DISASTER MITIGATION:
SUSTAINABLE APPROACHES FOR HIMALAYAN REGION

POST DISASTER RESETTLEMENT - THE SUSTAINABLE WAY

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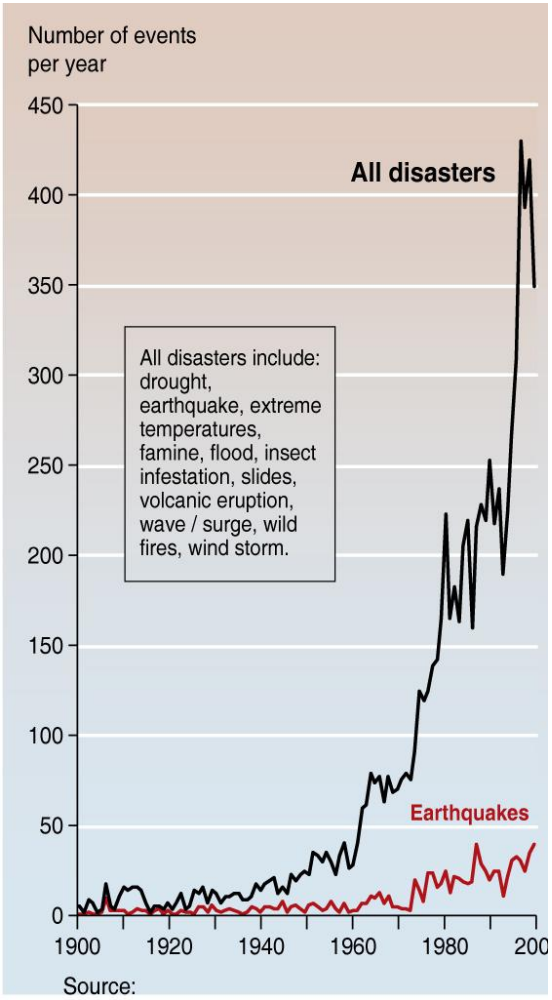
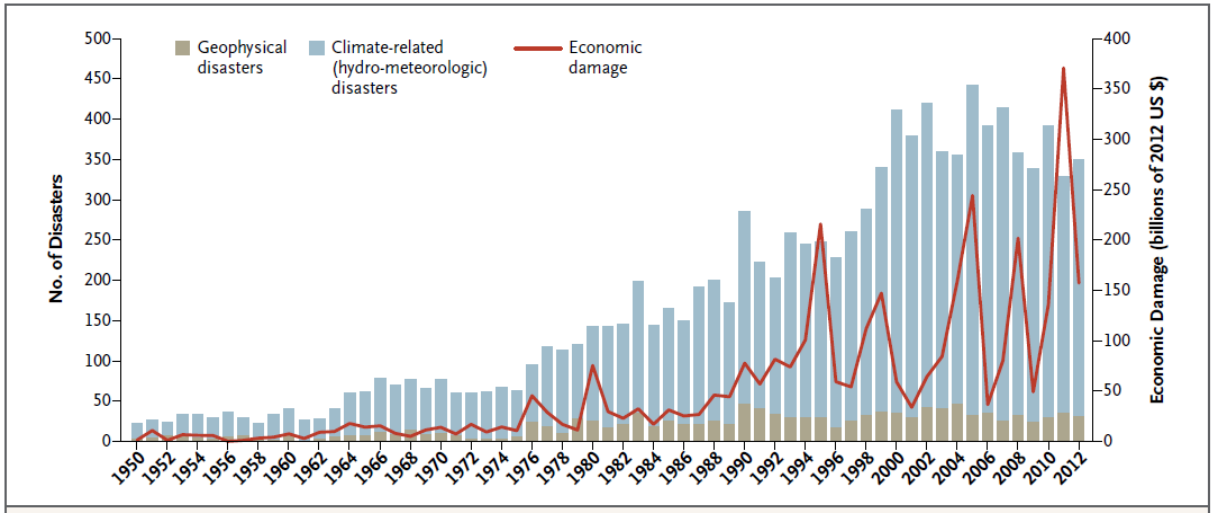


INCREASING TREND OF NATURAL DISASTERS



*(EM-DAT International **Disaster Database**, Center)*

Munich RE

Loss events worldwide 2014

10 deadliest events

Date	Event	Affected area	Fatalities
3-15.9.2014	Floods	India, Pakistan	665
3.8.2014	Earthquake	China	617
9-16.8.2014	Floods, landslides	Nepal	229
11-22.7.2014	Typhoon Rammasun (Glenda)	China, Philippines, Vietnam	195
April - May 2014	Floods, flash floods	Afghanistan	175
2.8.2014	Landslide	Nepal	156
October 2014	Floods	Democratic Republic of Congo	154
30.7.2014	Landslide	India	151
August - September 2014	Floods	India	151
December 2014	Cold wave	India	145

Source: Munich Re, NatCatSERVICE, 2015

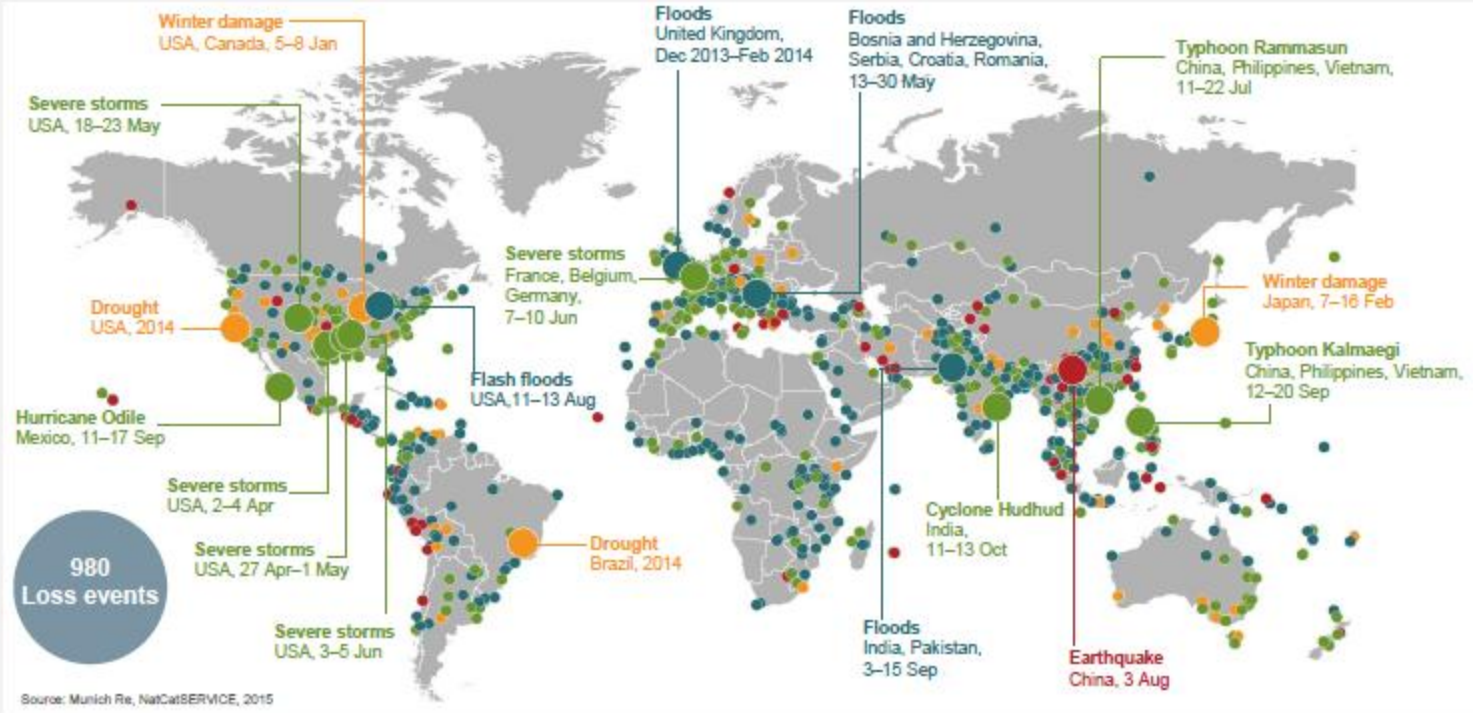
As at: January 2015

NatCatSERVICE

Loss events worldwide 2014

Geographical overview

Munich RE



- Loss events
- Selection of catastrophes
  Overall losses ≥ US$ 1,500m
- Geophysical events
  (Earthquake, tsunami, volcanic activity)
- Meteorological events
  (Tropical storm, extratropical storm, convective storm, local storm)
- Hydrological events
  (Flood, mass movement)
- Climatological events
  (Extreme temperature, drought, wildfire)

Mountains

Mountains form one of the most important bio-geographical resource zones of the world.

Mountains cover 24 per cent of the earth's continental surfaces and 52 per cent of Asia

They directly support 22 per cent of the world's people who live within mountain regions. A further 40 per cent live adjacent or very close to mountain areas and are benefited from mountain resources in more than one ways.

Over half the global population depends on mountain environments for a wide range of goods and services including for water, food, hydro-electricity, timber, biodiversity maintenance and mineral resources.

The Himalayan Region

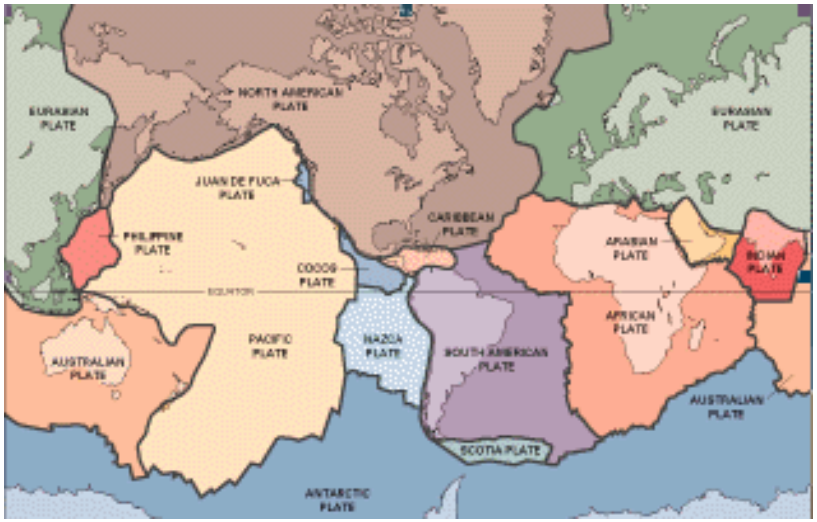
17 % of global Mountain Area

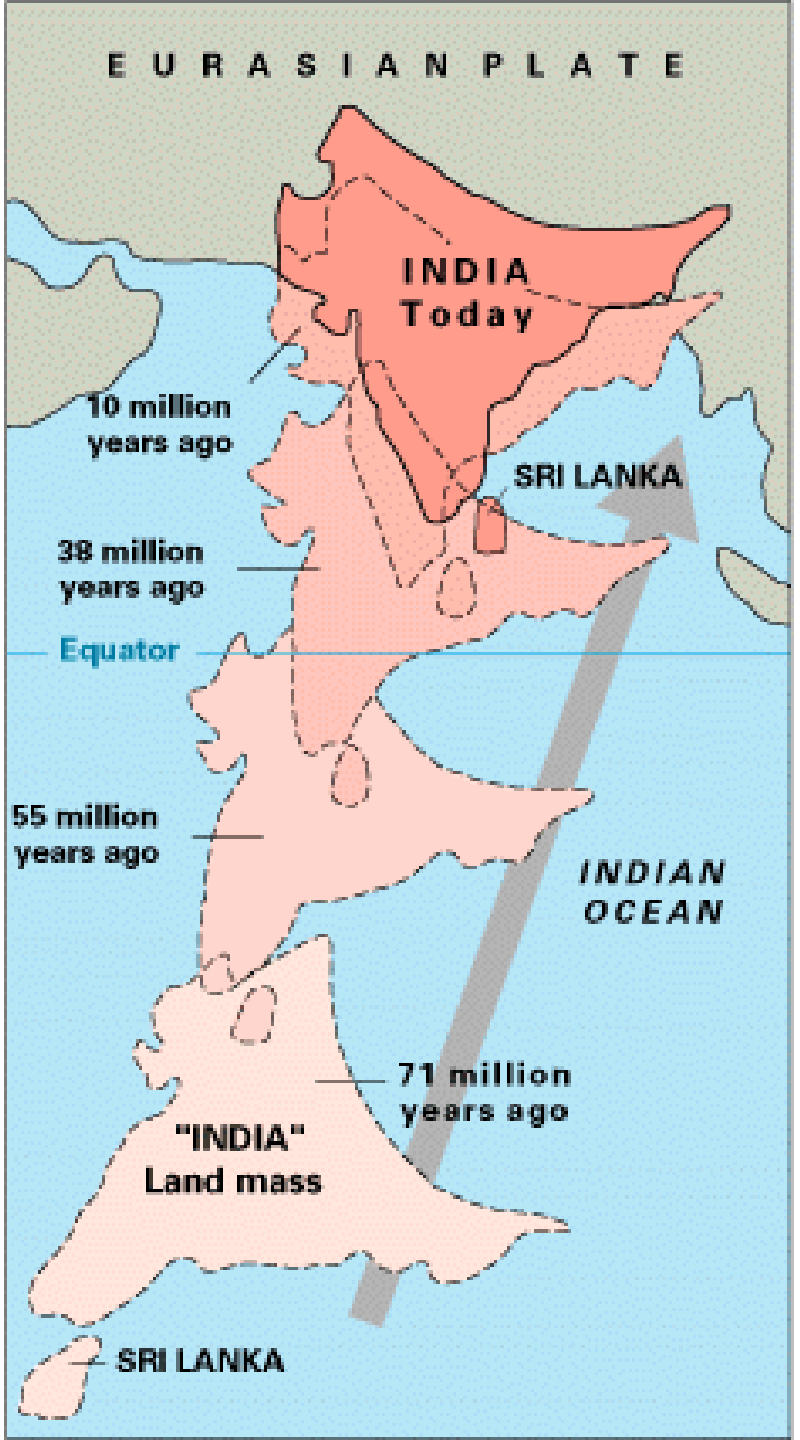
Area: 4.3 million sq km (Approx.)

Himalaya, youngest and the highest mountain range

Most populated mountain systems in the world

World's fastest uplift rate 10 mm/a (at Nanga Parwat)





The Himalayan Region

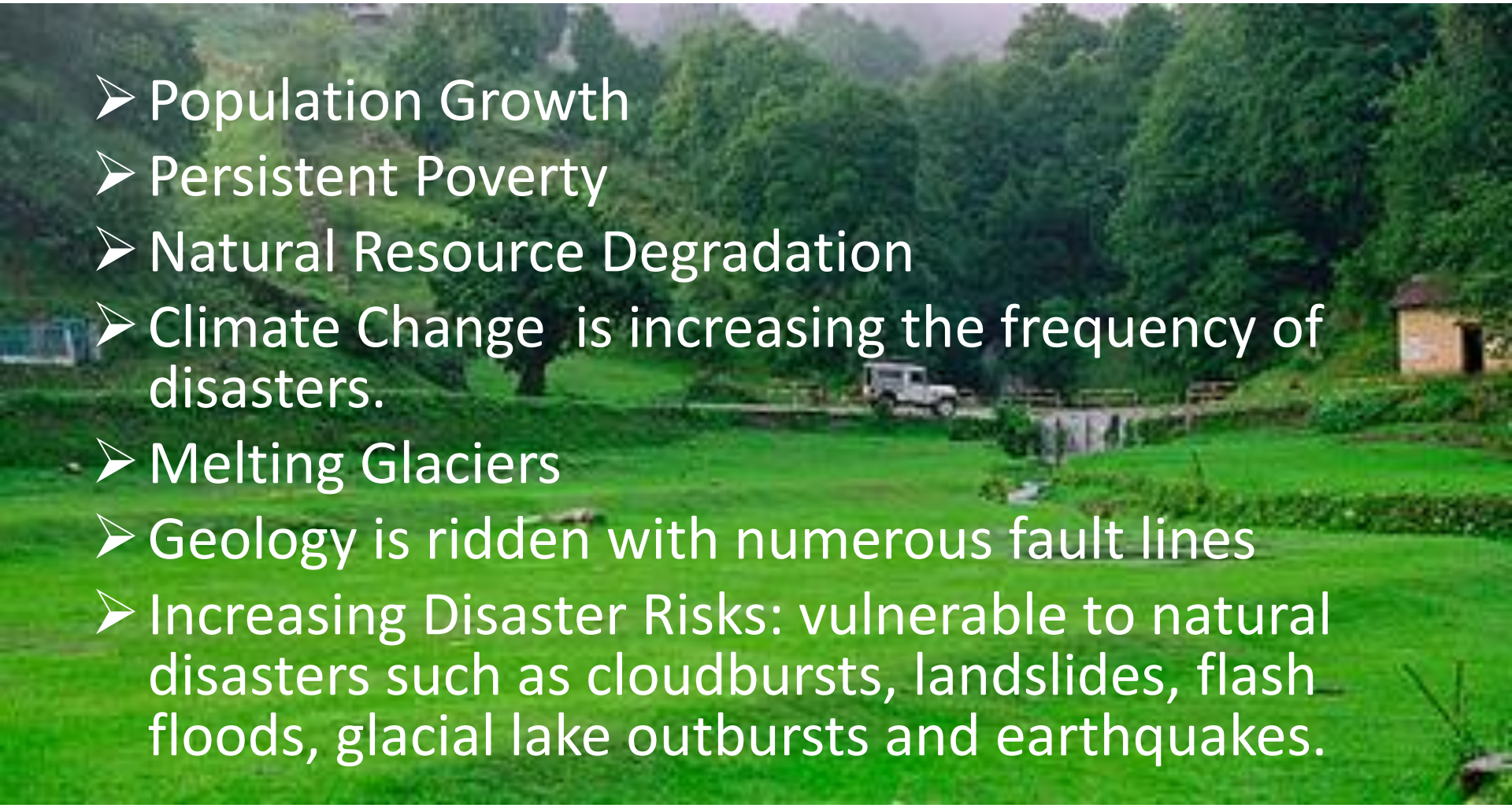
Eight Countries	Nine large Asian river systems
• AFGHANISTAN • BANGLADESH • BHUTAN • CHINA • INDIA • MYANMAR • NEPAL • PAKISTAN	• The Indus • Ganges • Brahmaputra • Irrawaddy • Salween • Mekong • Tarim • Yangtse • Yellow River

1.5 Billion People depend on Himalaya for Water, Food and Energy

THE HIMALAYAN ECOSYSTEM

- COMPLEX and FRAGILE
- SENSITIVE TO CLIMATE CHANGE
- PERSISTENT POVERTY
- RICH IN NATURAL RESOURCES
- BIOLOGICAL DIVERSITY
- SOCIO-CULTURAL & ETHNIC DIVERSITY
- PREDOMINANT SOURCE OF FRESH WATER

Challenges for Sustaining Himalayan Ecosystem



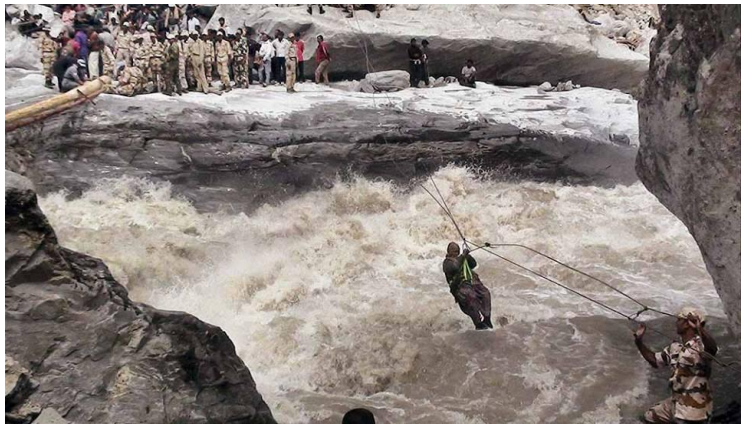
- Population Growth
- Persistent Poverty
- Natural Resource Degradation
- Climate Change is increasing the frequency of disasters.
- Melting Glaciers
- Geology is ridden with numerous fault lines
- Increasing Disaster Risks: vulnerable to natural disasters such as cloudbursts, landslides, flash floods, glacial lake outbursts and earthquakes.

FACTORS RESPONSIBLE FOR INCREASING THE VULNERABILITY OF HIMALAYAN COMMUNITIES

PHYSICAL ISOLATION	• The Himalayan communities are vulnerable due to physical isolation, the scattered settlement patterns, and the harsh climatic conditions.
DEVELOPMENT OF INFRASTRUCTURE	• The development of infrastructure for health, education, safe drinking water and sanitation is often overlooked due to the high construction costs and the physical distances and the nature of terrain involved.
DIFFICULT AVAILABILITY OF LAND	• The difficult availability of land area often compels for building any house or roads on vulnerable locations.
LACK OF EARTHQUAKE RESISTANT BUILDING TECHNOLOGIES	• The remotely located communities totally lack access to earthquake resistant building technologies and construction materials.
POOR COMMUNICATION TECHNOLOGY	• Because of the poor communication technology, the communities remain cut-off from the rest of the world.

Kedarnath floods

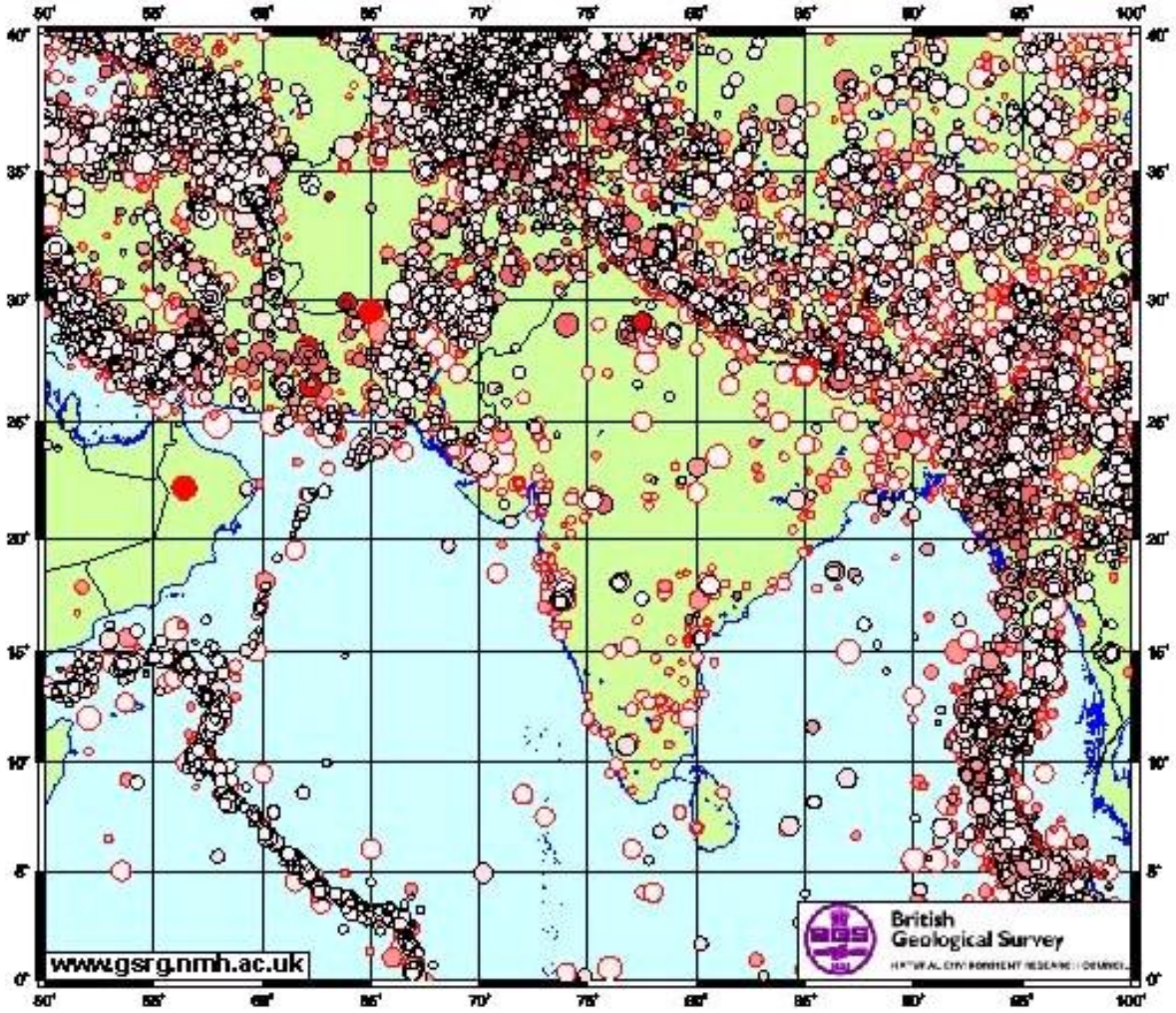
- June 2013
- Death Toll : 6000 (Approx)



Srinagar floods

- Sept 2014
- Death Toll : 600 (Approx)

Earthquakes



Earthquake events of magnitude more than 3

Nepal Earthquake

- 25th April 2015
- Death Toll : 8000 (Approx)

Landslides

Avalanche

Disaster Management Cycle

(NDMA 2016)

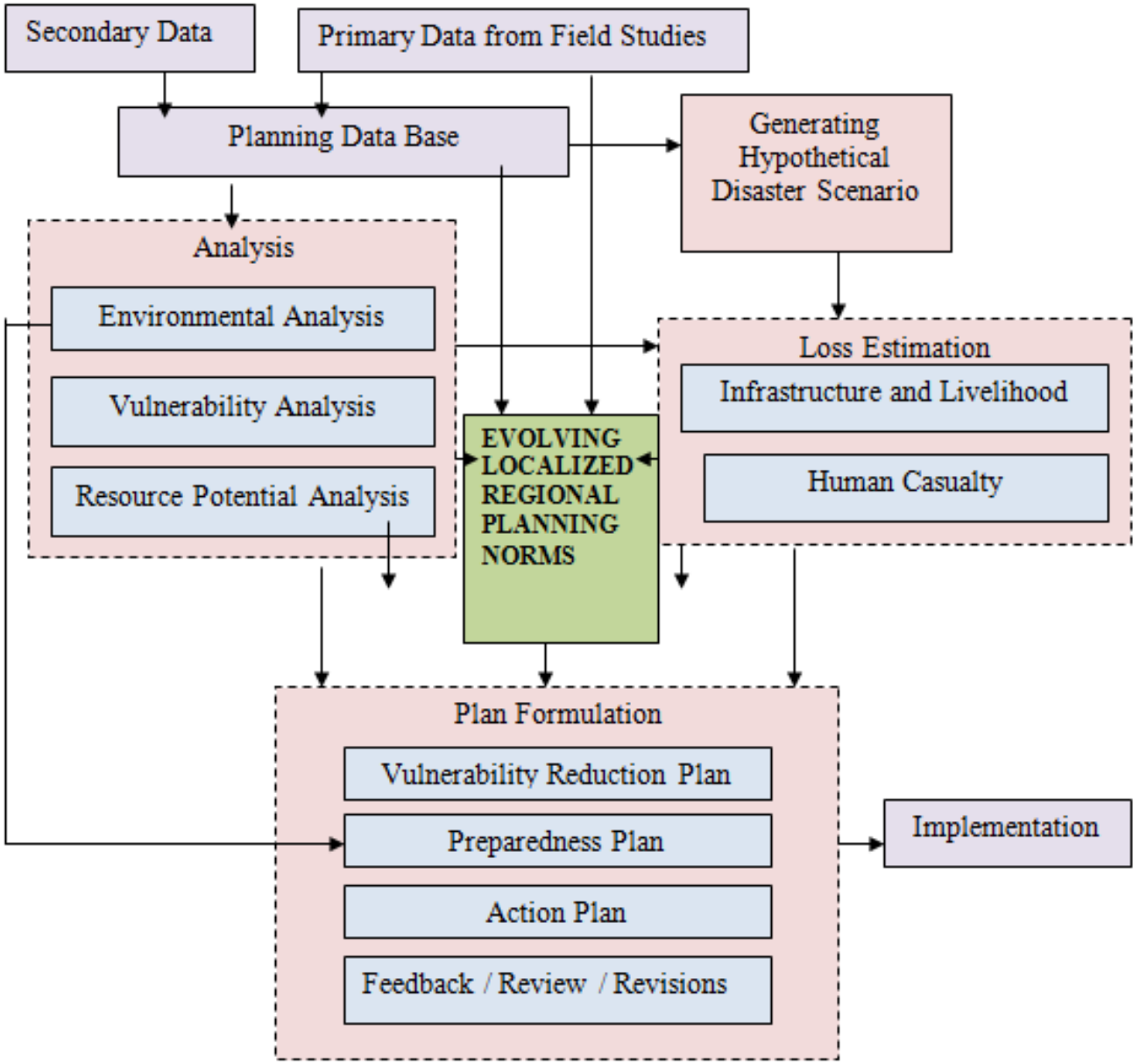
PLANNING PROCESS FOR DISASTER MANAGEMENT IN AN HIMALAYAN MICRO-REGION

Vulnerability Analysis

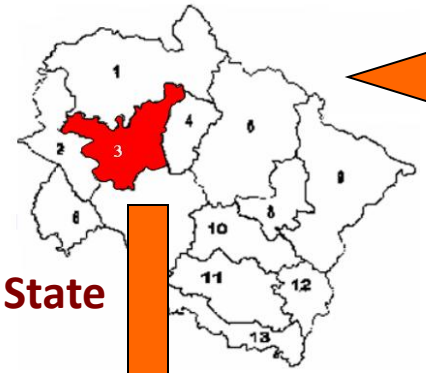
- Physical Vulnerability
- Social Vulnerability
- Economic Vulnerability
- Environmental Vulnerability

Resource Potential Analysis

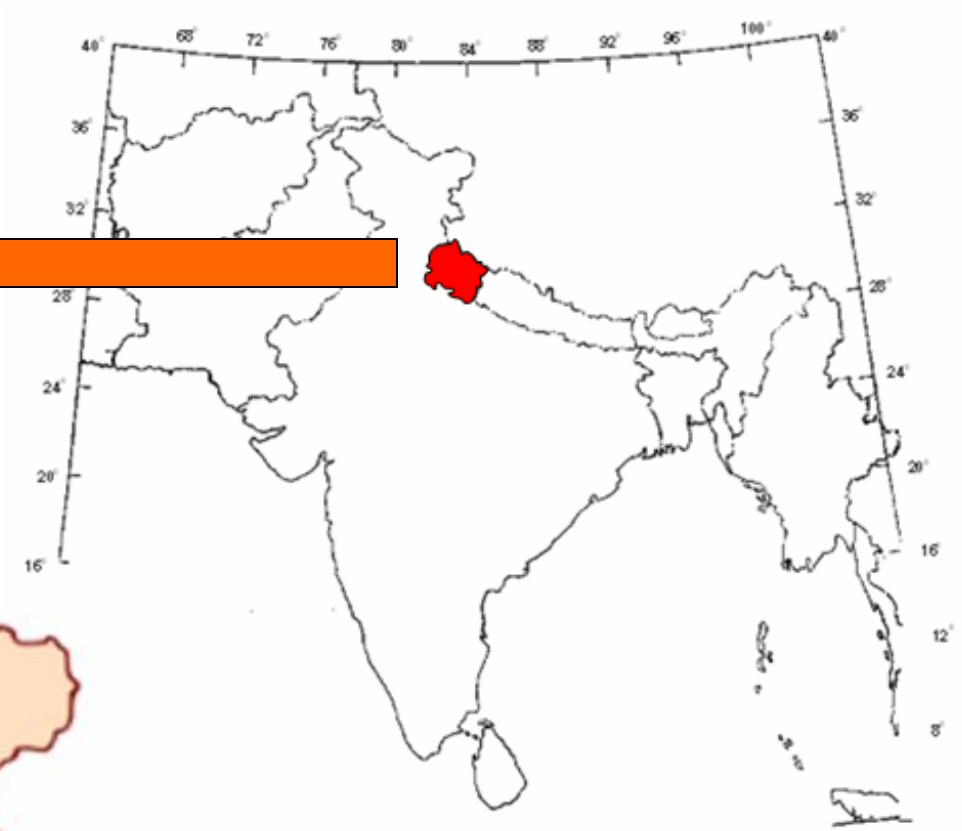
- Infrastructure
- Manpower
- Institutional setup
- Material Supplies



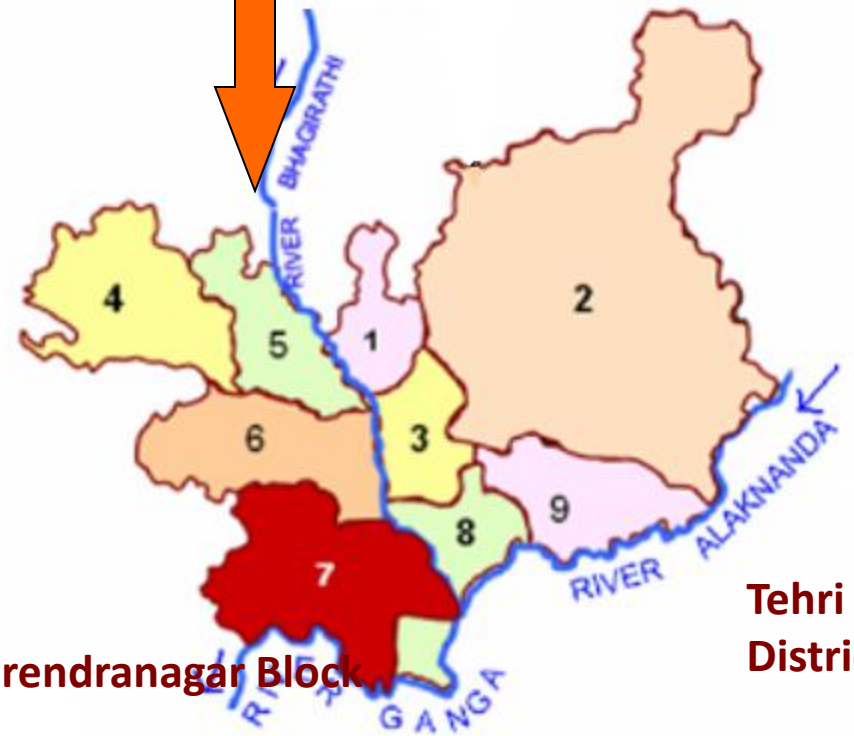
Study Area Profile



Uttaranchal State



India

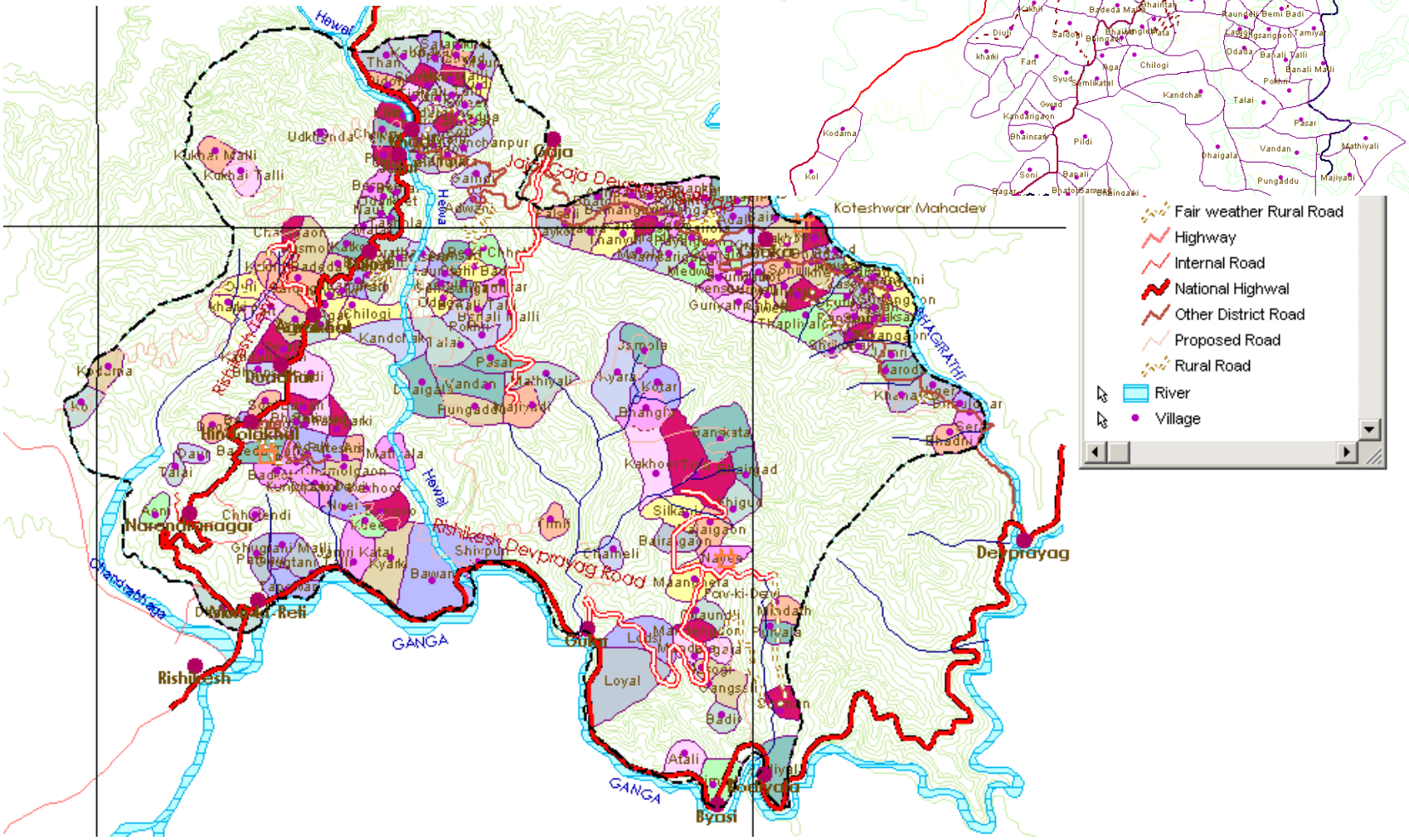


Tehri Garhwal District

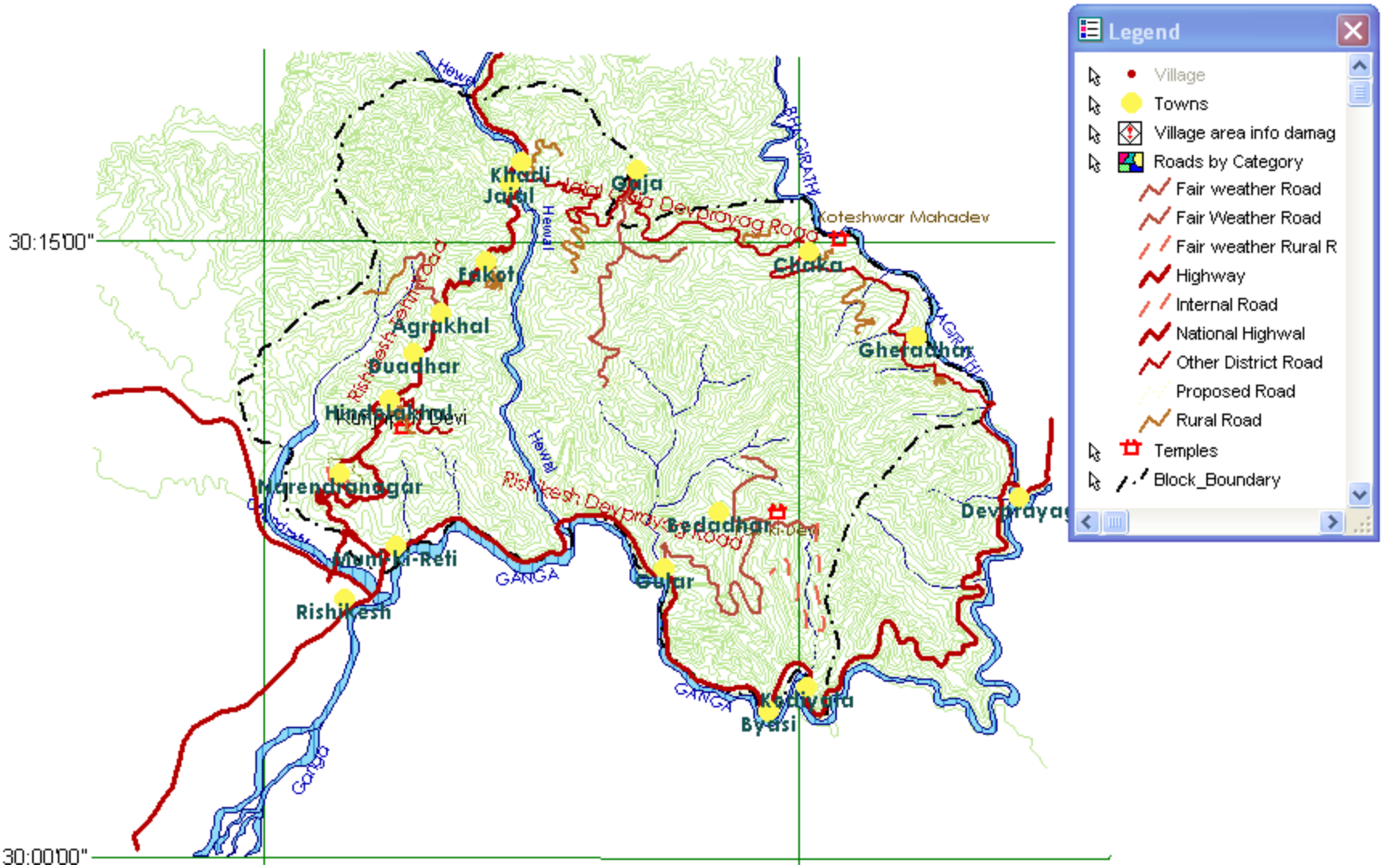
Narendranagar Block

Administrative Sub-division: Narendranagar Block

40 Kshetra Panchayats
103 Gram Panchayats
213 Villages
17 Market towns.

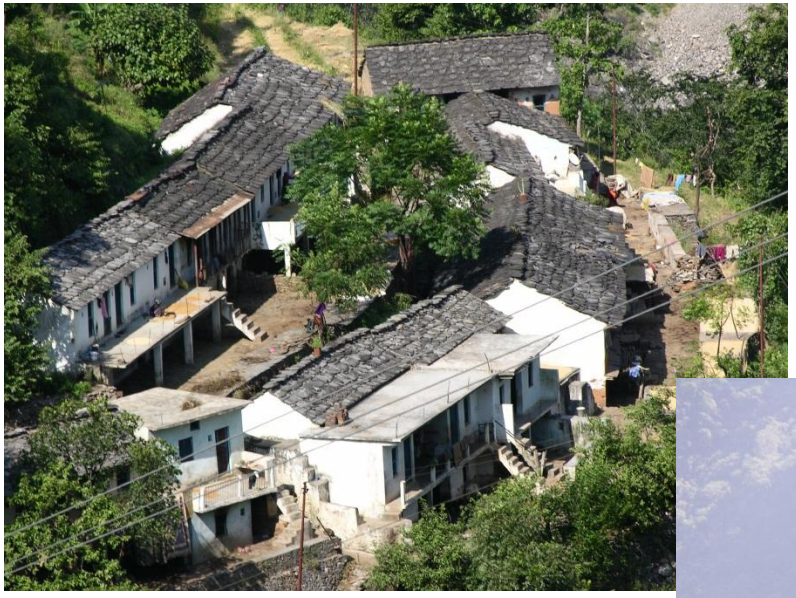


17 market Towns



Settlement Pattern

Organic village form following contours and physiographic features



Aerial view of village Kharsad of Narendranagar block

Aerial view of village Malas of Narendranagar block

House Form

Typical single storied house in Malas

Typical single storied house in Tamiyar

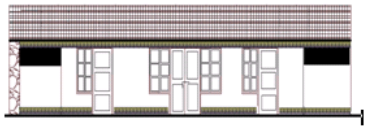


Figure A

Figure B

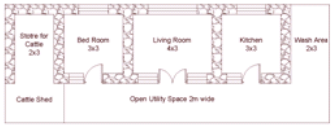


Figure C

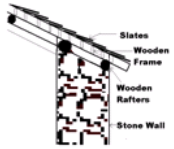


Figure D

A: Front elevation of a typical single storied house, B: Cross section of a typical single storied house,

C: Plan of a typical single storied house, D: Detail at M

Single Storied Houses

Typical double storied house in Maroda

Typical double storied house in Guriyali

Figure A

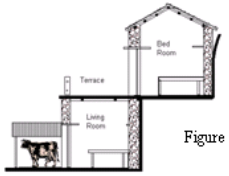


Figure B

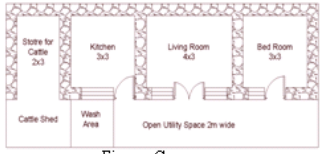


Figure C

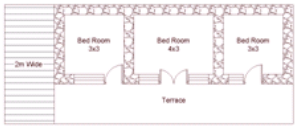


Figure D

A: Front elevation of a typical double storied house, B: Cross section of a typical double storied house,

C: Ground floor plan of a typical double storied house, D: First floor plan of a typical double storied house

Double Storied Houses

Building Components

Walling Material

Earth walls
Stone in mud (single story / double storied)
Stone in cement (single story / double storied)
Brick / Concrete block
Composite (Stone and Brick)
Composite (timber and stone)

Roofing Material

Slate
RCC
Others (thatch, timber, CGI)
Composite

Random rubble stone masonry in Narendranagar block

Random rubble stone masonry with mud plaster

Random rubble stone masonry with cement plaster

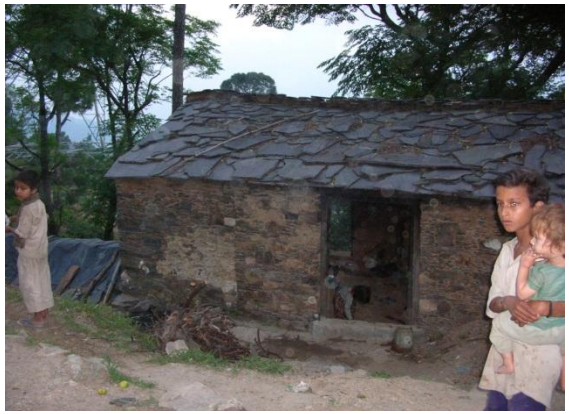
Clay Brick and Concrete Block Masonry Walls

(a) Brick walls without RC frame in Gaja

(b) Brick wall with RC frame in Tapowan

(c) Brick construction on stilts near Byasi

Roof Constructions



Slate Roof of a house in village Tamiyar

Thatch Roof of a house in Village Pokhri

Mixed Roofs in village Pasar

RCC Roofs of a residential building at Tapowan

Factors discussed for all types of Roofs,

•Positive Aspects or Strengths; Common Defects Observed; Performance during past earthquakes

Composite Constructions

(a) Collapse of slate and stone masonry wall with poorly designed RCC construction

Damage to random rubble stone masonry During Chamoli Earthquake

Damage to random rubble stone masonry at Anjar during Gujarat Earthquake 2001

(b) Collapse of typical stone and slate wall with slate roof

(a) Damaged unreinforced brick masonry wall in Muzaffarabad

(b) Little Damaged concrete block masonry constructed over stone and slate masonry wall during Chamoli Earthquake
Source: Jain *et. al.* (1999)

PERFORMANCE IN PREVIOUS EARTHQUAKES

Other Factors affecting Vulnerability

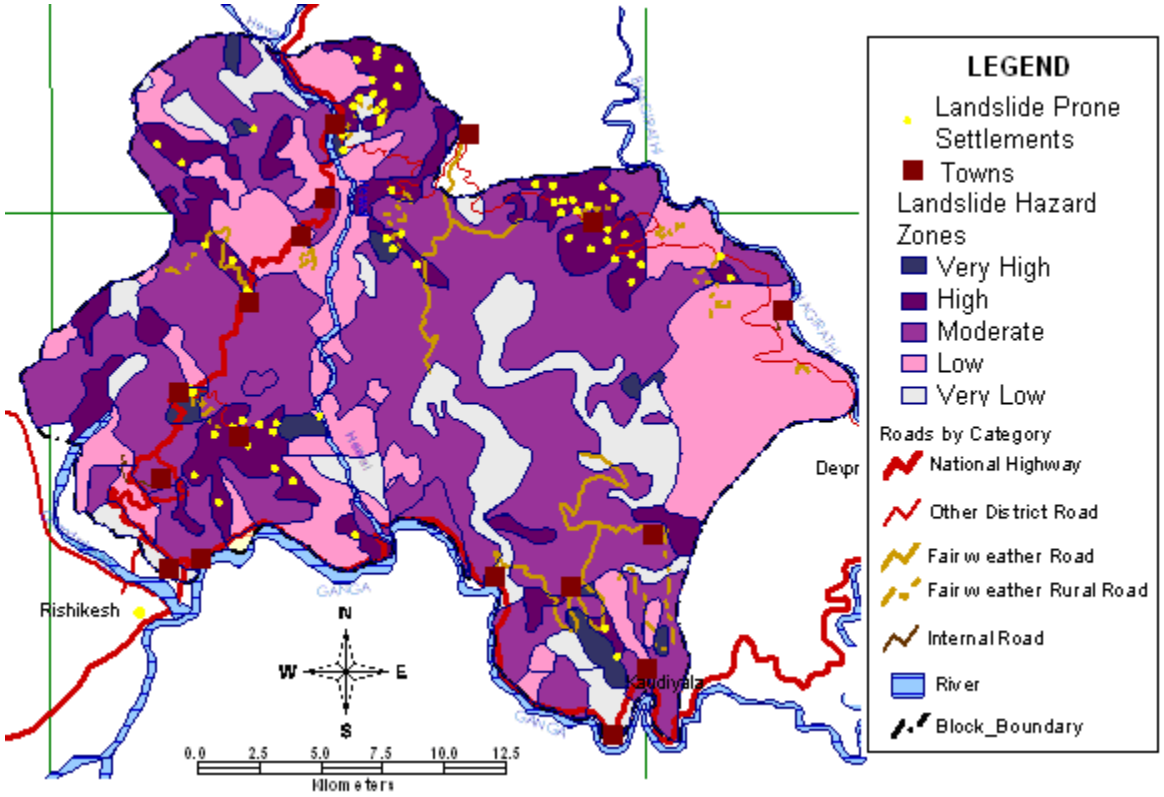
■Improper stilt construction on the slopes

■Dangerous locations

■Absence of proper joints in composite constructions breaking the integrity of structure

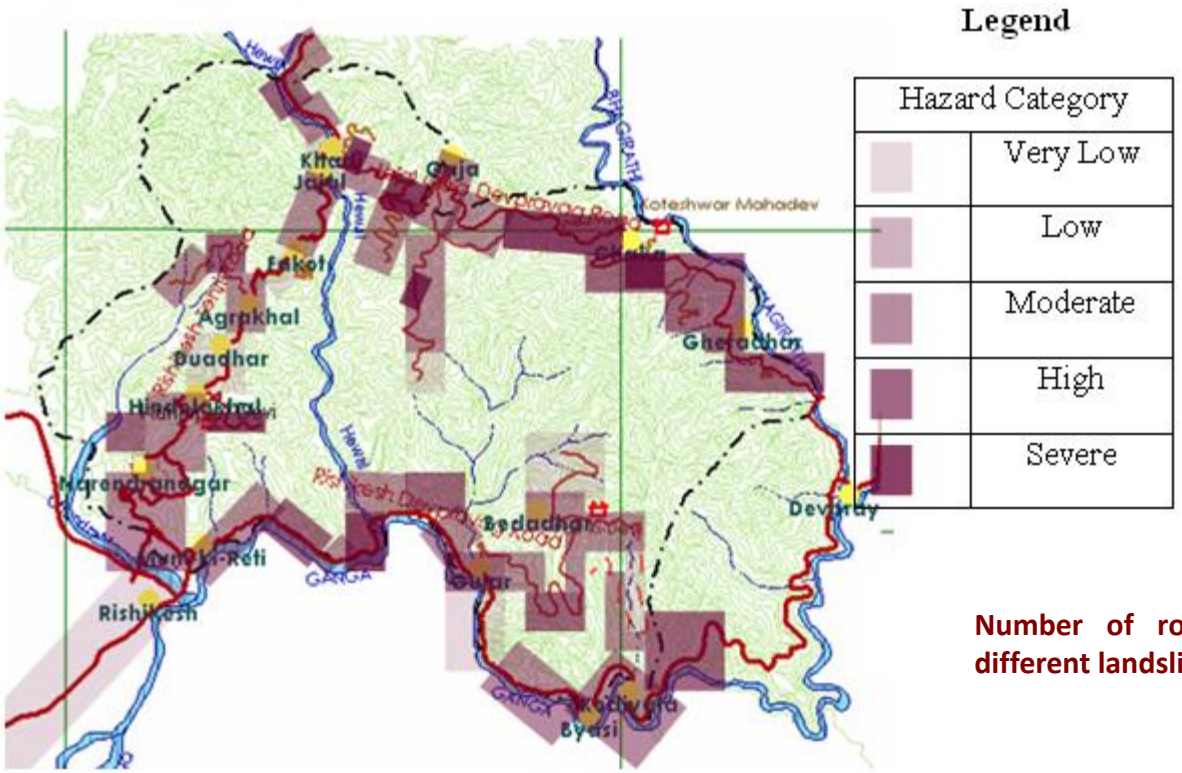
■Construction of upper story on weak lower stories

Landslide Vulnerability



Landslide prone settlements of Narendranagar block

Villages		No. of Market Towns		Total Pop	% Population
Number	Population	Number	Population		
65	15787	2	2345	18132	17.59%



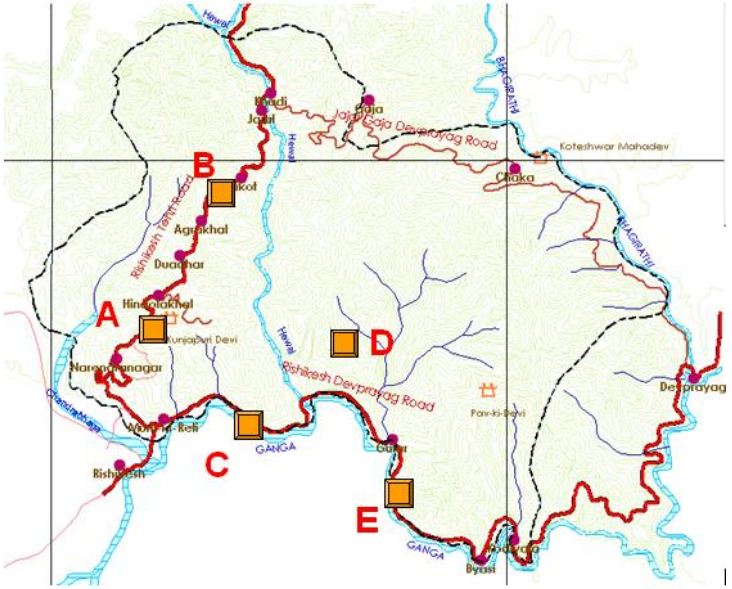
Number of road stretches under different landslide hazard zones

Landslide Hazard Zone	National / State Highways	Other District Roads	Fair Weather Roads	Rural roads
Very Low	4	1	2	1
Low	3	2	3	1
Moderate	10	3	2	2
High	3	2	3	0
Very High	1	2	1	0

Landslides after Rains in Study Area

View at A

View at B



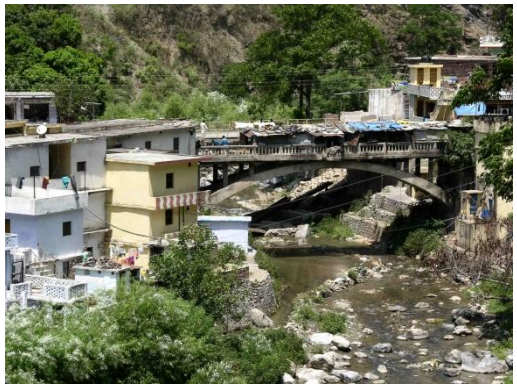
Landslides after Rains

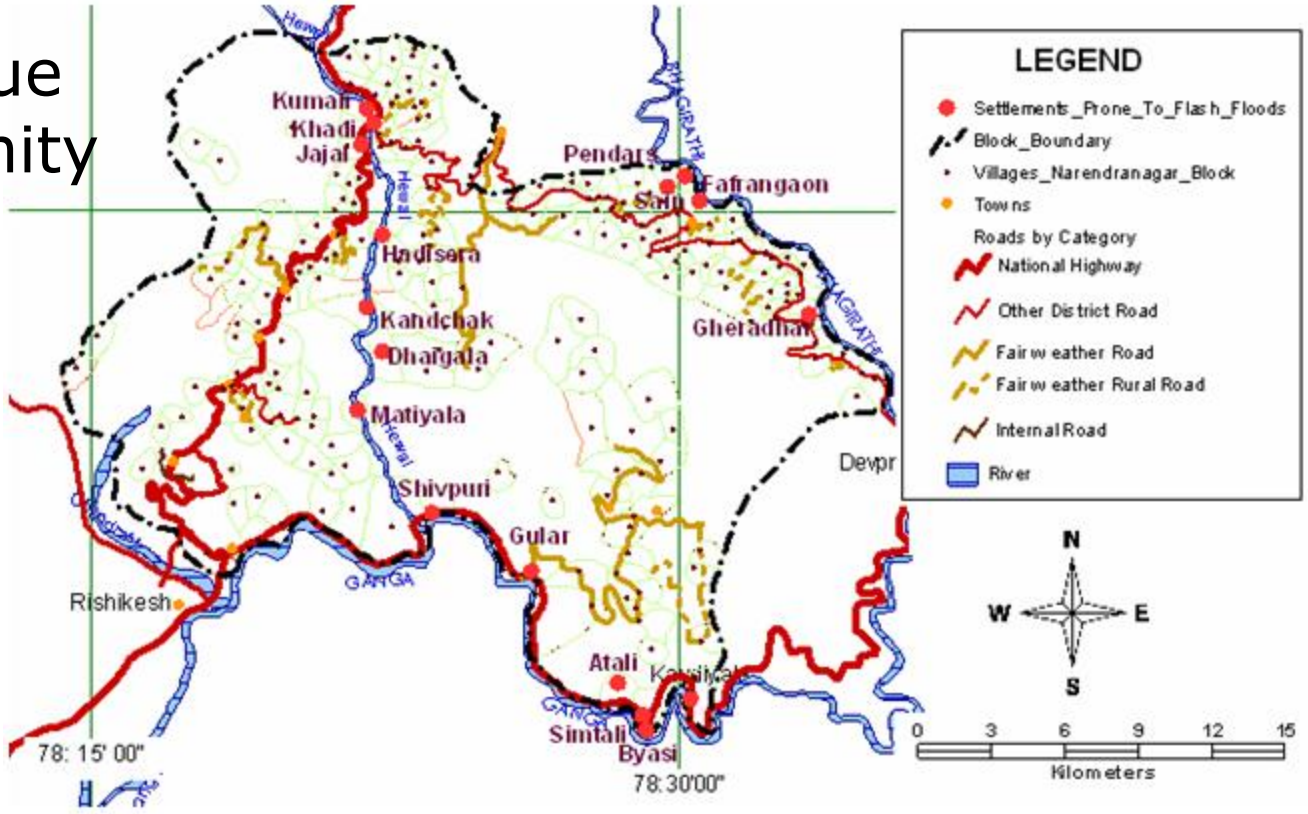
View at C

View at D

View at E

Vulnerability due to River Proximity

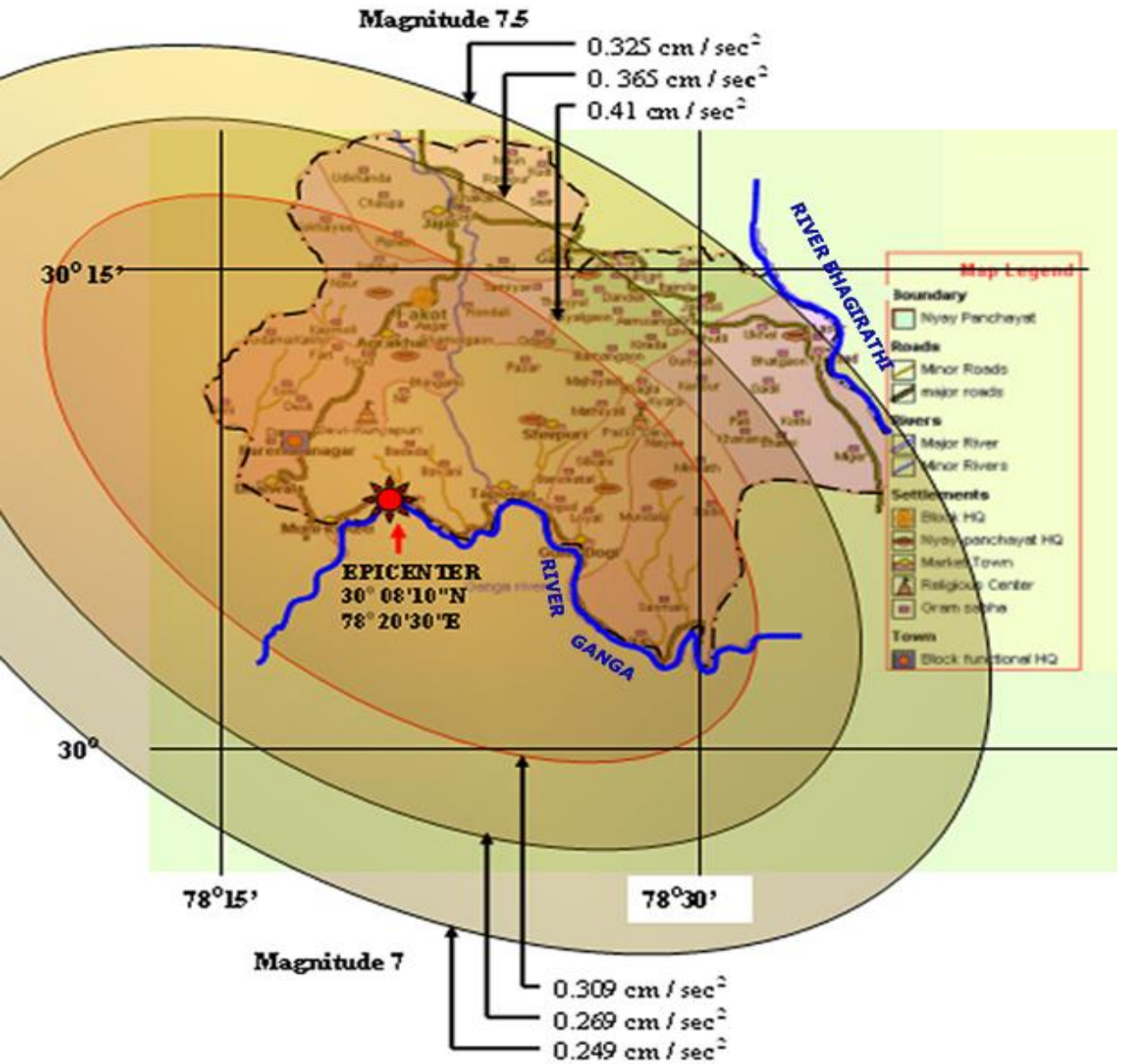




Settlements of prone to flash floods due to landslides after earthquakes

Villages		No. of Market Towns		Total Pop	% Population
Number	Population	Number	Population		
11	2103	6	7945	10048	9.75

Hypothetical Earthquake



The close proximity of three mega thrusts in Narendranagar block coupled with the fact that the river Ganga winds in a sinusoidal manner in this area plus the presence of more than 270 micro earthquake epicenters (EQ 86-2, EQ 87-16) in the time frame of 5 years indicates that tectonic stresses are building up in this area.

This could be a possible location of a medium to large sized earthquake in the future.

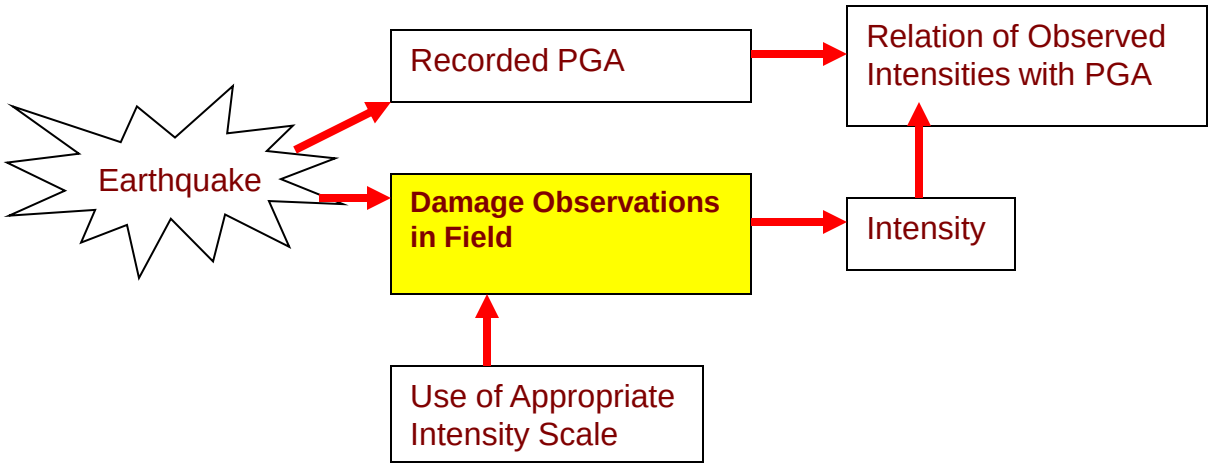
The point of inflexion of the Ganga River, which coincided with the micro zone D3, seems to be the candidate area for an earthquake scenario.

A hypothetical epicenter is considered near Tapowan at 300 08’10”N and 780 20’30”E. Destructive earthquakes in the lower Himalayas are in the magnitude range 6 – 8. Earthquake hazards in any region are best estimated by peak accelerations. These were computed (McGuire 1977) for earthquakes of magnitude 7.0 and 7.5 for different hypo central distances, to cover the entire Narendranagar block

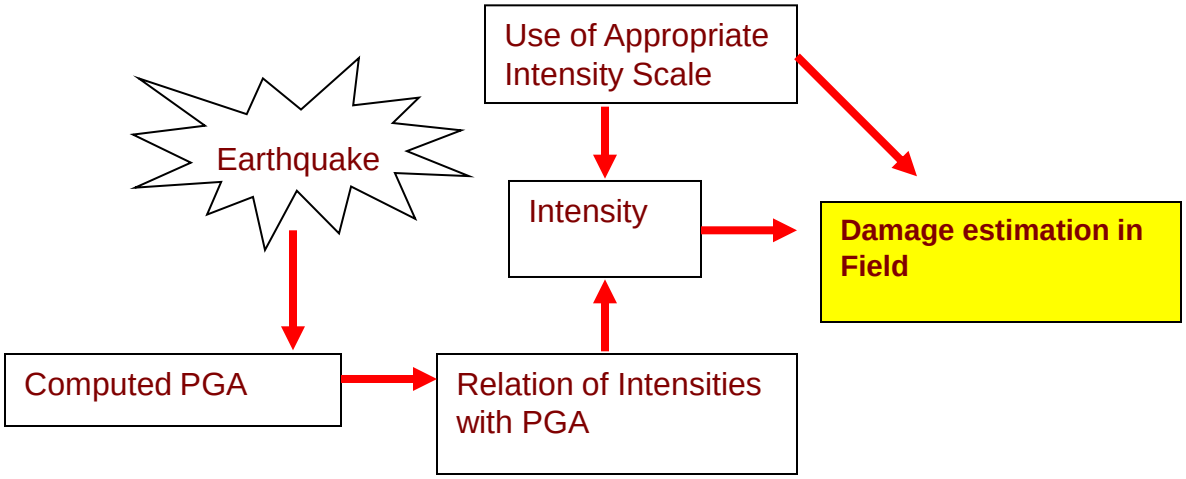
Hypo-central distance (km)	Peak accelerations (cm / sec^2)		Area (Sq. Km)	Length of Axis (km)	
	Mag 7.0	Mag 7.5		Long Axis	Short Axis
20 25 30	0.309 0.269 0.249	0.410 0.365 0.325	1257 1964 2828	50 66 82	20 28 36

The peak accelerations expected in seismic zone IV, on which Narendranagar block lies are 0.25 cm/sec^2

This implies that in Narendranagar block earthquake damage can be expected to be much higher than what is expected as per the seismic zoning map of India.

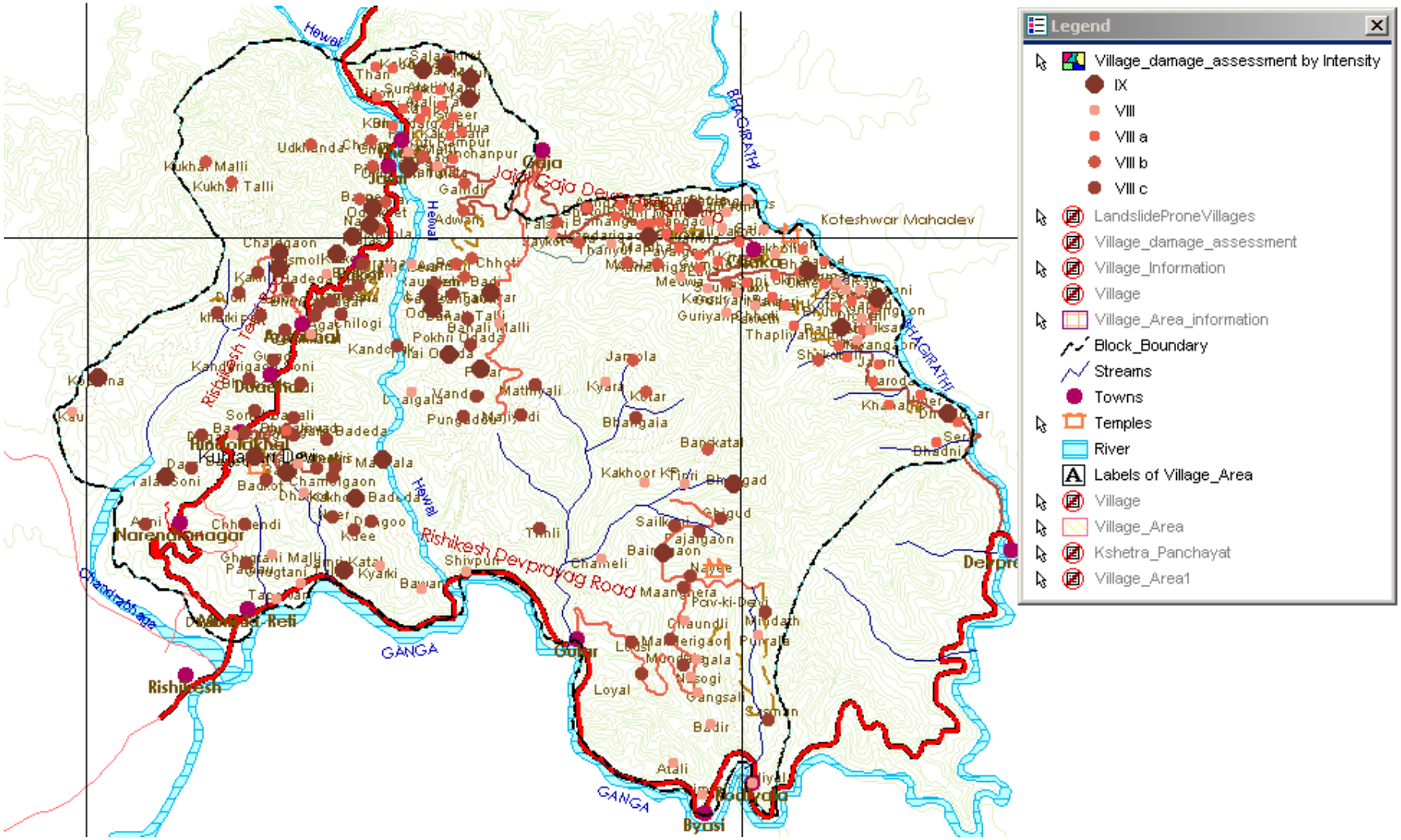


Methodology followed to determine Intensity of an Earthquake



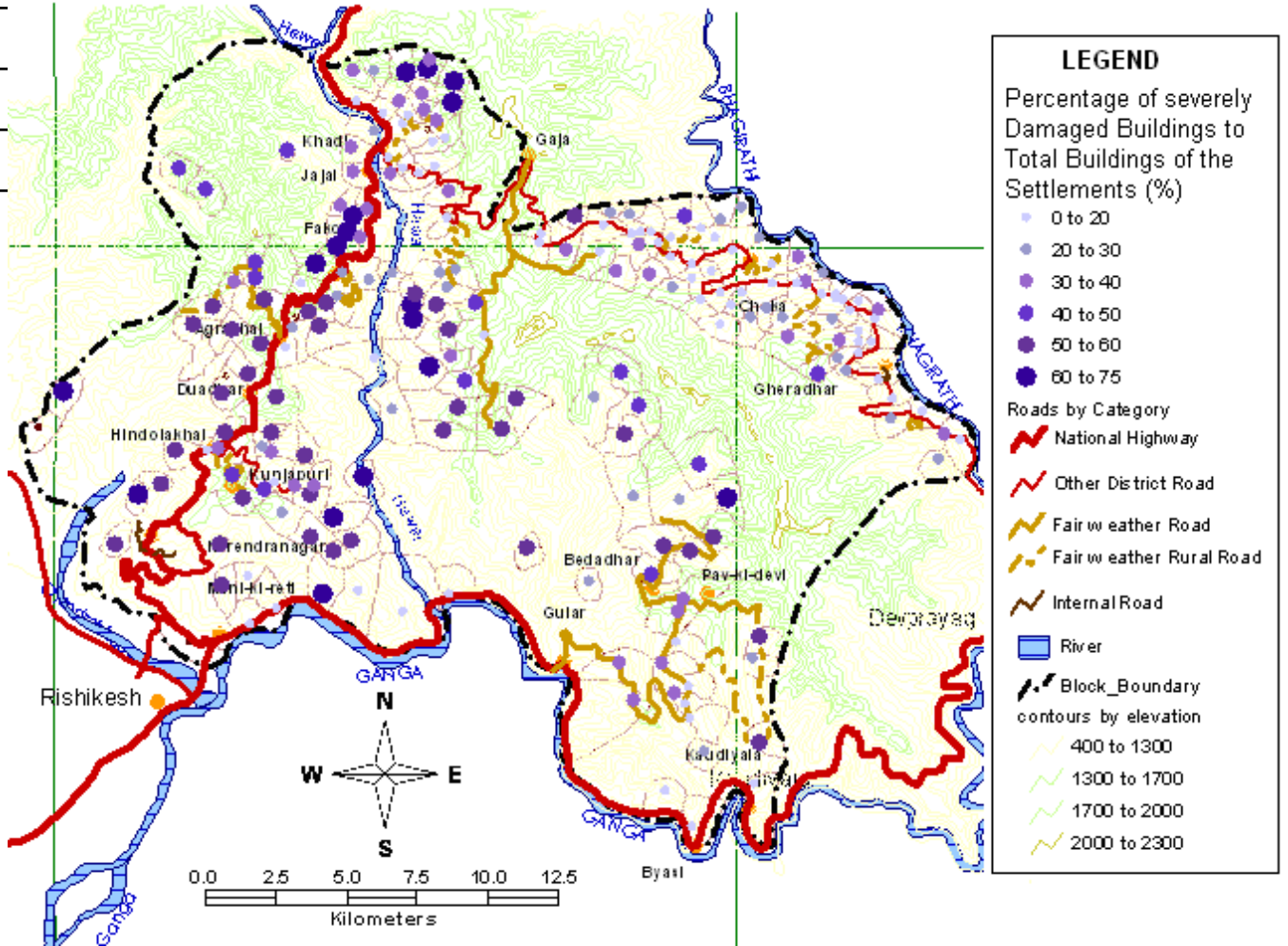
Methodology adopted to estimate the destruction caused by earthquake

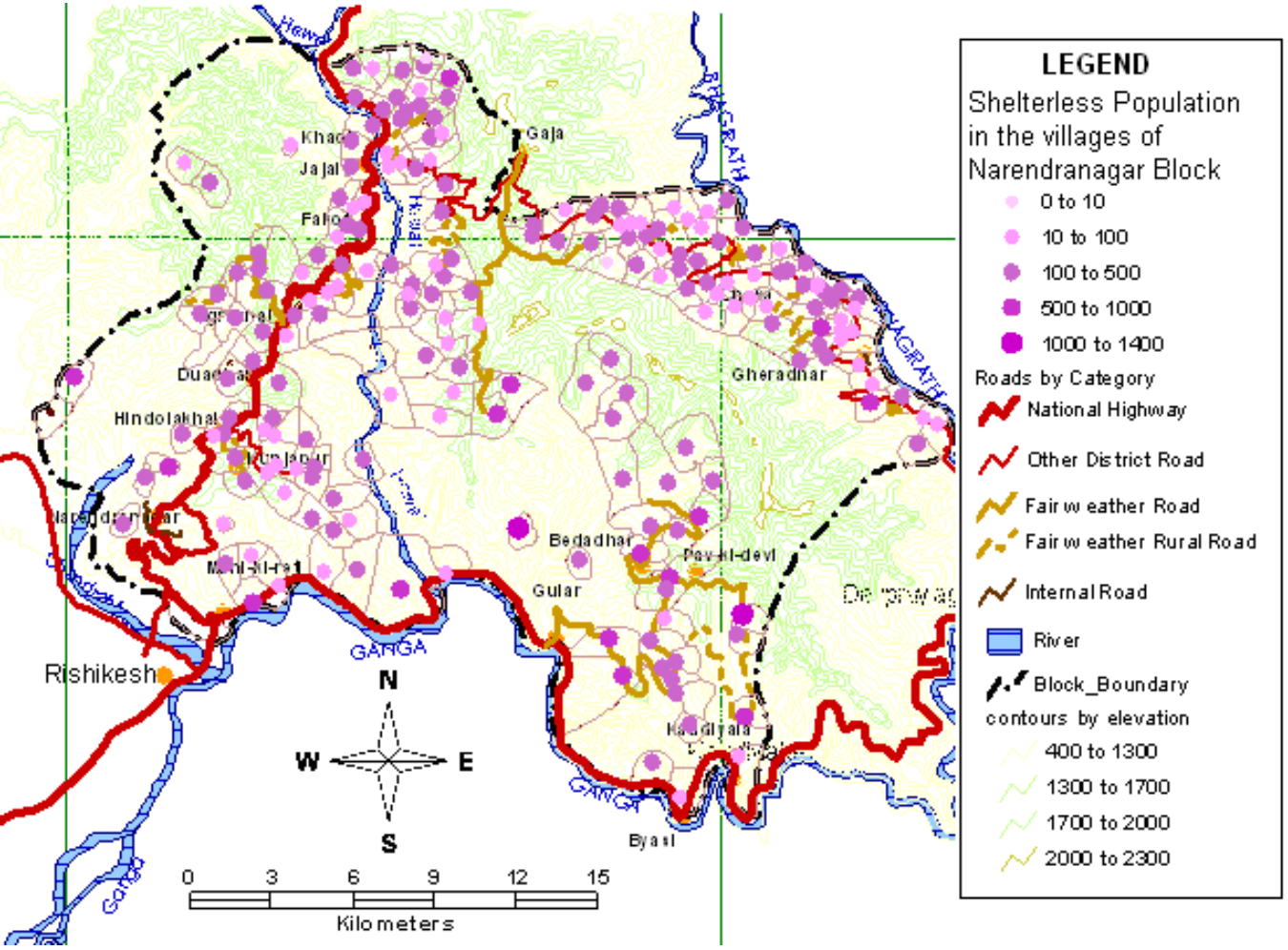
Intensities of Villages



Range (%)	Number of villages	Names of Market towns
0 to 10	16	Byasi, Kaudiyala, Muni-ki-reti, Gular
10 to 20	54	Jajal, Khadi, Gaja, Chaka
20 to 30	35	Narendranagar, Duadhar, Agrakhal, Fakot, Hindolakhal, Gheradhar, Bedadhar, Pav-ki-devi, Kunjapuri
30 to 40	35	Nil
40 to 50	15	Nil
50 to 60	41	Nil
> 60	17	Nil

Percentage of severely damaged buildings (G4 and G5) to total buildings



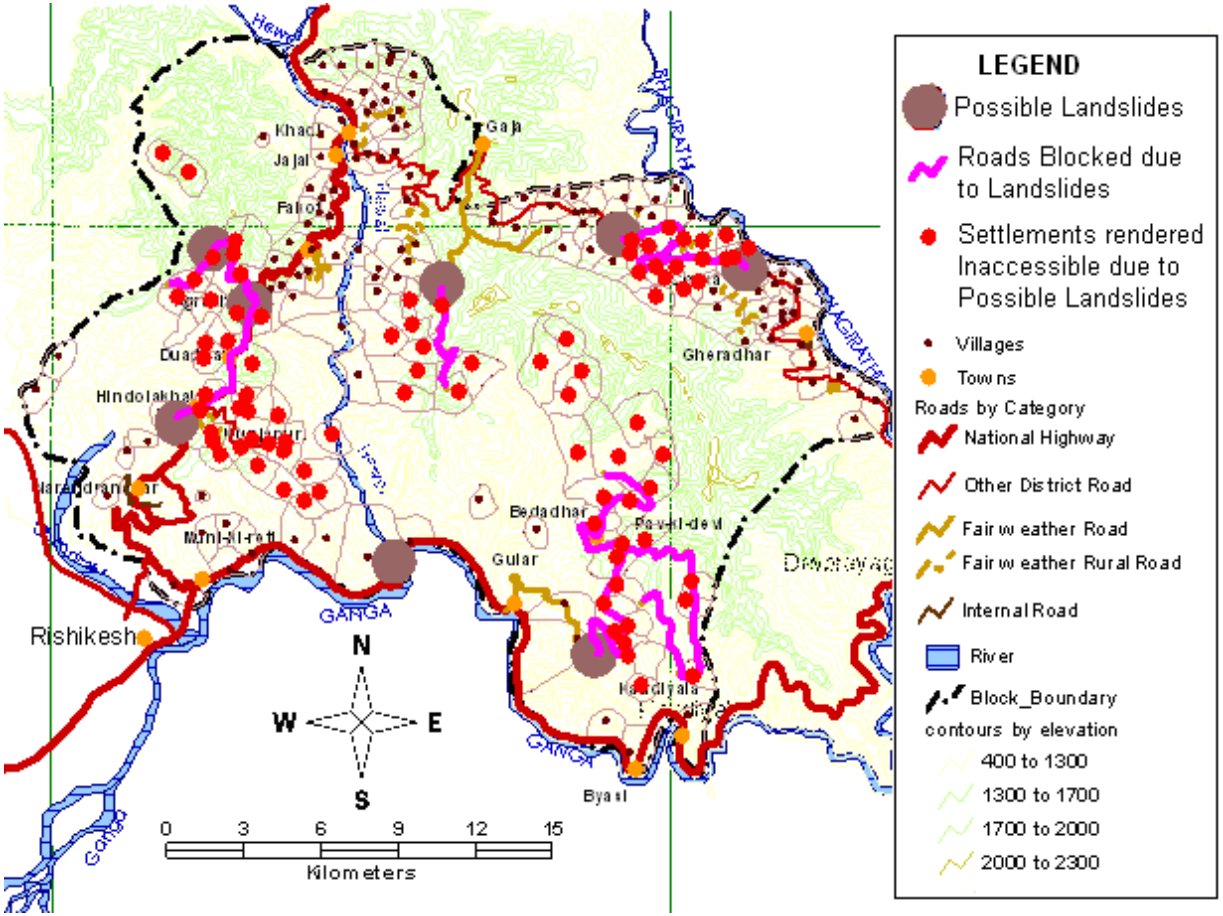


Total 8824 village houses and 14,554 market town houses would need to be vacated rendering population of 46,154 (63% of total village population) and 14,554 (47% of total market town population) would be rendered homeless.

Casualty Assessment

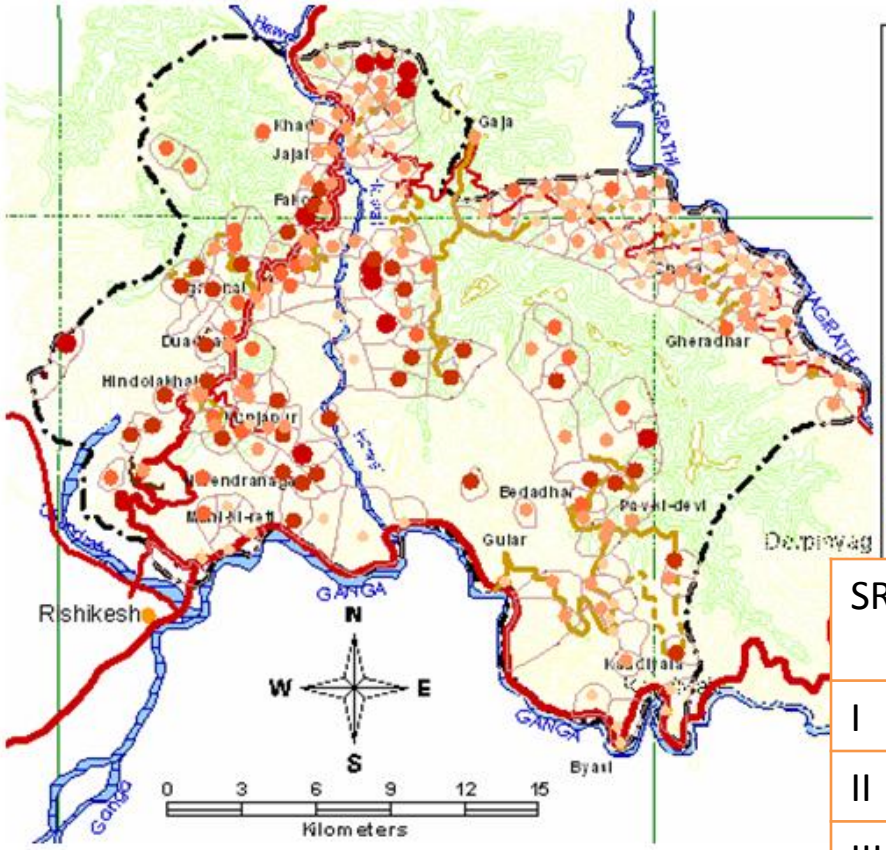
Injuries	Village		Market Towns		Total	
	No.	%	No.	%	No.	%
Dead or unsavable	801	1.1	189	0.6	990	0.96
Life threatening injuries needing immediate medical attention	1201	1.6	283	0.9	1484	1.44
Injury requiring hospital treatment	1201	1.6	283	0.9	1484	1.44
Light injury not requiring hospital treatment	801	1.1	189	0.6	990	0.96

LANDSLIDE OCCURRENCE AND INACCESSIBILITY



As results of these landslides total 85 settlements with a total population of 27462 (26.65%) would be rendered completely inaccessible

SEISMIC RISK INDICATOR (SRI)



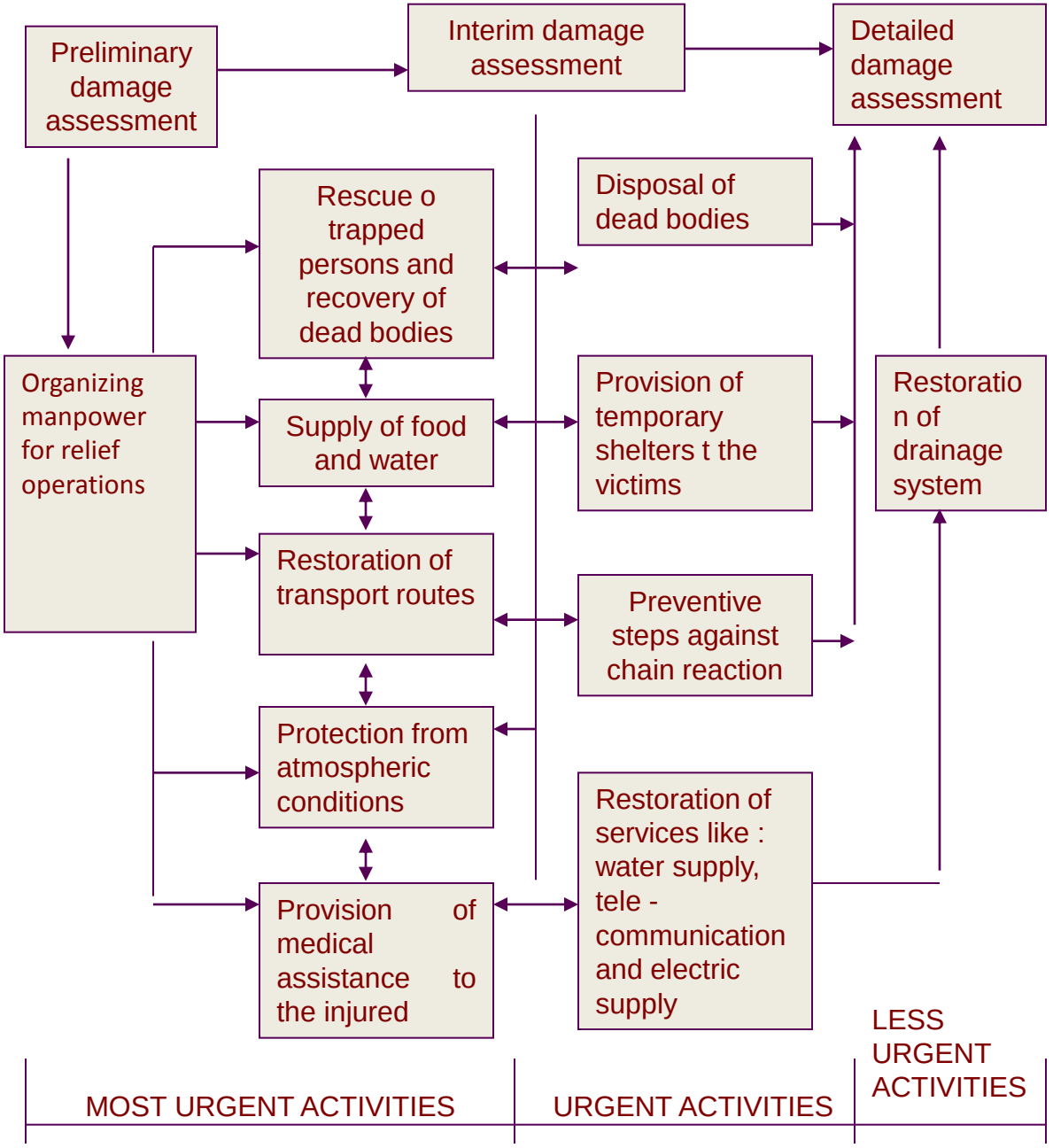
SRI	Description	Number of Villages	Number of Market Towns
I	Very Low Risk	76	5
II	Low Risk	65	12
III	Moderate Risk	27	-
IV	High Risk	34	-
V	Very High Risk	12	-
Total		214	17

Seismic Risk Indicator (SRI) is determined from the number of people dead per 100000 population at settlement level

POST DISASTER RESTTLEMENT

Short-Term Imperatives

EMERGENCY ACTIVITIES



POST DISASTER RESTTLEMENT

Medium-Term Imperatives

PHYSICAL REHABILITATION

- Restoring Infrastructure

Rebuilding roads, schools, health centres etc.

Replanning of roads on fragile terrains

Green roads

Ecological considerations for new buildings

ECONOMIC REHABILITATION

- Restoring Livelihoods

Sustainable options to evolve pattern of livelihoods

Should not impinge upon fragile resource base

Skill based production

Relocation of population wherever necessary

SOCIAL REHABILITATION

- Rehabilitation of Affected Community

Restoring psychological and social balance

appropriate institutional and medico-psychological interventions

Role of Non-government organizations

Role of local PRIs

POST DISASTER RESTTLEMENT

Long-Term Imperatives

Long–Term imperatives

Mountain Specific Development Perspective to deal with:

- Inaccessibility
- Diversity of micro eco systems
- Fragility of terrain, disaster proneness
- Environmental sensitivity
- Balancing Economic and Environmental Needs

Sustainable Economic Development

- Decentralized planning. Development of a region-specific model for sustainable development.
- Explicit recognition of constraints and worth of the mountain areas in the promotion of economic activities.
- Selection of activities on the criteria of maximum economic benefit to local population and minimum short and long term damage to ecology and environment.
- Assessment of carrying capacity of locations/areas for promoting activities (e.g. tourism) and settlement (towns/cities) and enforcement of suitable regulations to ensure sustainability.
- Assessments of the technologies used in infrastructure and other construction activities. Discouragement of the use of environment-damaging and encouragement that of environment-friendly technologies.
- Environment impact of the entire pattern of activities needs to be assessed with a view to ensuring sustainability of the overall development pattern at the micro, meso and macro, regional level.

Thank You