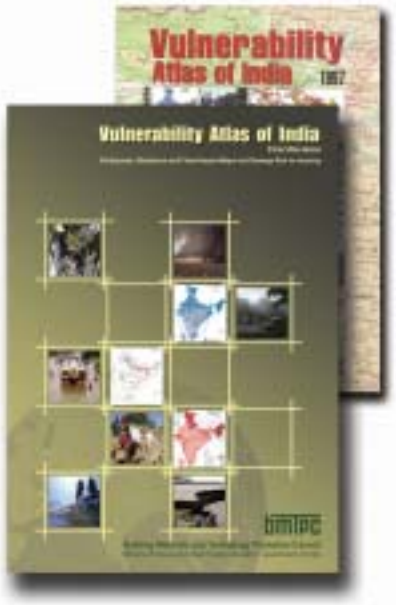
AN INTRODUCTION TO THE

Vulnerability Atlas of India

First Revision



A Tool to natural disaster prevention, preparedness and mitigation for housing and related infrastructure

bmtpc

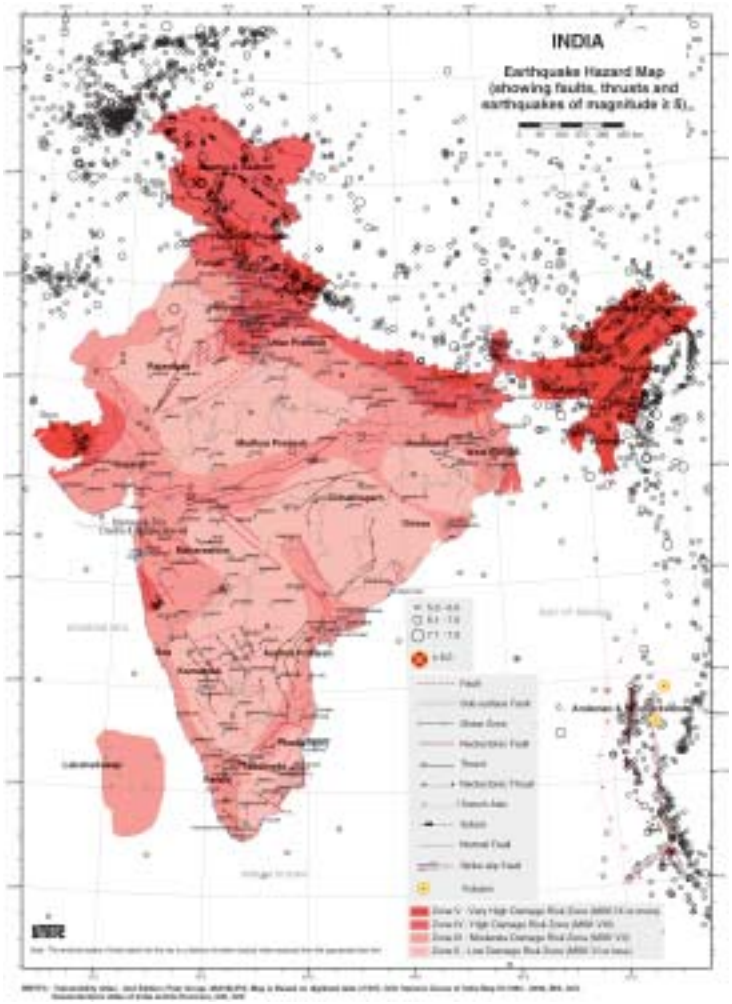
Building Materials and Technology Promotion Council
Ministry of Housing & Urban Poverty Alleviation, Government of India

Background

With its vast territory, large population and unique geo-climatic conditions, Indian sub-continent is exposed to natural catastrophes traditionally. Even today the natural hazards like floods, cyclones, droughts and earthquakes are not rare or unusual phenomenon in the country. While the vulnerability varies from region to region, a large part of the country is exposed to such natural hazards which often turn into disasters causing significant disruption of socio-economic life of communities leading to loss of life and property. Concerned with the impact of natural disasters in the background of the United Nations' resolution, and realising that the preparedness and prevention are integral components of the development process, the Governments at the Central and State levels are gradually evolving strategies policies and programmes for natural disaster mitigations, preparedness and prevention. In the process modernisation is fast taking place in fields like forecasting, satellite and remote sensing, computerised systems of vulnerability and risk assessment and other technologies for warning and monitoring. In response to UN General Assembly Resolution declaring 1990-2000 as International Decade for Natural Disaster Reduction, the Government of India has taken several initiatives for strengthening disaster reduction strategies including preparation of Vulnerability Atlas of India

Apropos the Yokohama Strategy for Safer World in 1994, the erstwhile Ministry of Urban Development, Government of India (1994) had constituted an Expert Group to study the following issues related to impact of natural hazards particularly with respect to housing and infrastructure.

i. **Need to identify vulnerable areas with reference to natural hazards such as earthquakes, cyclones, floods, etc., having a potential of damaging housing stock and related infrastructure.**
ii. **Preparation of a Vulnerability Atlas showing areas vulnerable to natural disasters and determination of risk levels of houses.**
iii. **Formulation of a strategy for setting up Techno-legal regimes for enforcing disaster resistant construction and planning practices in natural hazard prone human settlements.**



Hazard Vulnerability in India

Hazard Vulnerability in India

Indian Subcontinent: among the world's most disaster prone areas

- 59% of land vulnerable to Earthquakes
- 8.5% of land vulnerable to Cyclones
- 5% of land vulnerable to Floods

> 1 million houses damaged annually + human, social, other losses

Earthquakes

- 10.9% land is liable to severe earthquakes (intensity MSK IX or more)
- 17.3% land is liable to MSK VIII (similar to Latur / Uttarkashi)
- 30.4% land is liable to MSK VII (similar to Jabalpur quake)

Biggest quakes in: Andamans, Kuchchh, Himachal, Kashmir, N.Bihar and the North East

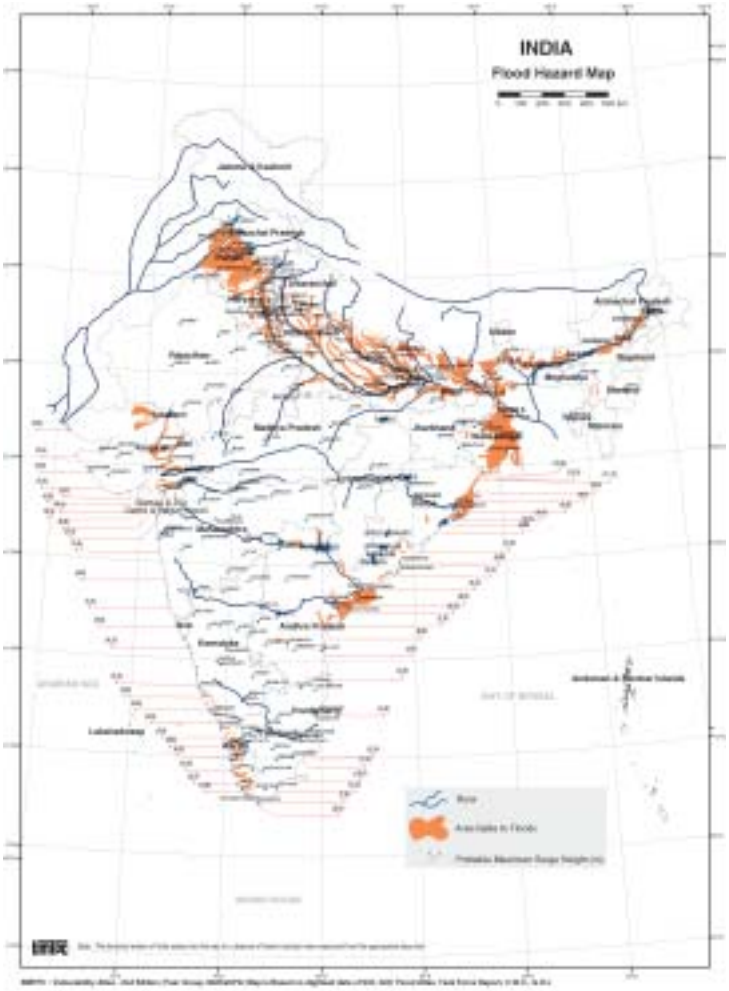
Wind and Cyclones

- 1877-2005: 283 cyclones (106 severe) in a 50 km wide strip on the East Coast
- Less severe cyclonic activity on West Coast (35 cyclones in the same period)
- In 19 severe cyclonic storms, death toll > 10,000 lives

In 21 cyclones in Bay of Bengal (India+Bangladesh) 1.25 million lives have been lost

Floods

- Floods in the Indo-Gangetic-Brahmaputra plains are an annual feature on an average, a few hundred lives are lost
- millions are rendered homeless
- lakhs of hectares of crops are damaged every year



A Qualitative Shift in Strategy

Stakeholders in the process of disaster mitigation

- **Policy makers**
- **Decision Makers**
- **Administration**
- **Professionals (architects and engineers at various levels)**
- **Professional Institutions**
- **R&D Institutions**
- **Financial Institutions**
- **Insurance Sector**
- **Community**
- **NGOs**
- **Common Man**

A Qualitative Shift in India's Strategy

The Government recognised the need for a shift from a *post disaster reactive* approach to a *pre-disaster pro-active* approach:

- Preparedness
- Mitigation
- Prevention

This will minimise the damage, losses and trauma to the people on one hand and reduce the costs of relief, rehabilitation and reconstruction.

The Disaster Management Act 2005 – inacted on 23rd December, 2005 lays down institutional and coordination mechanism at all level and provides for establishment of Disaster Mitigation Fund and Disaster Response Fund at national, state and district level.

This shift in strategy is feasible because of:

- Advancements in Science and Technology
- Effective implementation has shown decline in casualties.
- Advancements in forecasting technologies and warning systems
- Government policy to strengthen Hazard Mapping, R&D and Standardisation
- Enlargement and reinforcement of disaster prevention systems, equipment and facilities.

Goals of Disaster Prevention

Objectives:

The objectives of India's National Policy for natural disaster reduction is to reduce:

- loss of lives
- property damage
- economic disruption

Goals:

- Creating Public Awareness about Safety from Disasters
- Amending/Enacting legislation for safety from Hazards
- Planning development areas with safety from Hazards
- Protection of habitations from adverse hazard impacts
- Constructing new buildings safe from Hazards
- Retrofitting existing buildings for improving hazard resistance

Legislation Needed

- Amendments to town/country planing acts and Master plan area development rules
- Land use zoning in hazard prone areas and establishing techno-legal regimes
- Incorporation of safety requirements in building bye-laws of local bodies/panchayats – applicable to new buildings and extensions of old buildings. Empowering local bodies to exercise control
- Legislation to upgrade hazard resistance of critical buildings for use and safety of large number of people – schools, hospitals, cinemas, congregation halls, water tanks, towers, telephone exchanges, fire stations, headquarters of police and administration.

The Peer Group

- **Dr.A.S.Arya (Chairman)**
  National Seismic Advisor, Ministry of Home Affairs, Government of India
- **Dr. N. Lakshmanan (Member)**
  Director, Structural Engineering Research Centre, Chennai
- **Shri Prabhas Pande (Member)**
  Director, Earthquake Geology -NR, Geological Survey of India (GSI), Lucknow
- **Shri S.R.Kalsi (Member)**
  Addl.Director General (Services), India Meteorological Department (IMD), New Delhi
- **Shri Mukesh Kumar Sinha (Member)**
  Director (FE&SA), Central Water Commission, New Delhi
- **Shri M.Mohanty (Member)**
  Scientist D - Seismology, Department of Science and Technology, New Delhi
- **Dr.S.K.Thakkar (Member)**
  Professor, Railway Chair, Department of Civil Engineering, Indian Institute of Technology Roorkee
- **Shri T.N.Gupta (Member)**
  Former Executive Director, BMTPC, New Delhi
- **Dr.Prem Krishna (Member)**
  Former Professor, Deptt. of Civil Engineering, and AICTE Professor, IIT, Roorkee
- **Shri R.K.Celly (Member Convenor)**
  Executive Director, BMTPC
- **Shri J.K.Prasad (Co-Convenor)**
  Chief - Building Materials, BMTPC

Output of the Expert Group set up in 1994

Part-I: Techno Legal Measures

Techno-Legal aspects of earthquake / windstorm / flood hazards and land use zoning. Disaster damage scenarios and cost-benefit analysis. Recommendations and Action Plan

Part-II: The Vulnerability Atlas of India

Statewise hazard maps and districtwise risk tables

Part-III: Technical Guidelines

Land-use zoning and design guidelines for improving hazard resistant construction of buildings and housing.

Vulnerability Atlas of India - 1997

Based on Part-II of the report, Vulnerability Atlas of India was brought out by BMTPC in 1997.

This Atlas has served as an useful tool for policy planning on natural disaster prevention and preparedness specially for hosing and related infrastructure. The IDNDR also adjudged the project with High Demonstrative Value.

Revision of the Atlas

Changes in the hazard scenario in the country since publication of Atlas:

- Formation of new States (3) and new Districts (90).
- Revision Earthquake Hazard Zones by BIS.
- Availability of Data on faults and thrusts from Seismotectonic Atlas published by GSI.
- Updated information on flood prone areas from Central Water Commission.
- Revised wind speed of coastal India and storm surge height from IMD.
- Updated data on Probable Maximum Precipitation in a district.
- Availability of new Housing Data as per Census 2001.
- Availability of Landslide Hazard Zonation Atlas of India.

To examine the above issues closely, the Ministry of Housing & Urban Poverty Alleviation constituted a Peer Group with representation from different concerned agencies.

The Peer Group after considering all aspects in detail, through a series of meetings and dialogues, prepared the revised Vulnerability Atlas of India giving the State-wise Hazard Maps with respect to earthquakes, cyclones/windstorms and floods in digitized form as well as district-wise housing tables.

Special Features in Revised Atlas

- Digitisation of all data sets in the various maps including boundaries of the States and Districts according to the Survey of India Maps as well as the boundaries of the various hazard zones, thus improving their accuracy.
- The Vulnerability and Risk Tables of Housing Data in each district is now based on wall types and roof types as per 2001 Census data. The district names and reference numbers are taken according to 2001 Census for ease of cross reference.
- Inclusion of a note on Tsunami wave effects in coastal regions of the country.
- Inclusion of Landslide Hazard Zones.

The Digitized Hazard Maps

The monitoring of hazards is carried out by the following most important organisations in the country: Seismic occurrence and cyclone hazard monitoring by India Meteorological Department (IMD) and flood monitoring by the Central Water Commission. In addition noteworthy contributions are made by Geological Survey of India and the Department of Earthquake Engineering, University of Roorkee (now Indian Institute of Technology Roorkee) in this regard. The Bureau of Indian Standards Technical Committees on Earthquake Engineering and Wind Engineering have a Seismic Zoning Map and the Wind Velocity Map including cyclonic winds for the country. The Seismic Zoning Map was revised in 2002. The Central Water Commission has a Flood Atlas of India. The Group has used these hazard maps to prepare 1:2 million scale maps by superposing the above available data on digitised Survey of India map as the base map. The earthquake, wind storm and flood hazard maps are drawn for each State and UT separately. Various district boundaries are clearly shown for easy identification of the hazard risk prone areas. The intensities of earthquakes on MSK scale and intensity of the wind hazard related with wind speed are drawn on the maps to show various intensity zones. Flood prone areas are categorised in terms of unprotected and protected areas.

Statewise Hazard Maps

- Statewise hazard maps (including Union Territories)
  - Earthquakes
  - Cyclones
  - Floods
- Each administrative district boundary clearly marked with hazard intensity
- Maps drawn at 1:2 million using digitised Survey of India maps as base.

Earthquake Hazard Maps

- Based on Seismic Zoning map of India given in IS 1893:2002.
- Seismo-tectonic features are marked as per Seismo-Tectonic Atlas of GSI.
- Epicentres and years of occurrence of earthquakes (>5.0 intensity), as per IMD catalogue of earthquakes.

Wind & Cyclone Hazard Maps

- Based on wind speed maps given in IS 875 (Part III) 1987.
- Alongwith design wind speed, the number of cyclones which have crossed each latitude of the sea coast in the past are also marked.

Flood Hazard Maps

- Based on the revised Flood Atlas of India prepared by the Central Water Commission.
- Other low lying areas outside river flood plains (which are also flooded during heavy rains due to choked drainage path) could not be plotted because of lack of data, which has to be collected by each state administration.

The Risk Tables

Building Types identified for Disaster Vulnerability

Example: Distt. Kendrapara, Orissa

Number of housing units of various types classified by wall material and roof type, and number of buildings of each type.

Distribution of Houses by Predominant Materials of Roof and Wall and Level of Damage Risk

Table No. : OR 10 **State : ORISSA** **KENDRAPARA**

Wall / Roof		Census Houses: No. of Houses	Census Houses: %	Level of Risk under: EQ Zone V	EQ Zone IV	EQ Zone III	EQ Zone II	Wind Velocity m/s: 55 & 50	47	44 & 39	33	Flood Prone Area in %
				Area in %				Area in %				
						89.2	10.8	100				35.5
WALL												
A1 - Mud Unburnt Brick Wall	Rural	266,645	75.2									
	Urban	6,906	1.9									
	Total	***273,551***	***77.1***			*M*	*L*	*VH*				*VH*
A2 - Stone Wall	Rural	593	0.2									
	Urban	35	–									
	Total	***628***	***0.2***			*M*	*L*	*H*				*VH*
Total - Category - A		***274,179***	***77.3***									
B - Burnt Bricks Wall	Rural	55,783	15.7									
	Urban	10,826	3.1									
	Total	***66,609***	***18.8***			*L*	*VL*	*H*				*H/M*
Total - Category - B		***66,609***	***18.8***									
C1 - Concrete Wall	Rural	585	0.2									
	Urban	13	–									
	Total	***598***	***0.2***			*VL*	*VL*	*L*				*L/VL*
C2 - Wood wall	Rural	3,264	0.9									
	Urban	584	0.2									
	Total	***3,848***	***1.1***			*VL*	*VL*	*VH*				*H*
Total - Category - C		***4,446***	***1.3***									
X - Other Materials	Rural	8,889	2.5									
	Urban	648	0.2									
	Total	***9,537***	***2.7***			*VL*	*VL*	*VH*				*VH*
Total - Category - X		***9,537***	***2.7***									
TOTAL BUILDINGS		**354,771**										
ROOF												
R1 - Light Weight Sloping Roof	Rural	297,744	83.9									
	Urban	12,052	3.4									
	Total	***309,796***	***87.3***			*L*	*VL*	*VH*				*VH*
R2 - Heavy Weight Sloping Roof	Rural	2,201	0.6									
	Urban	465	0.1									
	Total	***2,666***	***0.7***			*L*	*VL*	*H*				*H*
R3 - Flat Roof	Rural	35,814	10.1									
	Urban	6,495	1.8									
	Total	***42,309***	***11.9***	*Damage Risk as per that for the Wall supporting it*								
TOTAL BUILDINGS		**354,771**										

Probable Maximum Precipitation at a Station of the district in 24 hrs is 400 mm

Housing Category : Wall Types

Category - A : Buildings in field-stone, rural structures, unburnt brick houses, clay houses

Category - B : Ordinary brick building, buildings of the large block & prefabricated type, half-timbered structures, building in natural hewn stone

Category - C : Reinforced building, well built wooden structures

Category - X : Other materials not covered in A,B,C. These are generally light.

Notes : *1. Flood prone area includes that protected area which may have more severe damage under failure of protection works. In some other areas the local damage may be severe under heavy rains and choked drainage.*

2. Damage Risk for wall types is indicated assuming heavy flat roof in categories A, B and C (Reinforced Concrete building).

3. Source of Housing Data : Census of Housing, GOI, 2001

Housing Category : Roof Type

Category - R1 : Light Weight (Grass, Thatch, Bamboo, Wood, Mud, Plastic, Polythene, GI Metal, Asbestos Sheets, Other Materials)

Category - R2 : Heavy Weight (Tiles, Slate)

Category - R3 : Flat Roof (Brick, Stone, Concrete)

EQ Zone V : Very High Damage Risk Zone (MSK > IX)

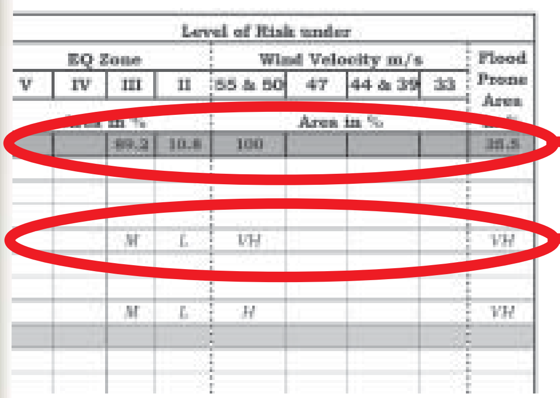
EQ Zone IV : High Damage Risk Zone (MSK VIII)

EQ Zone III : Moderate Damage Risk Zone (MSK VII)

EQ Zone II : Low Damage Risk Zone (MSK < VI)

Level of Risk : VH = Very High, H = High, M = Moderate, L = Low, VL = Very Low

BMTPC **Building Materials & Technology Promotion Council** **Peer Group, MoH&UPA, GOI**



The percentage area of the district likely to be subjected to a particular intensity of hazard

The damage risk to buildings indicated as Very High (VH), High (H), Medium (M), Low (L) and Very Low (VL).
The damage risk terms have been clearly explained in the Atlas.

VULNERABILITY ATLAS OF INDIA

An indispensable tool for pre-disaster pro-active approach in disaster management

Building Materials & Technology Promotion Council, Ministry of Housing & Urban Poverty Alleviation, Government of India will be happy to collaborate with national and international agencies/organizations:

- Providing a common understanding on vulnerability analysis and mitigation practices.
- Setting up a regional collaborative mechanism in the above areas.
- Assisting other countries in the process of preparation of Vulnerability Atlas wishing to undertake similar efforts.
- Collaborating in national capacity building programmes targeted at local authorities, and private sector practioners on disaster, prevention practices.

UNCHS (Habitat II): Views on the Vulnerability Atlas of India

"We would like to indicate our interest in exploring possible collaborative activities between the Government of India and UNCHS (Habitat) both, in bringing the application of Atlas to the local/district level, and in possible dissemination to other countries as part of regional cooperation initiatives".

For procuring the Vulnerability Atlas of India
Please send a Demand Draft of Rs.5000/- plus Rs.200 as postage
Or US$200 plus $20 as postage drawn in favour of BMTPC, New Delhi.

For further information, contact

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