology

Total Number of Sample Surveyed=1183

	Urban Core	Urban Fringe	Sub-Urban Core	Sub-Urban Fringe	Rural Core	Rural Fringe
☐ Adobe	13.8%	3.4%	15.2%	30.5%	53.1%	32.8%
☐ Stone	0.0%	3.8%	0.0%	4.6%	1.2%	37.2%
☐ Brick in Mud	29.2%	8.3%	10.9%	16.6%	17.3%	7.7%
☐ Brick in Cement	20.8%	26.3%	47.8%	27.2%	9.9%	8.2%
☐ Frame (Reinforced Concrete)	26.1%	44.0%	15.2%	11.3%	2.5%	3.3%
☐ Stone and Adobe (Mixed)	0.2%	0.0%	2.2%	0.7%	3.7%	3.3%
☐ Stone and Brick in Mud (Mixed)	0.2%	2.3%	0.0%	2.0%	0.0%	1.1%
☐ Brick in Mud and Brick in Cement (Mixed)	5.0%	9.4%	6.5%	4.6%	1.2%	1.6%
☐ Others	4.6%	2.6%	2.2%	2.6%	11.1%	4.9%

Building distribution (Predominant)

N
W E
S
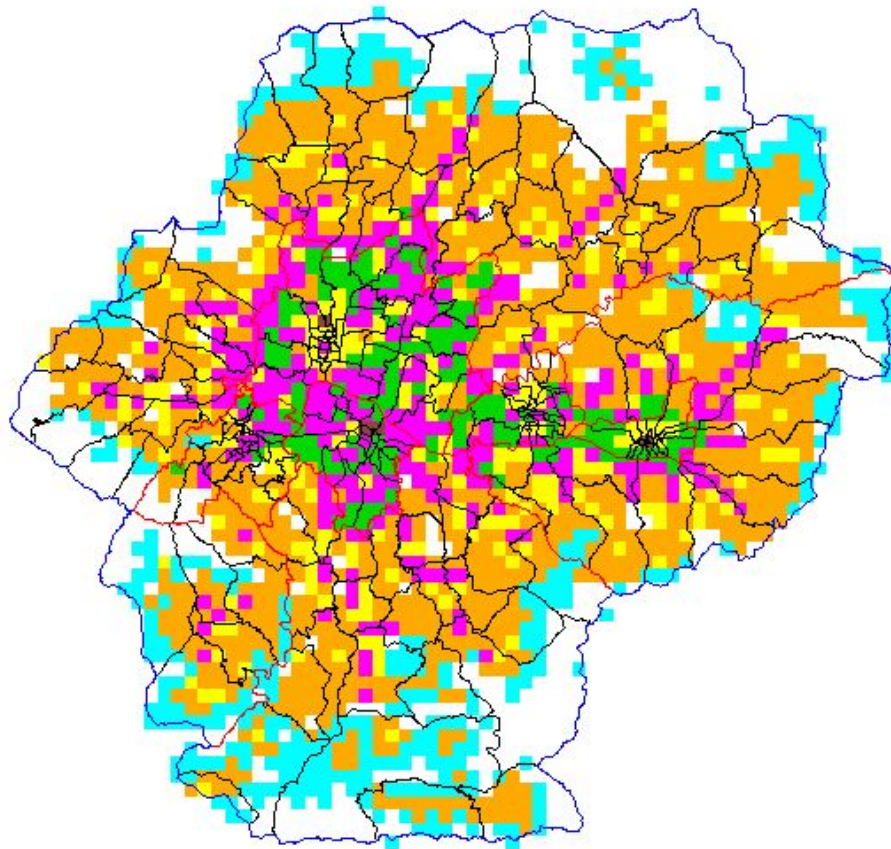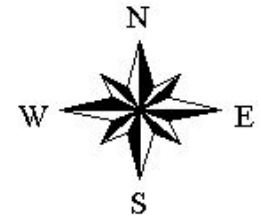
Legend
- ☐ Study area
- ☐ Municipality & District
- ☐ Ward & VDC

Predominant building type
- Stone
- Adobe
- BM regular
- BM well built
- BC
- RC
- ☐ No Building

(mesh size = 500m)
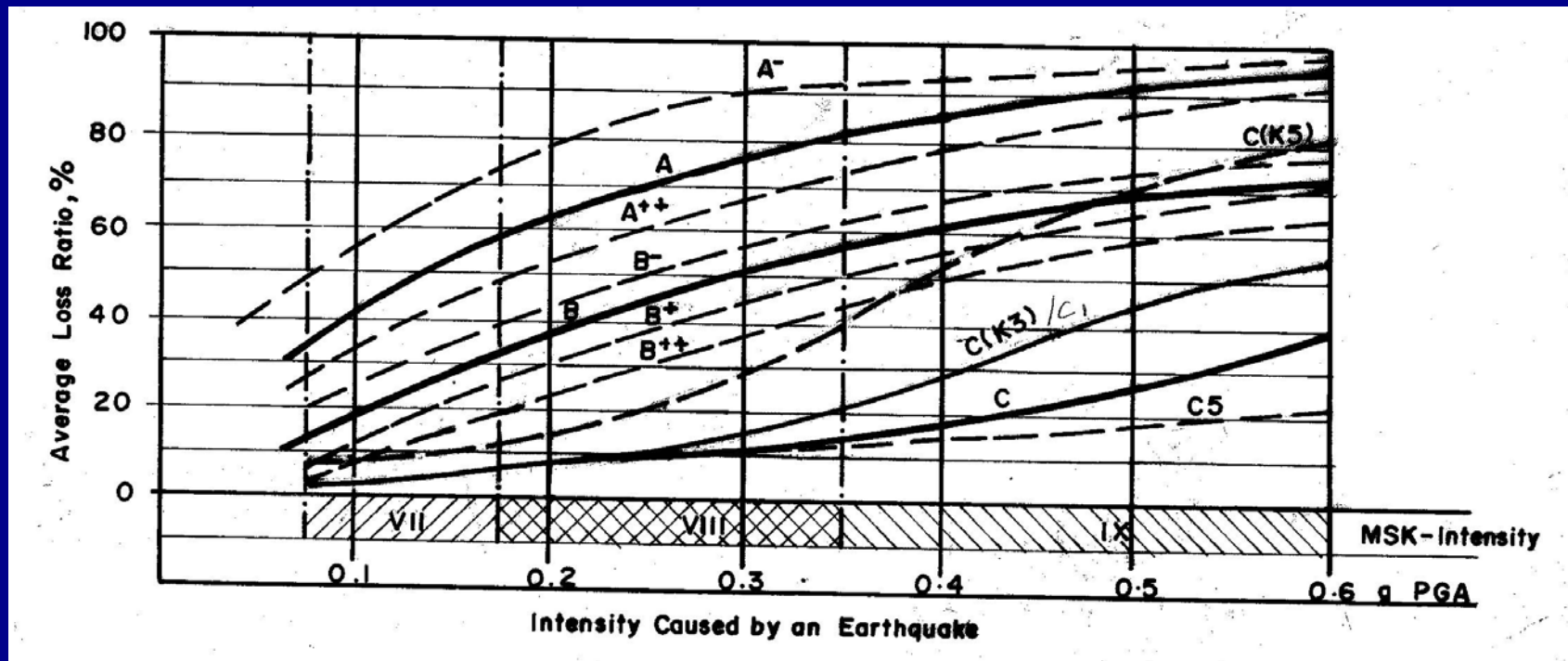
THE STUDY ON EARTHQUAKE DISASTER MITIGATION
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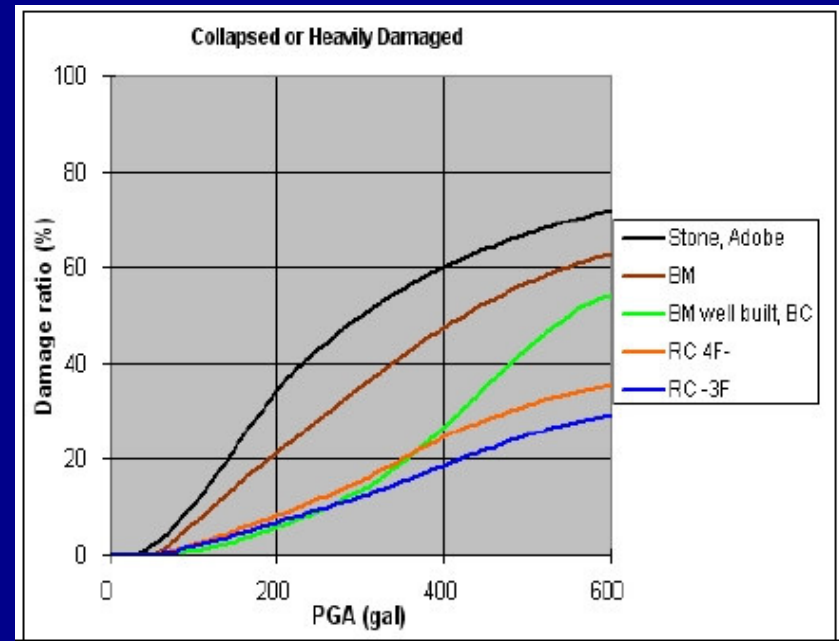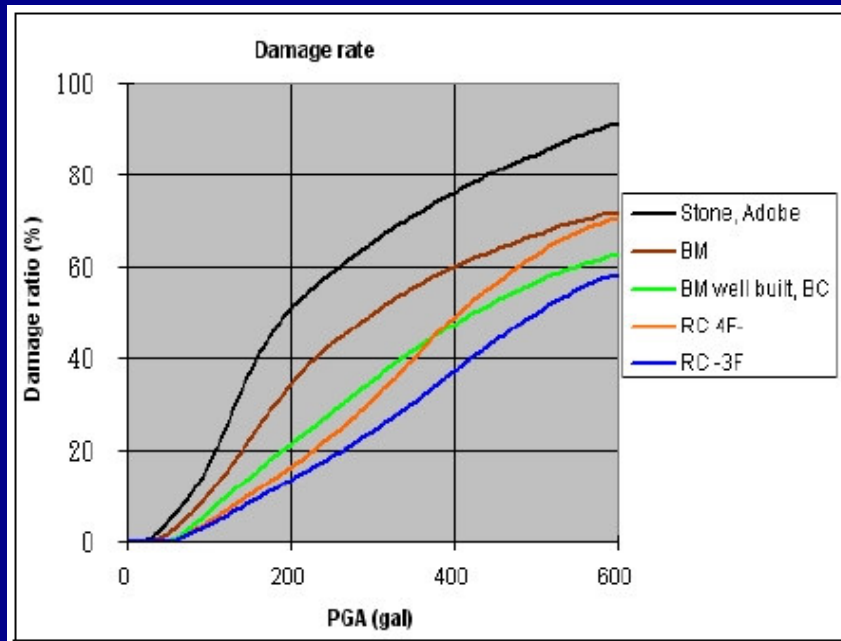
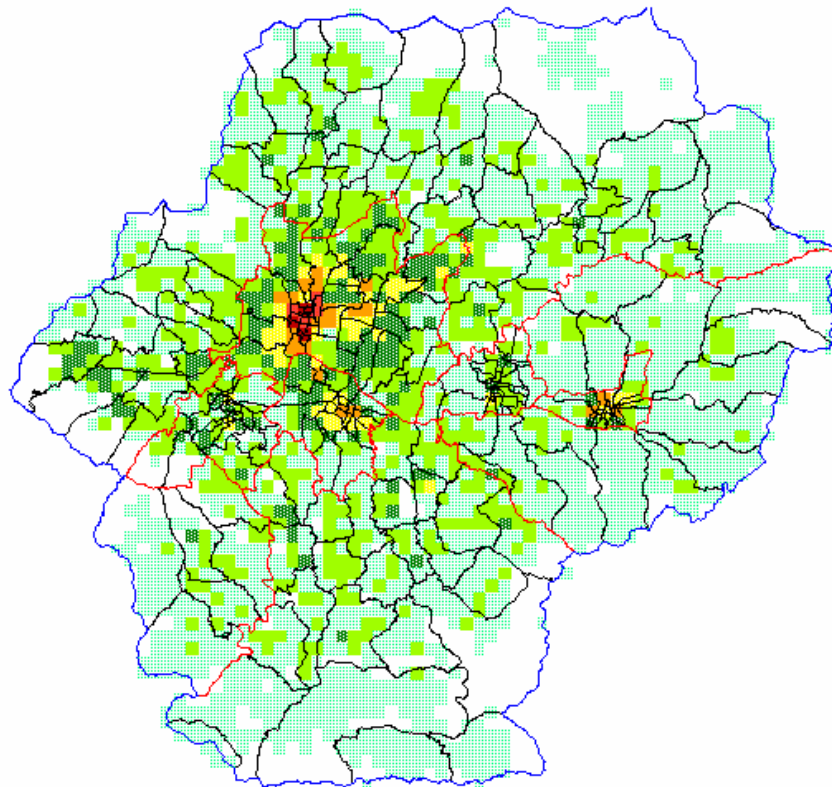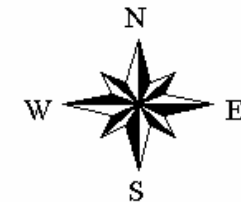0   5   10   15   20 Kilometers

Vulnerability Function

Nepal National Building Code

Vulnerability Functions Modified using 1988 Eq Damage Data

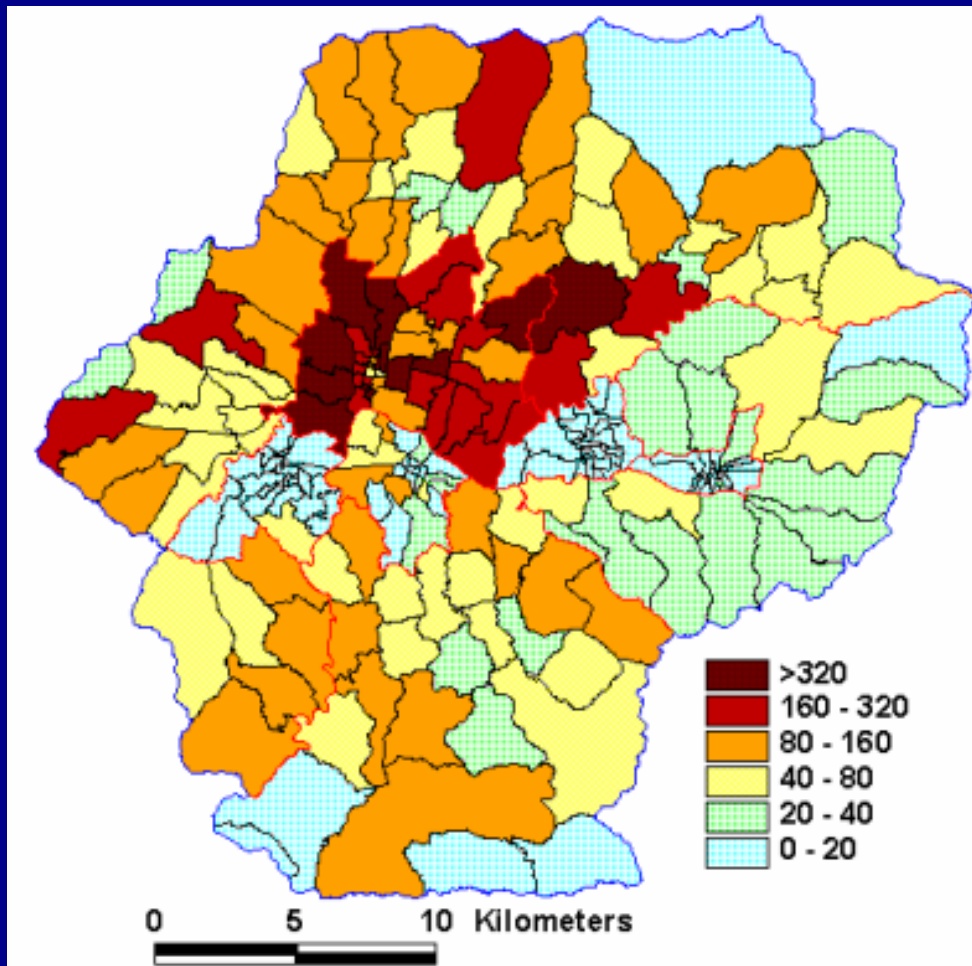Heavily Damaged Building Distribution (Mid Nepal Earthquake)

SEDM: Casualties (Deaths)

Legend:
- >320 (dark red)
- 160 - 320 (red)
- 80 - 160 (orange)
- 40 - 80 (yellow)
- 20 - 40 (green)
- 0 - 20 (light blue)

0   5   10 Kilometers

Mid Nepal EQ

- Used 1988 Eq Data

- Verified by Coburn and Spence (1992)

MERMP Experience 2003

Municipal Earthquake Risk Management Project
Project Implemented Municipalities
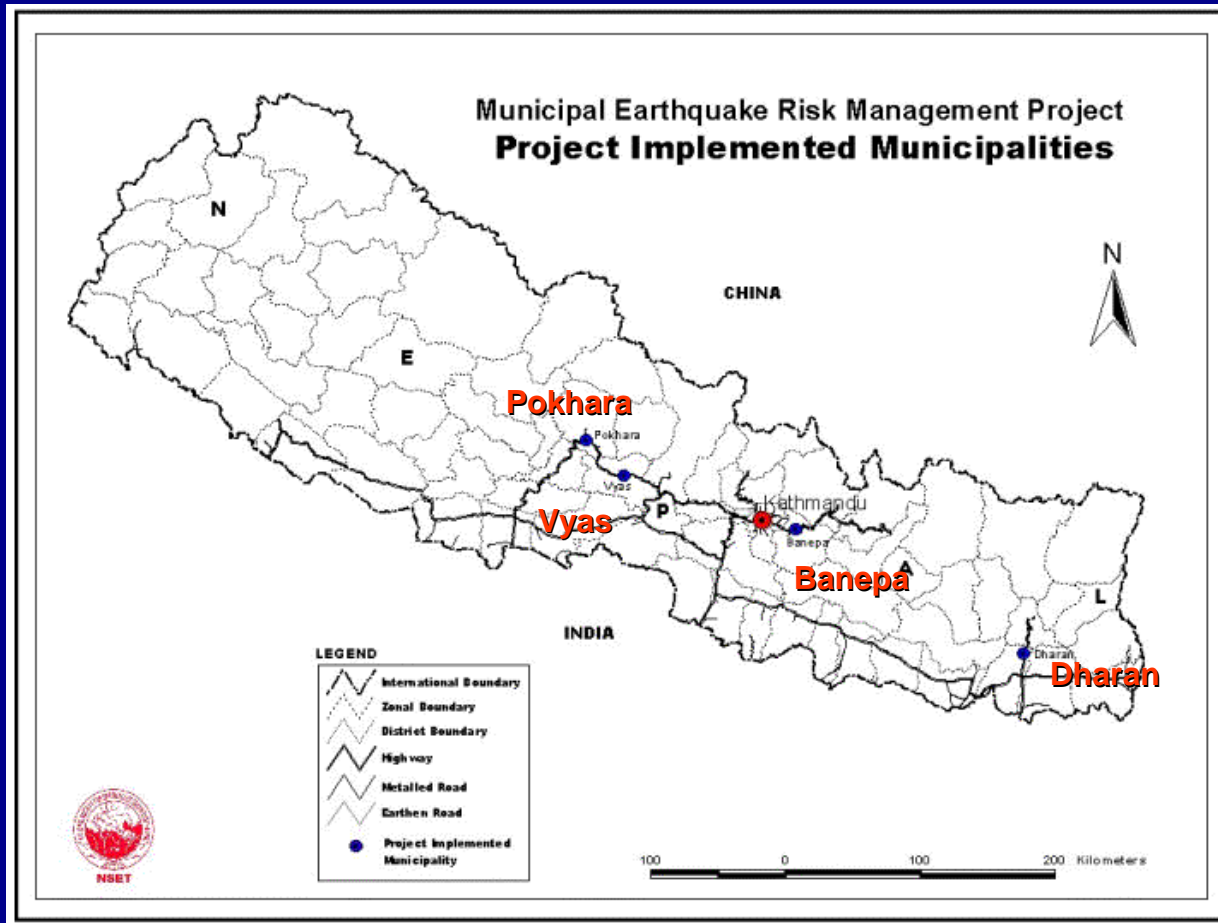
- **Under ADPC/AUDMP**

- **Consolidation Phase of KVERMP**

Seismic Hazard in RADIUS
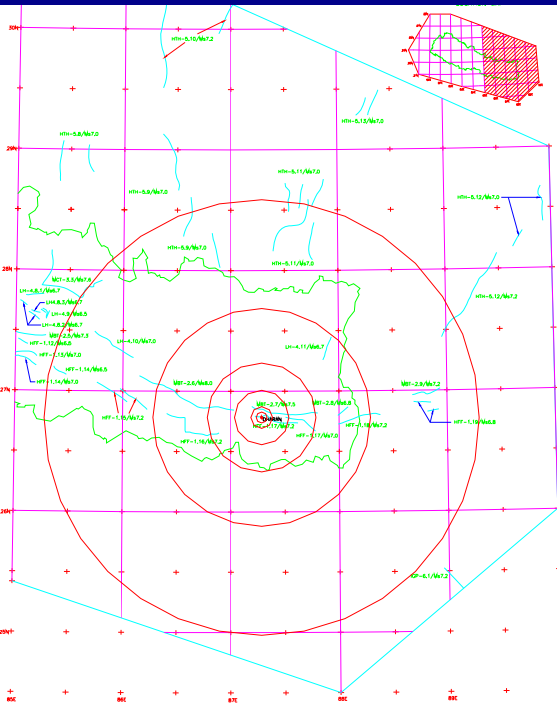
Color ID	Automatic Range		Manual Range	
	From	To	From	To
a	7.8	8.0	7.5	8.5
b	8.0	8.3	8.5	9.0
c	8.3	8.5	9.0	10.0
d	8.5	8.8	10.0	11.0

Intensity Map

MMI

Earthquake Risk Assessment
(Scenario Earthquake)

**Intensity Map
Dharan Municipality**

Labels on map: Phushre, Zeropoint, Vijaypur, Mangalbare, Chhatachowk, Dadaghopa, Bhanuchowk, BPKIHS, Tinkune

Legend
- Municipality boundary
- River Stream
- Highway
- Major roads
- Intyensity IX
- Intensity VIII

1 0 1 2 Kilometers
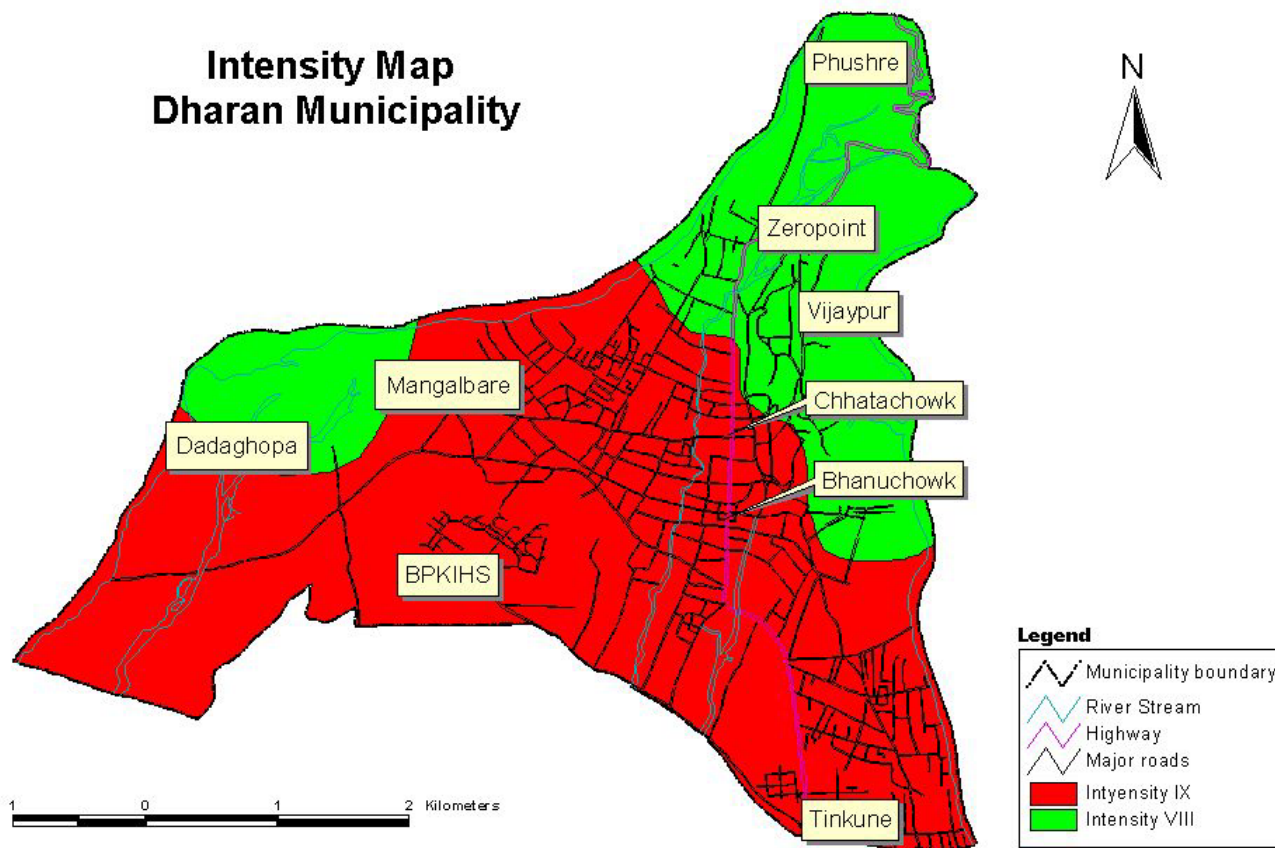
National Solciety for Earthquake Technology-Nepal (NSET)

- **VIII: Damage to masonry buildings.**
- **IX: Poorly built masonry structures collapse; all structures are damaged. Underground pipes broken.**
- **X: Most well-built masonry and frame structures and bridges are destroyed.**

Building Damage Estimation
(for Scenario Earthquake)

**Building Damage Pattern
Dharan Municipality**

Phushre

Zeropoint

Vijaypur

Mangalbare

Chhatachowk

Dadaghopa

Bhanuchowk

BPKIHS

Tinkune

Legend
- Municipality boundary
- River Streams
- Highway
- Major roads
- Less than 30 % Damage
- 30 to 40 % Damage
- More than 40 % Damage

1   0   1   2 Kilometers

National Solciety for Earthquake Technology-Nepal (NSET)
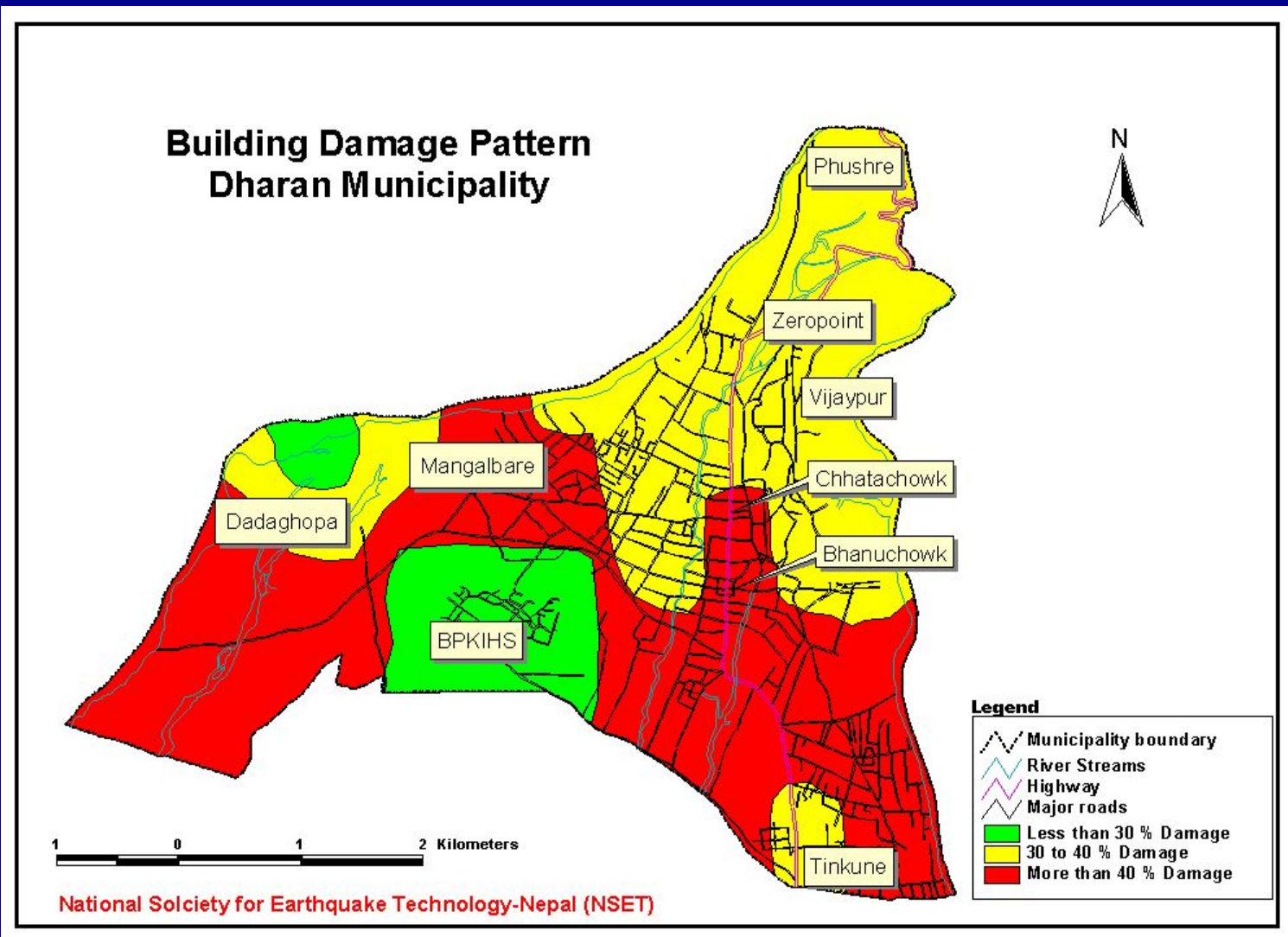
40 % of the Total Building Stock Could be Damaged

- **<u>Risk Assessment</u>** requires undertaking the following steps:
  - Collection and collation of available existing data
  - Kick-off meeting to introduce the project to the community
  - Hazard assessment
  - Vulnerability assessment
  - Damage estimation (theoretical)
  - Damage estimation (non-theoretical) using interviews
  - Preparation of the earthquake scenario
  - Implementation of the scenario workshop
  - Dissemination of the earthquake scenario
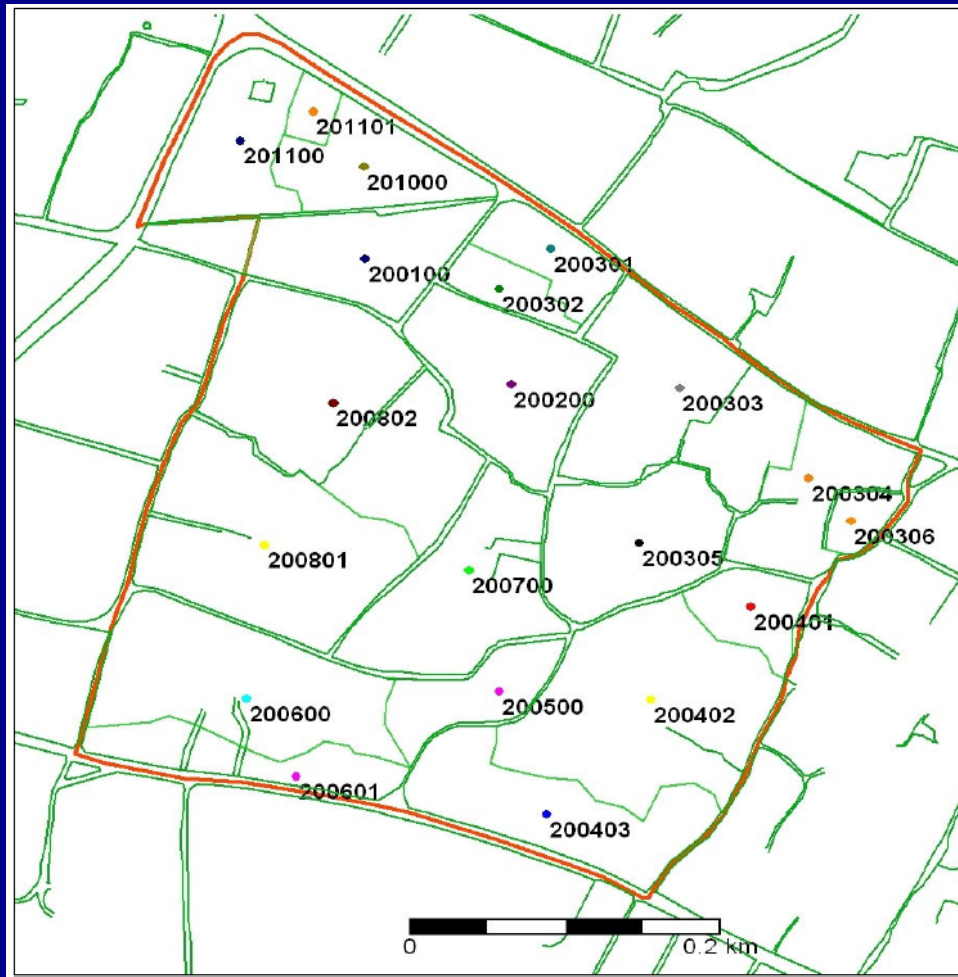
Process!

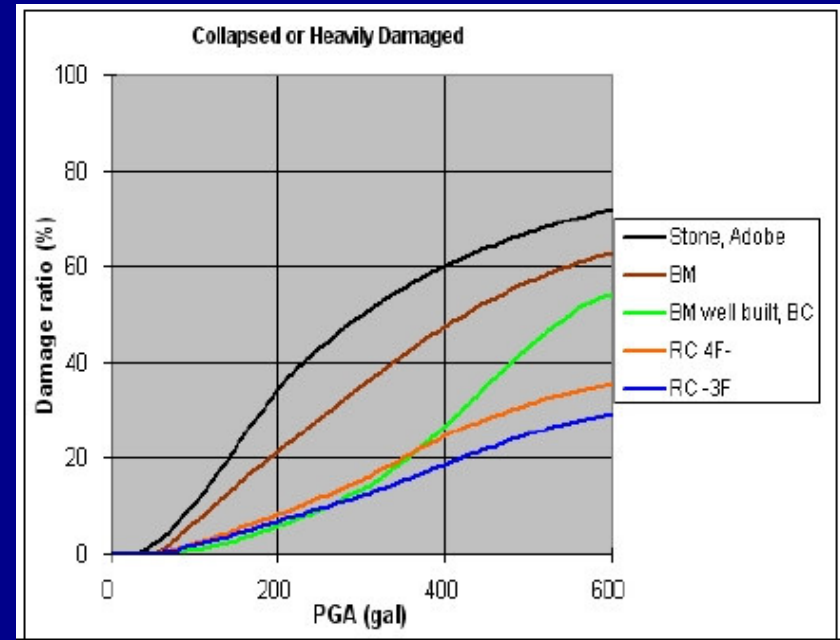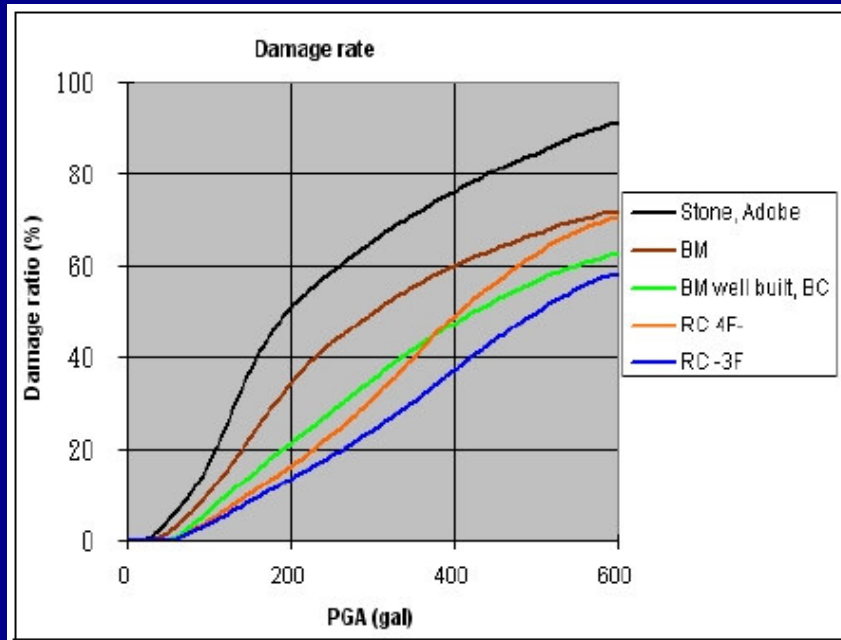Figure 4.9: Homogeneous area digitising: an example from Ward no 20

Vulnerability Functions Modified using 1988 Eq Damage Data

Building type: R. C. Framed (≤3 storied)

MMI		VI	VII	VIII	IX
PGA (% g)		5-10	10-20	20-35	>35
Damage Pattern (% of buildings)	Total Collapse	0-2	2-7	7-15	15-30
	Partial Damage	0-4	4-14	14-30	30-60

Source NSET Nepal

Building Damage
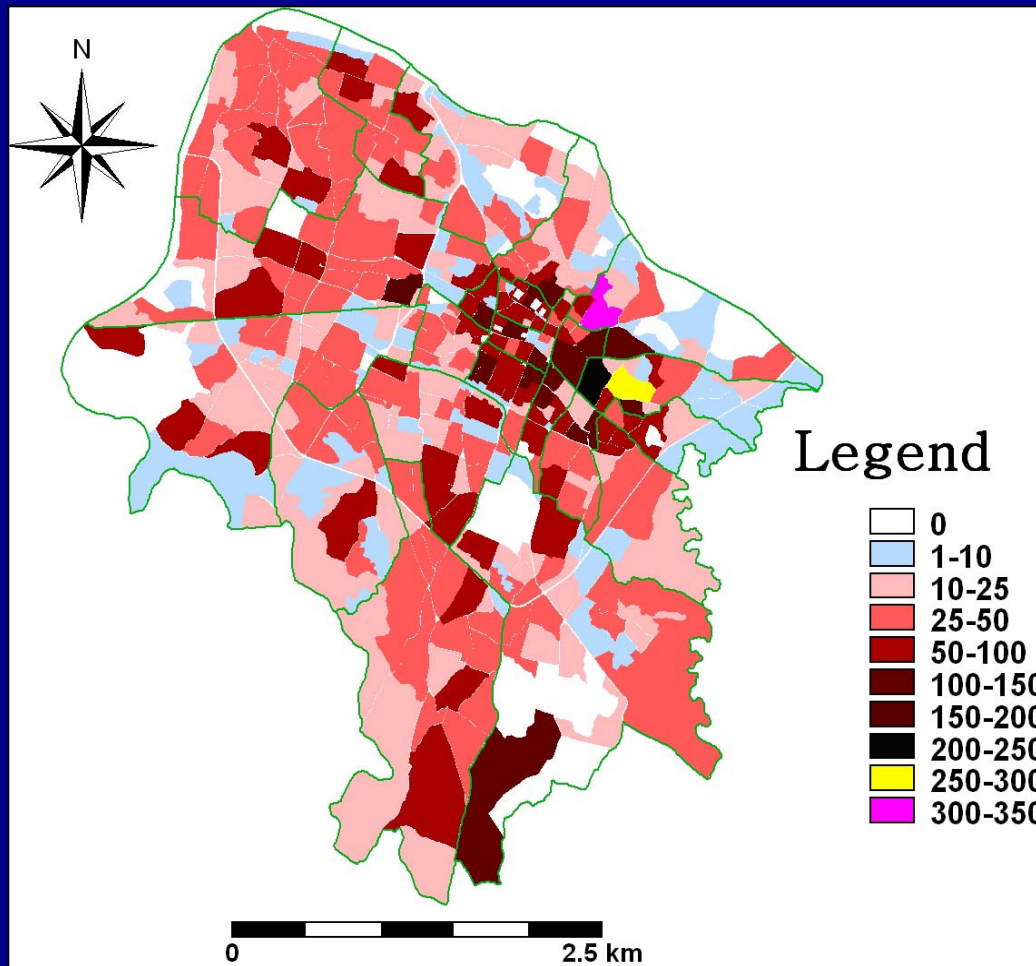
**Building Damage:
About 50%
Total Number of
Building Damage:
20,000**

Legend

☐	0
☐	1-10
☐	10-25
☐	25-50
☐	50-100
☐	100-150
☐	150-200
☐	200-250
☐	250-300
☐	300-350

0   2.5 km

(Source: Guragain, 2004)

Selected Wards: Individual Buildings
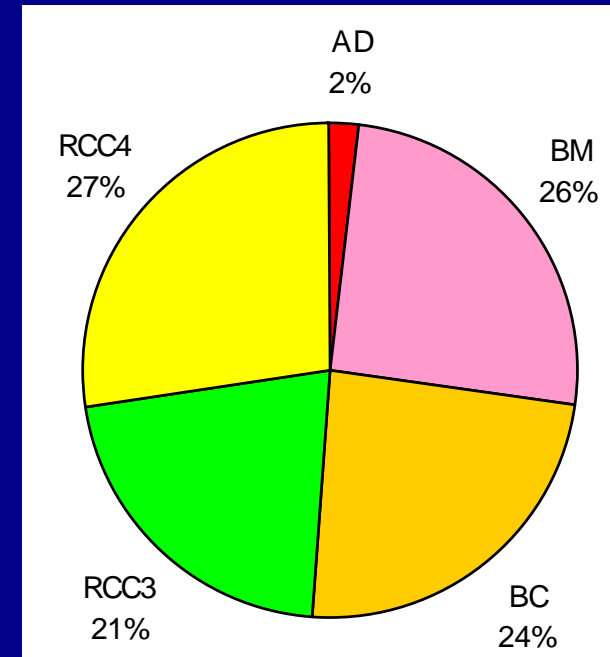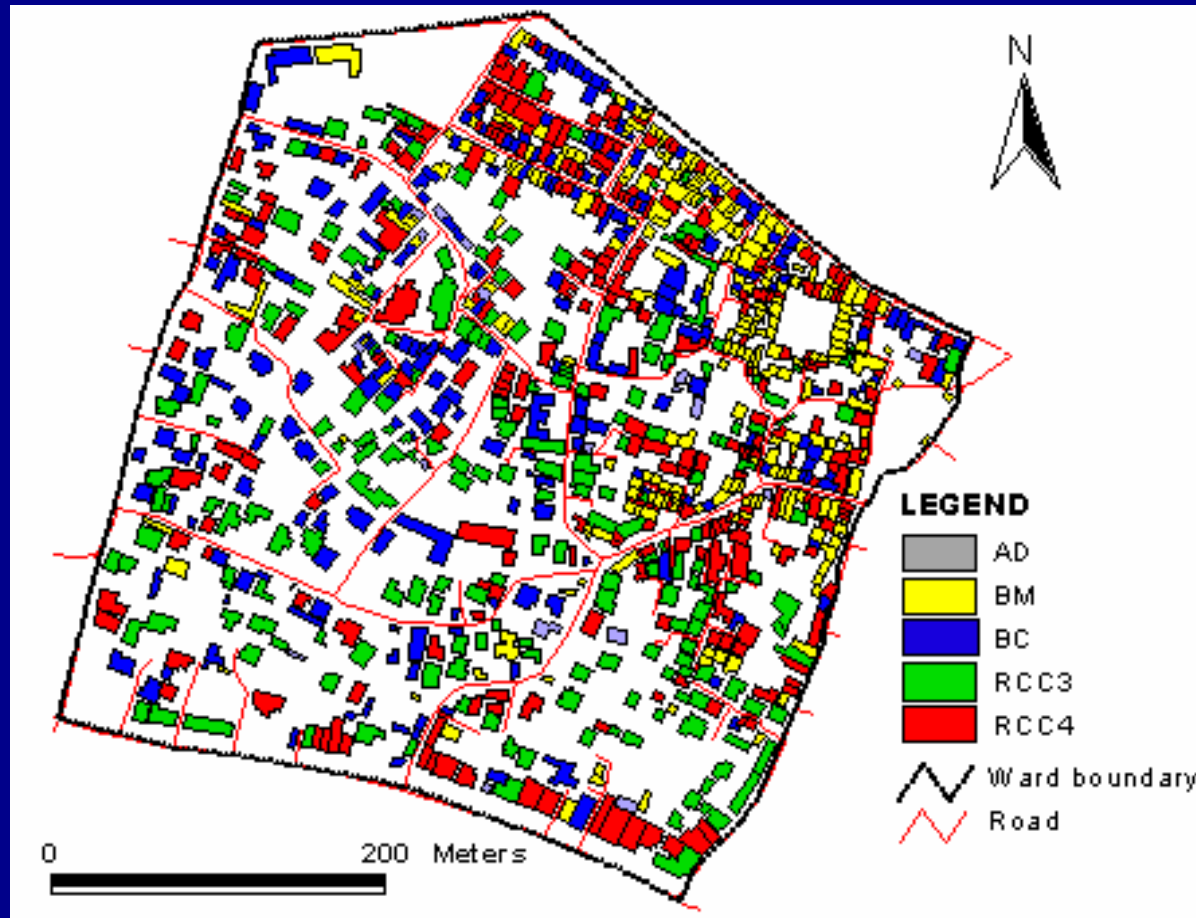
Building Classification (Jimee, 2006)

Selected Wards: Detail Building Parameters

Table 4-2: Comparison of building parameters

Building Parameters	Age	Wall cracks	Floor cracks	Dampness	Plinth band	Lintel band	Roof band	Gable band	Geometry	Soft storey	Partial floor	Total weight	Final weights
Age	0	1	1	1	1	1	1	1	1	1	1	10	0.061
Wall cracks	2	0	2	2	2	2	2	2	2	2	2	20	0.121
Floor cracks	2	1	0	2	2	2	2	2	2	2	2	19	0.115
Dampness	2	1	1	0	2	2	2	2	2	2	2	18	0.109
Plinth band	2	1	1	1	0	1	2	2	2	2	2	16	0.097
Lintel band	2	1	1	1	2	0	2	2	2	2	2	17	0.103
Roof band	2	1	1	1	1	1	0	2	2	2	2	15	0.091
Gable band	2	1	1	1	1	1	1	0	2	2	2	14	0.085
Geometry	2	1	1	1	1	1	1	1	0	2	2	13	0.079
Soft storey	2	1	1	1	1	1	1	1	1	0	2	12	0.073
Partial floor	2	1	1	1	1	1	1	1	1	1	0	11	0.067
Total weight												165	1.000

MMI		VI	VII	VIII	IX	X
Damage Grades for Different Classes of Buildings	Weak	DG4	DG5	DG5	DG5	DG5
	Average	DG3	DG4	DG5	DG5	DG5
	Good	DG2	DG3	DG4	DG4	DG5

Casualties due to intensity IX earthquake

Severity Level 1 - Day

Severity Level 1 - Night

Severity Level 4 -Day

Severity Level 4 - Night

Schools (class rooms)

LEGEND
- 0 persons
- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 50
- Ward boundary
- Road
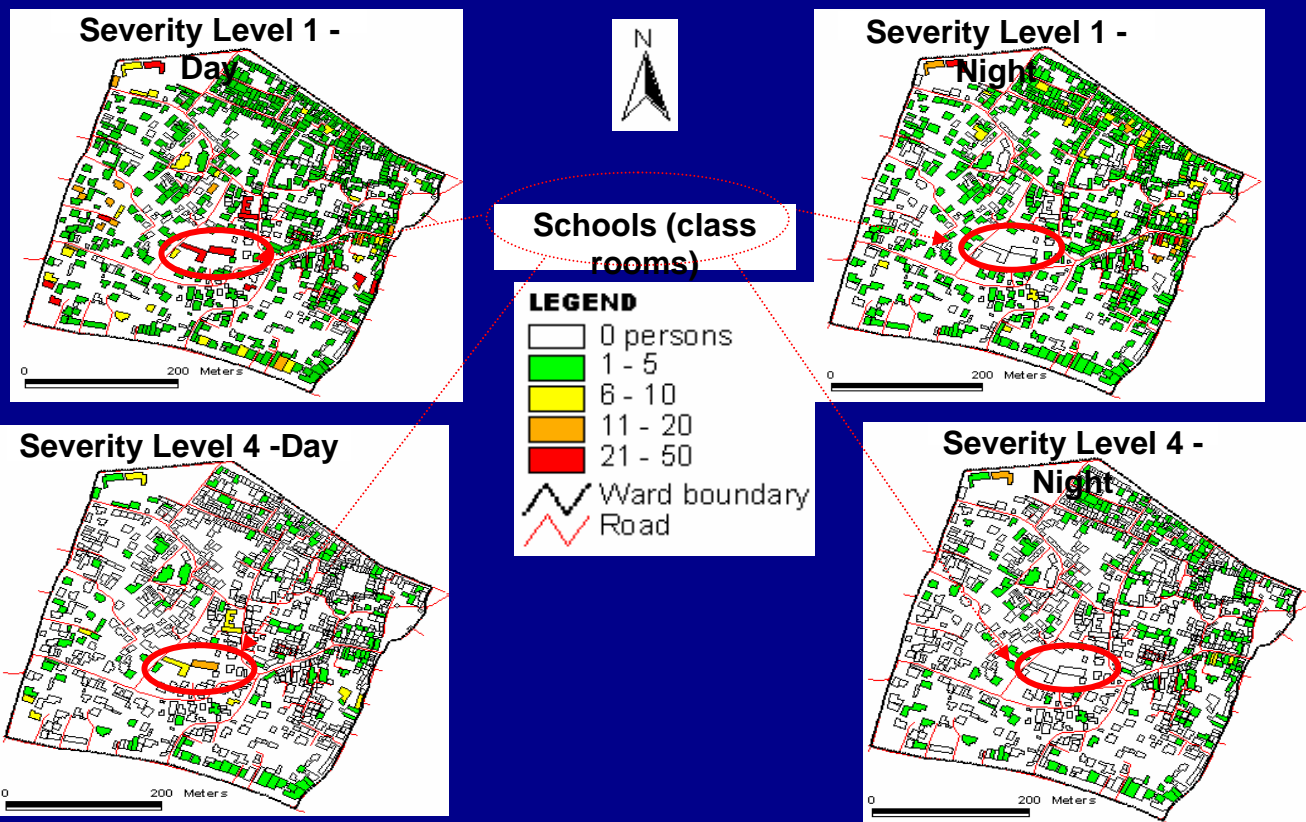
Table 5-1: Injury severity levels description

Building Damage Level	Injury Level (in %)			
Injury Level (in %)	Severity 1	Severity 2	Severity 3	Severity 4
Partial Damage	1	0.1	0.001	0.001
Complete Damage	40	20	5	10

Source: Islam, 2004

Very Detail: Water during Emergency

Major Probable Evacuation Points in Kathmandu metropolitan City (KMC)

Evacuation Places	People holding capacity	Water (ltrs/day)	Reserve tanks for three days
Golf Course and Pashupati area	68,099	1,021,479	383
Birendra Intl. Conference Hall	14,286	214,286	80
Trally Park	8,893	133,393	50
Tudikhel (Khula Manch, Tudinkhel, Ratna park, Stadium, and Bhricuti Mandap area)	66,571	998,571	374
Exhibition Road area	4,957	74,350	28
Bhadrakali Military Camp area	10,809	162,141	61
Thapathali campus area	3,305	49,569	19
Chhauni Military area	28,055	420,822	158
National Trading Corporation	10,136	152,044	57
Balaju Buspark area	12,237	183,551	69
Total	227,347	3,410,205	1279

Very Detail: Identification of Non-structural Vulnerability Reduction Options

Steel Frame →
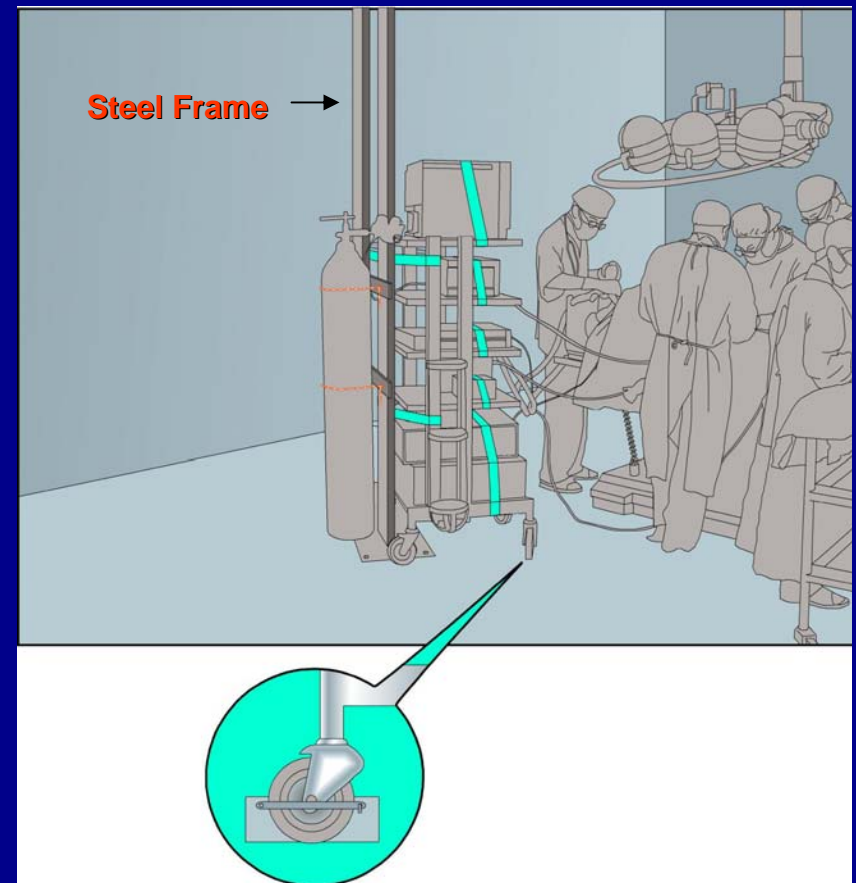
Improving Safety of Operation Theaters

Ongoing/Upcoming Programs

With Universities

- TU Master's Degree Students (3 Persons) working in Ilam at Individual Buildings Level

  - Buildings

  - Population

  - Infrastructure

GRIP

- 2 Municipalities

MPPW+UNDP+IRP

- 5 Municipalities

Lessons

- RA can be done at different level/accuracy

- RA as a Powerful City Planning Tool

- RA has been very Important Awareness Tool

- Involvement from City/Community Level is Very Important for Proper Utilization of the Outcome

Thank You!