NATIONAL DISASTER MANAGEMENT

TOOLKIT FOR URBAN PLANNING

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FORWORD

National Institute of Disaster Management (NIDM) has appointed DDFCL to prepare the Toolkit for Urban Planning for DRR and for making resilient cities with special reference to earthquake, landslide, cyclone/floods, and tsunamis. Guidelines on all these events have been prepared and published. Beside, guidelines for other aspects are also published by the National Disaster Management Authority (NDMA).This report has been modified as per observations/ suggestions made by NIDM vide its letter dated July 31, 2012. As suggested the whole report is further regrouped into five broad chapters. Individual suggestions are also incorporated in their proper places and reference points.

The report is the outcome of hard work put in by multidisciplinary team, consisting of, among others, Regional Planners, Urban Planners, Structural Engineers, Social Scientists and Economists. DDFCL appreciates NIDM for the confidence entrusted on us and provided the opportunity to work on this project. This report is very important step in the direction of safe and secured community and resilient cities in India.

This report on Urban Planning in Disaster Management is prepared after studying already published reports by NDMA, International Agencies research documents, zonal regulations, building codes, byelaws and literature on earlier events. Their relevant proposals are given due importance while formulating proposals for Urban Planning practices at National, State, Town, Zone and Project levels. They are part of basic structure to prepare for response and mitigate disaster risk through planning process. Planning proposals are series of precautions to develop resilient cities/ town with minimum or no casualty in the disaster prone areas. The success of this exercise lies in its implementation and adoption by all State Governments in its true spirit.

Amit Bose

Director

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ABBREVIATIONS

Following Abbreviations have been used by National and International Institutions/Organisations in DRR:

AICTE	All India Council for Technical Education
ALTM	Airborne Laser Terrain Mapping
APC	Areas of Particular Concern
ARMVs	Accident Relief Medical Vans
ATI	Administrative Training Institute
AERB	Atomic Energy Regulatory Board
AHP	Analytical Hierarchy Process
ARMV	Accident Relief Medical Van
ASI	Archaeological Survey of India
ACTS	Advanced Computational Testing and Simulation
ACWC	Area Cyclone Warning Centre
AFS	Area Forecast System
AICTE	All India Council for Technical Education
AIR	All India Radio
AM	Amplitude Modulation
AMSU	Advance Microwave Sounding Unit
APCF	Aircraft Probing of Cyclone facility
APC[1]	Areas of Particular Concern
APHM & ECRP	Andhra Pradesh Hazard Mitigation and Emergency Cyclone Recovery Project
APSDMS	Andhra Pradesh State Disaster Mitigation Society
ARC	Armoured Reconnaissance Aircraft
ASSOCHAM	Associated Chambers of Commerce and Industry
BAI	Builders Association of India
BIS	Bureau of Indian Standards
BMTPC	Building Material Technology Promotion Council
BPR	Bottom Pressure Recorders

BPS	Bottom Pressure Sensors
BMTPC	Building Materials & Technology Promotion Council
BRO	Border Roads Organisation
BARC	Bhabha Atomic Research Centre
Bn	Battalion
BOO	Build Operate Own
BOOT	Build Operate Own Transfer
BSI	Botanical Survey of India
BSNL	Bharat Sanchar Nigam Limited
CAA	Constitutional Amendment Act
CBOs	Community-Based Organisations
CBRI	Central Building Research Institute
CBSE	Central Board of Secondary Education
CDRN	Corporate Disaster Resource Network
CIDC	Construction Industry Development Council
CESS	Centre for Earth Science Studies
CFI	Construction Federation of India
CMT	Centroid Moment Tensor
CMZ	Coastal Management Zone
CoS	Committee of Secretaries
CRZ	Coastal Regulation Zone
CRS	Central Receiving Stations
CSC	Common Service Centers
CSIR	Council of Scientific and Industrial Research
CSR	Corporate Social Responsibility
CESS	Centre for Earth Science Studies
COA	Council of Architecture
CPWD	Central Public Works Department
CRRI	Central Road Research Institute
CWPRS	Central Water and Power Research Station
CARTOSAT	Cartographic Satellite

CDMM	Centre for Disaster Management and Mitigation, Vellore
CLRSM	Centre for Landslide Research Studies and Management
CRF	Calamity Relief Fund
CRRI	Central Road Research Institute
CSIO	Central Scientific Instrumentation Organisation
CBDM	Community-Based Disaster Management
CBRN	Chemical, Biological, Radiological and Nuclear Agencies
CCMNC	Cabinet Committee on Management of Natural Calamities
CCS	Cabinet Committee on Security
CDM	Cyclone Disaster Management
CDMA	Code Division Multiple Access
CDMC	Cyclone Distress Mitigation Committee
CDMIS	Cyclone Disaster Management Information System
CDT	Civil Defense Teams
CERP	Cyclone Emergency Reconstruction Project
CESS	Centre for Earth Science Studies
CEWS	Cyclone Early Warning System
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board
CIDS	Chief of the Integrated Defence Staff
CII	Confederation of Indian Industry
CMC	Crisis Management Committee
CMG	Crisis Management Group
COS	Committee of Secretaries
CPAP	Continuous Positive Air Pressure
CPDAC	Coastal Protection & Development Advisory Committee
CRC	Cyclone Review Committee
CRF	Calamity Relief Fund
CRMI	Cyclone Risk Mitigation Investments
CSO	Central Statistical Organisation
CSS	Common Service Scheme

CWC	Central Water Commission
CWC[1]	Cyclone Warning Centre
CWDS	Cyclone Warning Dissemination System
CZM	Coastal Zone Management
DAMA	Demand Assigned Multiple Access
DBT	Department of Biotechnology
DCWDS	Digital Cyclone Warning Dissemination System
DDA	Digital Data Adaptor
DDC	Data Distribution Centre
DEM	Digital Elevation Model
DEOC	District Emergency Operations Centre
DES	Directorate of Economics and Statistics
DIT	Department of Information Technology
DMIS	Disaster Management Information System
DMP	Disaster Management Plan
DMU	Disaster Management Unit
DoE	Department of Environment
DOS	Data Oriented Service
DoS	Department of Space
DoT	Department of Telecommunications
DPAD	Data Processing and Application Development
DRC	Data Radio Channel
DRDO	Defense Research and Development Organisation
DRM	Disaster Risk Management
DRMP	Disaster Risk Management Programme
DSS	Decision Support Systems
DST	Department of Science & Technology
DTH	Direct-To-Home
DVB	Digital Video Broadcasts
DVB-RCS	Digital Video Broadcast with Return Carrier through Satellite
DVC	Data Validation Centre

DWR	Doppler Weather Radar
DWS	Disaster Warning System
DEM	Digital Elevation Model
DGM	Directorate of Geology and Mining
DM	Disaster Management
DMA	Disaster Management Authority
DMP	Disaster Management Plan
DMS	Disaster Management Support
DoM	Department of Mines
DrISS	Doppler Radar and Infrared Satellite Sensing
DRM	Disaster Risk Management
DTRL	Defence Terrain Research Laboratory
DAE	Department of Atomic Energy
DMA	Disaster Management Authority
DOD	Department of Ocean Development
DART	Deep Ocean Assessment & Reporting System (DART) in Indian TWS
DBCP	Data Buoy Cooperation Panel
DCR	Development Control Regulations
DDMA	District Disaster Management Authority
DM	Disaster Management
DNA	Deoxyribo Nucleic Acid
DRR	Disaster Risk Reduction
DRM	Disaster Risk Management
DRN	Disaster Response Network
DST	Department of Science & Technology
DVA	Detailed Vulnerability Assessment
ECMWF	European Centre for Medium-Range Weather Forecasting
EEP	Emergency Evacuation Plan
EEZ	Exclusive Economic Zones
EGIA	Ecologically and Geomorphologically Important Areas
EIA	Environment Impact Assessment

EPA	Environmental Protection Act, 1986
EPZ	Export Processing Zone
ER	Emergency Response
ERP	Emergency Response Platform
ESCAP United Nations	Economic and Social Commission for Asia & Pacific
ESS	Earth and Space Science
EW	Early Warning
EWER	Early Warning Emergency Response
EWS	Early Warning System
EO	Earth Observations
EOC	Emergency Operations Centre
EPIRB	Emergency Position-Indicating Radio Beacons
EOC	Emergency Operations Centre
EREC	Earthquake Risk Evaluation Centre
EGAS	Ecologically and Geomorphologically Important Areas
ENC	Electronic Navigational Chart
FICCI	Federation of Indian Chambers of Commerce and Industry
FM	Frequency Modulation
FSI	Forest Survey of India
FTDMA	Frequency Time Division Multiple Access
FEMA	Federal Emergency Management Agency
FTP	File Transfer Protocol
GDC	Geospatial Data Centre
GIS	Geographic Information System
GOES	Geostationary Operational Environmental Satellite
GoI	Government of India
GSI	Geological Survey of India
GTS	Ground Tracking Station
GIS	Geographic Information System
GOI	Government of India
GPS	Global Positioning System

GSI	Geological Survey of India
GPR	Ground Penetrating Radar
GPRS	General Packet Radio Service
GSDMA	Gujarat State Disaster Management Authority
GSDP	Gross State Domestic Product
GSM	Global System for Mobile Communications
GTCS	Global Telecommunication System
GWB	Ground Water Board
HDSS	Hazard Decision Support System
HFL	High Flood Level
HHZ	High Hazard Zone
HLCC	High Level Cabinet Committee
HLT	Hurricane Liaison Team
HPC	High Powered Committee
HSC	Hazard Safety Cells
HUDCO	Housing & Urban Development Corporation
HCR	High Corrosion Resistant
HTL	High Tide Line
IAF	Indian Air Force
IAY	Indira AwasYojana
ICAR	Indian Council of Agricultural Research
ICMAM	Integrated Coastal Area & Marine Management
ICRC	International Committee on Red Cross
ICS	Incident Command System
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDKN	India Disaster Knowledge Network
IDNDR	International Decade of Natural Disaster Reduction
IDRN	India Disaster Resource Network
IGNOU	Indira Gandhi National Open University
IIT	Indian Institute of Technology

IMD	India Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
INMARSAT	International Maritime Satellite
IOC	Integrated Operation Centre
IRC	Indian Red Cross
ISDN	Integrated Service Digital Network
ISRO	Indian Space Research Organisation
ICS	Incident Command System
IDRN	India Disaster Resource Network
IIA	Indian Institute of Architects
IIRS	Indian Institute of Remote Sensing
IIT-K	Indian Institute of Technology – Kanpur
IIT-R	Indian Institute of Technology – Roorkee
INTACH	Indian National Trust for Archaeological and Cultural Heritage
ITC	International Institute for Geo-Information Science and Earth Observation
IDNDR	International Decade for Natural Disaster Reduction (1990-99)
IDRN	India Disaster Response Network
IE(I)	Institution of Engineers (India)
IIG	Indian Institute of Geomagnetism
IISc	Indian Institute of Science
ISET	Indian Society of Earthquake Technology
ITIs	Industrial Training Institutes
ICG/ITSU	International Coordination Group for the Tsunami Warning System in the Pacific
ICG/IOTWS	Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning System
ICMAM	Integrated Coastal and Marine Area Management
ICZMP	Integrated Coastal Zone Management Project
IDRN	India Disaster Resource Network
IE(I)	Institution of Engineers (India)

IHO	International Hydrographic Office
INCOIS	Indian National Centre for Ocean Information Services
INHD	Indian Naval Hydrographic Department
IOC	Intergovernmental Oceanographic Commission
IRS	Incident Response System
IRTs	Incident Response Teams
ISDN	Integrated Services Digital Network
ITI	Industrial Training Institute
IWO	Initial Withdrawal of the Oceans
JFM	Joint Forest Management
JMA	Japan Meteorological Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JTWC	Joint Typhoon Warning Centre
LAN	Local Area Network
LBSNAA	LalBahadurShastri National Academy of Administration
LHZ	Low Hazard Zone
LMC	Last-Mile Connectivity
LRB	Low-Rise Buildings
LHM	Landslide Hazard Management
LiDAR	Light Detection and Ranging
LMP	Landslide Management Plan
LP	Landslide Potential
LRA	Landslide Risk Analysis
LSZ	Landslide Susceptibility Zonation
LTL	Low-Tide Line
MAN	Metropolitan Area Network
MAP	Management Action Plan
MCS	Meso-scale Convective System
MDD	Meteorological Data Distribution
MFTDMA	Multi-Frequency Time Division Multiple Access
MHA	Ministry of Home Affairs

MHRD	Ministry of Human Resource Development
MMP	Mission Mode Projects
MoA	Ministry of Agriculture
MoEF	Ministry of Environment and Forests
MoES	Ministry of Earth Sciences
MoHFW	Ministry of Health & Family Welfare
MoI&B	Ministry of Information and Broadcasting
MoIT	Ministry of Information Technology
MoRD	Ministry of Rural Development
MoUD& PA	Ministry of Urban Development and Poverty Alleviation
MoWR	Ministry of Water Resources
MPCS	Multipurpose Cyclone Shelters
MSSRF	M.S. Swaminathan Research Foundation
MTN	Main Telecommunication Network
MTNL	Mahanagar Telephone Nigam Limited
MW	Medium Wave
MCI	Medical Council of India
MFR	Medical First Responder
MHA	Ministry of Home Affairs
MHRD	Ministry of Human Resource Development
MoD	Ministry of Defence
MoM	Ministry of Mines
MoR	Ministry of Railways
MoSRTH	Ministry of Shipping, Road Transport and Highways
MAH	Major Accident Hazard
MFRs	Medical First Responders
MoUD	Ministry of Urban Development
MCIT	Ministry of Communication and Information Technology
MEA	Ministry of External Affairs
MEOCs	Mobile Emergency Operations Centers
MFRs	Medical First Responders

MoCI	Ministry of Commerce and Industries
MoF	Ministry of Finance
MoHRD	Ministry of Human Resource Development
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoIB	Ministry of Information and Broadcasting
MOST	Method of Splitting Tsunami
MoPR	Ministry of Panchayati Raj
NABARD	National Bank for Agriculture and Rural Development
NAP	National Afforestation Programme
NASA	National Aeronautical and Space Administration
NATMO	National Thematic Mapping Organization
NBSSLUP	National Bureau of Soil Survey and Land-Use Planning
NCCF	National Calamity Contingency Fund
NCDMI	National Cyclone Disaster Management Institute
NCEP	National Centre for Environmental Prediction
NCERT	National Council of Educational Research and Training
NCMC	National Crisis Management Committee
NCMRWF	National Centre for Medium Range Weather Forecasting
NCPP	National Coastal Protection Project
NCRMF	National Cyclone Risk Management Facility
NCRMP	National Cyclone Risk Mitigation Project
NCST	National Committee of Science & Technology
NCZP	National Coastal Zone Policy
NDCI	National Disaster Communication Infrastructure
NDEM	National Database for Emergency Management
NDM	National Disaster Management
NDMA	National Disaster Management Authority
NDMR	National Disaster Mitigation Reserve
NDMRC	National Disaster Mitigation Resource Centre
NDRF	National Disaster Response Force
NEC	National Executive Committee

NeGP	National e-Governance Plan
NEP	National Environment Policy
NHC	National Hurricane Centre
NHMIS	Natural Hazards Management Informatics Program of NIC
NHO	Naval Hydrographic Office
NIC	National Informatics Centre
NIDM	National Institute of Disaster Management
NIO	North Indian Ocean
NIOT	National Institute of Ocean Technology
NIRD	National Institute of Rural Development
NISA	National Industrial Security Academy
NMS	Network Management Software
NMTN	National Meteorological Telecommunication Network
NRSA	National Remote Sensing Agency
NSDI	National Spatial Data Infrastructure
NSS	National Service Scheme
NSSO	National Sample Survey Organisation
NTRO	National Thematic Research Organisation
NFVM	National Forest Vegetation Map
NWP	Numerical Weather Prediction
NWSTG	National Weather Service Telecommunications Gateway
NYKS	Nehru Yuvak Kendra Sangathan
NBC	National Building Code
NCC	National Cadet Corps
NDRF	National Disaster Response Force
NER	North Eastern Region
NGF	National Geotechnical Facility
NGO	Non-Governmental Organisation
NPEEE	National Programme in Earthquake Engineering Education
NRSC	National Remote Sensing Centre
NSS	National Service Scheme

NYKS	Nehru Yuva Kendra Sangathan
NAC	National Academy of Construction
NGRI	National Geophysical Research Institute
NICMAR	National Institute of Construction Management and Research
NIDM	National Institute of Disaster Management
NIT	National Institute of Technology
NITTTR	National Institute of Technical Teachers' Training and Research
NYKS	Nehru Yuva Kendra Sangathan
NAC	National Academy of Construction
NATMO	National Atlas and Thematic Mapping Organization
NBCC	National Building Construction Corporation Ltd.
NCMC	National Crisis Management Committee
NCRMP	National Cyclone Risk Mitigation Programme
NDEM	National Database for Emergency Management
NEC	National Executive Committee
NECP	National Emergency Communications Plan
NEOC	National Emergency Operations Centre
NERMP	National earthquake Risk Mitigation Project
NEWC	National Early Warning Centre
NNRMS	National Natural Resources Management System
NPCBEERM	National Programme for Capacity Building of Engineers in Earthquake Risk Management
NPCBAERM	National Programme for Capacity Building of Architects in Earthquake Risk Management
NPDM	National Policy on Disaster Management
NQRT	National Quick Response Team
OC	Operations Centre
OSDMA	Orissa State Disaster Mitigation Authority
PAD	Programme Associated Data
PAS	Public Address System
PMSS	Probable Maximum Storm Surge

PPP	Public-Private Partnership
PRI	Panchayati Raj Institution
PSDN	Public Switched Data Network
PSTN	Public Switched Telephone Network
PVA	Participatory Vulnerability Assessment
PS	Persistent Scatterer
PWD	Public Works Department
PC-NNRMS	Planning Committee of Natural Resource Management System
PMWS	Probable Maximum Wind Speed
PSHA	Probabilistic Seismic Hazard Analysis
PTHA	Probabilistic Tsunami Hazard Analysis
PTWC	Pacific Tsunami Warning Centre
QIP	Quality Improvement Programme
QRMT	Quick Response Medical Team
QRT	Quick Response Team
RF	Radio Frequency
RMP	Resource Management Plan
RMTN	Regional Meteorological Telecommunication Network
RRC	Regional Response Centre
RS	Radiosonde
RSMC	Regional Specialized Meteorological Centre
RTH	Regional Telecommunication Hub
RW	Radio Wind
R&D	Research and Development
RDP	Resource Damage Potential
RDSO	Research Designs and Standards Organisation
R&D	Research and Development
RCC	Reinforced Cement Concrete
RM	Risk Management
RVS	Rapid Visual Screening
R&D	Research & Development

RTSMN	Real Time Seismic Monitoring Network
S&T	Science and Technology
SAC	Space Applications Centre
SACC	Scientific Advisory Committee to the Cabinet
SCA	Service Centre Agency
SCPC	Single Channel per Carrier
SCS	Satellite Communication System
SDA	State Designated Agency
SDC	State Data Centers
SDMA	State Disaster Management Authorities
SDRF	State Disaster Response Force
SDSS	Spatial Decision Support System
SEC	State Executive Committee
SEOC	State Emergency Operations Centre
SERC	Structural Engineering Research Centre
SEZ	Special Economic Zone
SFR	State of the Forest Report
SHG	Self-Help Group
SHIFOR	Statistical Hurricane Intensity Forecast
SHIPS	Statistical Hurricane Intensity Prediction Scheme
SIRD	State Institute of Rural Development
SMS	Short Message Service
SoI	Survey of India
SRSA	State Remote Sensing Agency
SSM/I	Special Sensor Microwave/Imager
STIFOR	Statistical Typhoon Intensity Forecast
SW	Short Wave
SWAN	State-Wide Area Network
SAR	Synthetic Aperture Radar
SASE	Snow and Avalanche Study Establishment
SDMA	State Disaster Management Authority

SDRF	State Disaster Response Force
SLHZ	Seismic Landslide Hazard Zonation
SMR	Slope Mass Rating
SOP	Standard Operating Procedure
SEC	State Executive Committee
SEMCs	State Earthquake Management Committees
SERC	Structural Engineering Research Centre
SOI	Survey of India
SRRs	Structural Response Recorders
SRTEE	School of Research and Training in Earthquake Engineering
SDMA	State Disaster Management Authority
SDRF	State Disaster Response Force
SEMCs	State Earthquake Management Committees
SEOCs	State Emergency Operations Centers
SRC	State Relief Commissioner
TC	Tropical Cyclone
TDM	Time Division Multiplex
TIPS	Typhoon Intensity Prediction Scheme
TRAI	Telecom Regulatory Authority of India
TRMM	Tropical Rainfall Measuring Mission
TAC	Technical Advisory Committee
TEWS	Tsunami Early Warning System
THZ	Tsunami Hazard Zone
TMT	Thermo Mechanically Treated
TWS	Tsunami Warning System
UAV	Unmanned Aerial Vehicle
UFS	User-Facing Service
UGC	University Grants Commission
UKMO	United Kingdom Meteorological Office
ULB	Urban Local Body
USWS	United States Weather Service

UT	Union Territory
UGC	University Grants Commission
ULB	Urban Local Body
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UN (OCHA)	United Nations Office for the Coordination of Humanitarian Affairs
UEVRP	Urban Earthquake Vulnerability Reduction Project
UGC	University Grants Commission
ULBs	Urban Local Bodies
UN	United Nations
UNDP	United Nations Development Programme
UEVRP	Urban Earthquake Vulnerability Reduction Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VHF	Very High Frequency
VIC	Village Information Centre
VKC	Village Knowledge Centre
VPN	Virtual Private Network
VR	Virtual Reality
VRC	Village Resource Centre
VSAT	Very Small Aperture Terminal
VSS	VanaSamrakshanaSamithies
VTF	Village Task Force
VVF	Village Volunteer Force
WMO	World Meteorological Organisation
WIHG	Wadia Institute of Himalayan Geology
ZSI	Zoological Survey of India

GLOSSARY OF TERMS

Following Glossary has been used by National and International Institutions/Organisations in DRR:

Arrival Time: Time of arrival of the first wave of a tsunami at a particular location.

Afforestation: Systematic plantation in a deforested area to increase its forest cover

Bathymetry: The measurement of depth of water in oceans, seas and lakes; also

Information derived from such measurements.

Carbon Sequestration: A geo-engineering technique for the long-term storage of carbon dioxide or other forms of carbon, for the mitigation of global warming using subsurface saline aquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

Coastal Area: The area of land behind the sea coast up to the zero inundation line during the estimated future tsunamis and beyond the coast in the sea requiring tsunami management; the area on the landward side of the mean water line and the area up to 5m. water depth on the seaward side of the mean water line.

Crest Length: The length of a wave along its crest, sometimes also called crest width.

Cloudburst: Rain storm of great intensity usually over a small area for a short duration

Co-Seismic Landslides: Landslides triggered or induced by earthquakes.

Creep: Any extremely slow slope movements which are imperceptible except through long-period measurements.

Disaster: A catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, and degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area.

Disaster Management: A continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for prevention of danger or threat of any disaster; mitigation or reduction of risk of any disaster or its severity or consequences; capacity building; preparedness to deal with any disaster; prompt response to any threatening disaster situation or disaster; assessing the severity or magnitude of effects of any disaster; evacuation, rescue and relief; and rehabilitation and reconstruction.

Debris: The slope forming material that contains a significant proportion of coarse material; 20 per cent to 80 per cent of the particles are larger than 2mm; the remainder less than 2mm in size.

Debris Avalanche: A debris avalanche is an extremely rapid downward movement of rocks, soil, mud and other debris mixed with air and water.

Debris Flow: It is a mixture of water and clay, silt, sand and rock fragments that flows rapidly down steep slopes. A debris flow is slower than a mudflow.

Debris Slide: A debris slide is a jumble of material (clay, silt, sand and rock fragments) that moves downhill.

Deforestation: Removal of a forest by human activity

Estimated Time of Arrival: Computed arrival time of the first wave of a tsunami at the coast after the occurrence of specific major disturbance in the ocean like earthquakes, landslides, volcanic activity in the ocean, meteorite impact on the ocean surface etc.

Estuaries: Long narrow interlaced water bodies associated with the coast, experiencing tidal exchange, including portions of the rivers joining the sea.

Elapsed Time: Time interval between observed time of arrival of the first wave of a tsunami at a specific location on the coast and the time of returning to the normal water-level conditions.

Evacuation Map: A drawing or representation that outlines danger zones and designates limits beyond which people must be evacuated to avoid any harm from tsunami waves.

Earthquake: An earthquake is a series of vibrations on the earth's surface caused by the generation of elastic (seismic) waves due to sudden rupture within the earth during release of accumulated strain energy.

Far-field Tsunami: A tsunami capable of widespread destruction, not only in the immediate region of its generation, but across the entire ocean basin.

Factor of Safety: Factor of safety for a slope or a landslide, irrespective of the shape of the failure surface, is expressed in terms of the proportion of the measured shear strength that must be mobilised to just maintains limiting equilibrium. At limit equilibrium, the factor of safety of a slope in a deterministic analysis is unity.

Fall: The more or less free and extremely rapid descent of masses of soil or rock, of any size from steep slopes or cliffs is called a fall.

Flash Flood: Very fast rise and recession with characteristics of small volume flow and high discharge, which causes high damage because of suddenness and force.

Flow: The downward movement of a loose mixture of debris, water and air that moves in a fluid-like manner.

Green's Function: A type of function used to solve inhomogeneous differential equations subject to boundary conditions.

Gravity: Gravity is a constant force exerting a pull on everything on or above the earth's surface in a direction towards the center of the planet.

Hazard: A threatening event or the probability of occurrence of a potentially damaging phenomenon (e.g., an earthquake, a cyclonic storm or a large flood) within a given time period and area.

High-Risk Areas: Geographical areas which fall under seismic zones III, IV and V, which are vulnerable to potential impact of earthquakes, landslides, rock falls or mudflows.

Hazard: A threatening event or the probability of occurrence of a potentially damaging phenomenon (e.g., an earthquake or a large flood) within a given time period and area

Inundation Distance: The distance that a tsunami wave penetrates onto the shore, measured horizontally from the mean water line.

Intensity: Intensity is the degree of damage caused by a tsunami.

Local Tsunami or near-field Tsunami: A tsunami which has destructive effects (confined to coasts within 200 km of the source with arrival time less than 30 minutes).

Local Authority: It includes panchayati raj institutions, municipalities, a district board, cantonment board, town planning authority or Zilla Parishad or any other body or authority, by whatever name called, for the time being invested by law, for rendering essential services or, with the control & management of civic services, within a specified local area.

Landslide: Landslides are downward and outward movement of slope materials such as rock debris and earth, under the influence of gravity.

Landslide Dam: When landslides occur on the slopes of a river valley, the sliding mass may reach the bottom of the valley and cause partial or complete blockage

of the river channel. This accumulated mass of landslide debris resulting in blockage of a river is commonly termed as landslide dam.

Landslide Hazard Map: Map of spatial and temporal extent of landslide hazard. It indicates those areas that are, or could be, affected by landslides, assessing the probability of such landslides occurring within a specific period of time.

Landslide Inventory: Documentation of all the known landslide incidences including stabilised, dormant, reactivated, and most recent slides

Landslide Risk Map: A map that integrates landslide hazard, landslide vulnerability and quantification of elements at risk

Landslide Susceptibility Map: A map that ranks slope stability of an area. It shows locations where landslides may occur in future (without a definite time frame). These maps go beyond an inventory map and depict areas that have the potential for land sliding.

Liquefaction: Liquefaction is a phenomenon in which the shear strength and stiffness of a soil is reduced by an earthquake or other rapid loading due to collapse of soil structure and temporary increase in pore water pressure.

Local Authority: It includes panchayati raj institutions, municipalities, a district board, cantonment board, town planning authority or ZillaParishad or any other body or authority, by whatever name called, for the time being invested by law, for rendering essential services, or, with the control and management of civic services, within a specified local area.

Mainstreaming: Mainstreaming disaster management into the development planning process essentially means looking critically at each activity that is being planned, not only from the perspective of minimizing that activity's potential contribution to the hazard.

Maximum Run-up: Maximum Run-up (Amplification) is the difference between the elevation of maximum tsunami and the elevation of the mean water level.

Maximum Water Level: Maximum water level is the difference between the elevation of the highest local water mark and the elevation of the shoreline at the time of the tsunami outbreak.

Mean Tsunami Height: Average height of a tsunami measured from the trough to the crest.

Mean Sea Level: The average height of sea surface, based upon hourly observation of tide height on the open coast or in adjacent waters which have free access to the sea.

Mitigation: Measures aimed at reducing the risk, impact or effects of a disaster or threatening disaster situation.

Mangrove: Mangroves are basically halophytic trees, shrubs, and other plants growing on sheltered shores, typically on tidal flats, deltas, estuaries, bays, creeks and the barrier islands. The best locations are where abundant silt and fresh water is brought down by rivers or on the backshore of accreting sandy beaches.

Mudflow: A fast flow of a mixture primarily of the smallest silt and clay particles oversaturated with water. A mudflow has the consistency of newly mixed concrete.

Near-Field Tsunami: A tsunami from a nearby source, generally less than 200 km or associated with a short travel time of less than 30minutes.

Non-Structural Measures: Non-engineered measures to reduce or avoid possible impacts of hazards such as education, training, capacity development, public awareness, communication, etc.

Paleo-tsunamis: Previous tsunamis determined from the study of the coastal sedimentary columns, using geological techniques. Recurrence rate of tsunamis can be deduced from these studies.

Preparedness: The state of readiness to deal with a threatening disaster situation or disaster and the effects thereof.

Regional Tsunami: A tsunami capable of destruction in a particular geographic region, generally within about1000 km of its source. Regional tsunamis also occasionally have very limited and localised effects outside the region.

Run-up level: Run-up level is defined as maximum elevation in land up to which it is inundated by sea water during a tsunami.

Risk: The anticipated number of lives in danger, damage to property and disruption of economic activity due to a particular natural phenomenon.

Risk Assessment: The determination of the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihood, and the environment

Risk Management: The systematic process of using administrative decisions, organisation, operational skills, and capacities to implement policies, strategies, and coping capacity of the society and communities to lessen the impact of hazards

Resilience: The capacity of a system to tolerate perturbation or disturbances without collapsing into a qualitatively different state, to withstand shock and rebuild when necessary.

Rapid Visual Screening (RVS): Rapid Visual Screening is a procedure requiring visual evaluation to assess the vulnerability of buildings, by permitting vulnerability assessment based on walk around of the building by a trained evaluator. The evaluation procedure and system is compatible with GIS-based city database and also permits use of the collected building information for a variety of other planning and mitigation purposes.

Seismic Hazard: In the context of engineering design seismic hazard is defined as the predicted level of ground acceleration which will be exceeded by 10 per cent over the probability of hazard at the site under construction due to occurrence of earthquake, anywhere in the region, in the next 50 years.

Seismic Retrofitting: The structural modifications to upgrade the strength, ductility and energy dissipating ability of seismically deficient or earthquake-damaged structures.

Snow Avalanche: Snow Avalanche is a slide of snow mass down a mountainside. It is a rapid, down slope movement of large detached mass of snow, ice and associated debris such as rock fragments, soil and vegetation.

Specific Risk: The expected degree of loss due to a particular natural phenomenon.

Structural Measures: Any physical construction to reduce or avoid possible impact of hazards, which include engineering measures and construction of hazard-resistant, protective structures and infrastructure.

Seismic Strengthening: The process of enhancing the strength of existing structures to make them resistant to seismic activity, ground motion or soil failure due to earthquakes.

State Authority (SDMA): The State Disaster Management Authority established under sub-section (l) of the section 14 of DM Act, 2005 and includes the Disaster Management Authority for the Union Territory constituted under that section.

State Government: The Department of the Government of the state having administrative control of the Disaster Management and includes Administrator of the Union Territory appointed by the President under Article 239 of the Constitution.

Travel Time: Time required for the first tsunami wave to propagate from its source to a given point on a coastline.

Tsunami: A Japanese term meaning "harbour wave", derived from the characters "tsu" meaning harbour and "nami" meaning wave, to describe a system of ocean gravity waves having a long wavelength and period (time between crests), formed as a result of large-scale disturbance of the sea caused by an earthquake.

Tsunami Damage: Loss or damage directly or indirectly caused by a destructive tsunami, including loss of lives, damage to assets, property and infrastructure as well as disruption of livelihoods of affected communities.

Tsunami Dispersion: Redistribution of tsunami energy, particularly as a function of its period, as it travels across a body of water.

Tsunami Height: The vertical distance between the crest (highest point over the water surface) and trough (lowest point over the water surface) of a tsunami.

Tsunami Magnitude: A number characterising the strength of a tsunami based on the tsunami wave height.

Tsunami Period: Time that a tsunami wave takes to complete a cycle. Tsunami period typically ranges from 5 minutes to two hours.

Tsunami Vulnerability Assessment: The tsunami vulnerability assessment is expressed as details of elements of the built, natural and human environments vulnerable to potential tsunami-related damage.

Tsunami Wavelength: Horizontal distance between successive crests of a tsunami wave.

Tsunami Wave-current: Water particles move in a circular or elliptical motion in a horizontal plane in wind driven waves, only up to certain water depth from water surface, where as tsunami waves generate a current velocity in water which is prevalent throughout the depth of water from seabed to the top surface.

Vulnerability Line: Vulnerability line is a setback line to be demarcated on the coastal stretches, taking into account the vulnerability of the coast to natural and manmade hazards.

VSAT: Very Small Aperture Terminal (VSAT) is a two-way satellite ground station with a dish antenna that is smaller than 3 meters, most commonly used to transmit narrowband or broadband data.

Vulnerability: The degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural (or manmade) phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss).

Chapter – 1: Background

1.1. Introduction

In India both civic status as well as demographic aspect is taken as criteria for declaring a settlement as urban. The Census of India 2001 defines an urban place on the basis of the following criteria:

1. All places with a municipality, corporation, cantonment board or notified town area committee, etc.
2. All other places which satisfy the following criteria:
   Minimum population of 5,000
   At least 75% of male working population engaged in non-agricultural pursuits and
   A density of population of at least 400 persons per square km.

Indian urbanization has proceeded as it has elsewhere in the world as a part and product of economic change. Occupational shift from agriculture to urban-based industry and services is one part of the change. New industrial investments and expansion of the services industry in new location is also another factor. The push factors like population growth and unemployment, etc. and pull factors like opportunities in the urban areas are debated in the studies of India's urbanization. Migration is not the principal or the dominant factor in urban growth. However, in the case of some large cities for a certain period of time, migration has been a major factor.

1.2 Indicators and patterns of urbanization

India has launched the programmes of economic liberalization since 1991. This strategy of linking the country with the global economy has accelerated urban growth. The urban areas are likely to play an increasingly important role with the continuing liberalization of the economy. Much of the growth of the economy will come from economic activities that are likely to be concentrated in and around existing cities and towns, particularly large cities.

In the year 1901, there were only 1,827 towns/UA which increased to 5,500 towns/UA in 2001. As for the magnitude, in 1901, only 25 million people

constituting 10.84 per cent of population lived in urban areas in India. In the 100 years since then, the urban population has grown 12 times and it is now around 285 million people constituting 28 per cent of the total population.

Table 1.1: Trend Of Urbanization India 1901-2001

Census Year	No. of UA/Towns	Urban Population in Million	% Urban Population	Number of Towns/UA per 10 Lakh Rural Population	Decennial Growth Rate of Population (%)
1901	1827	25.85	10.84	8.6	-
1911	1815	25.94	10.29	8.0	0.35
1921	1949	28.08	11.18	8.7	8.27
1931	2072	33.45	11.99	8.4	19.12
1941	2250	44.15	13.86	8.2	31.97
1951	2843	62.44	17.29	9.5	41.42
1961	2365	78.93	17.97	6.6	26.41
1971	2590	109.11	19.91	5.9	38.23
1981	3387	159.46	23.34	6.4	46.14
1991	3768	217.17	25.72	6.0	36.10
2001	5500	286.20	28.54	-	31.50
2011		1210.19			17.64

Source: Census of India, 2001

In India in the following 20 years (2001-21), the urban population will nearly double itself to reach about 550 million. According to the World Urbanization Prospects (the 1996 Revision), the urban population in the year 2025 will rise to 42.5 per cent (566 million). This concentration of population in urban areas compels urban planners to act on mission mode with planning strategies to match these town and cities resilient.

1.2.1 Urbanization: State-Level Variations

The state-wide variations are significant to understand the vulnerability of population due to natural hazards. Thirteen States are prone to earthquake, 22 States to landslide and 2,200 km shoreline to cyclone and tsunami. The pace and spread of urbanization is not uniform. Maharashtra with an urban population percentage of 42 per cent (41million), Gujarat with 37 per cent (19 million) and

Tamil Nadu with 44 per cent (27 million) and the least urbanized State Assam with 13 per cent in 2001 indicate this inter-regional variation. In 2021, Maharashtra (50.45%), Gujarat (44.45%), Tamil Nadu (42.54%), Karnataka (41.12%) and Andhra Pradesh (39.13%) will be the most heavily populated urbanized States in the country in that order.

Among the northern States, Punjab, Haryana and Western Uttar Pradesh have significant urbanization levels.

1.2.2 Physical Pattern of Urban Growth

It is very important to understand the shape and physical patterns of urban growth. In 1991, there were 3768 UAs/towns. About one-third of the urban population in 1991 resided in 23 metropolitan cities, another one-third in the remaining 277 Class I cities and the rest in the 3,468 UAs/towns. In 2001, there were 4,368 UAs/towns. About 38% of the total urban population are residing in 35 metro cities, 30.6% in remaining 358 Class I cities and the rest in 3,975 UAs/towns. According to a recent estimate, the number of metropolitan cities will be 51 by 2011 and 75 by 2021 AD. In addition, there would be 500 large cities (one lakh and above size) and 4,430 medium and small towns (less than one lakh population size).

The analysis of urbanization pattern and projections for the next 20 years is indicative of the fact that a bulk of the urban population will be living in metropolitan regions. Agglomerations covering several municipal jurisdictions will emerge as a distinct feature of India's urbanization. The investments on roads and highways, telecom, railways open new avenues for investment, especially on certain corridors having a mix of location of big, medium and small towns with work opportunities and quality of life supported by affordable urban infrastructure.

1.2.3 Rapid Urbanization Increases Disaster Risk[1]

- City authorities have difficulty providing basic infrastructure and services. As a

[1] United Nations (2000) Cities at Risk Making Cities *Safer Before Disaster Strikes, International Natural United Nations (2000) Cities at Risk Making Cities Safer Before Disaster Strikes, International Natural Disaster Reduction Programme Agency, UN Publications, New York.*

result, 30-60% of people live in densely populated squatter settlements.

- Demand for land in cities has led to use of unsuitable terrain (floodplains, unstable slopes, reclaimed land) prone to natural hazards.
- Urban development increases the flood risk by disrupting natural drainage channels.
- Fast-growing cities contain increasing numbers of poorly constructed or badly maintained buildings, leading to unnecessary deaths.
- Increasing numbers of industrial complexes and hazardous materials concentrated in urban areas puts cities at risk. In the event of a natural hazard, they may cause considerable secondary disasters such as fires, explosions, radioactive radiations, etc.

1.2.4 Types of Settlements

Urbanization in India may emerge in different types of settlement pattern depending on natural and induced growth potentials. Natural hazard impact assessment has not been given prime considerations planning authority. Hence, the growth pattern is guided by economic factors only. It may be urban corridors, multiple nuclei system, urban regions, generators of economic momentum or its configurations, watersheds or natural regions. A settlement hierarchy is set out to underpin decisions about the location and scale of new developments such as housing, employment creation and social and physical infrastructure provision. Provision of infrastructure should be focused on locations that are the most environmentally robust and provide the best economic return.

Megalopolis – a group of conurbations, consisting of more than ten million people each, e.g., Mumbai and Delhi.

Conurbation – a group of large cities and their suburbs, consisting of five to ten million people, e.g., Delhi NCR, Hyderabad-Secunderabad.

Metropolis – a large city and its suburbs consisting of multiple cities and towns.

The population is usually one to five million, e.g., Kolkata, Bangalore, Chennai,

Ahmedabad, etc.

Large city – a city with a large population and many services. The population is >1 million people but over 500,000 people, e.g., Bhubaneswar, Gwalior, Jalandhar, Bhillai, etc.

Medium town – a medium town has a population of 50,000 to 500,000, e.g., Bokaro, Ahmednagar, Ujjain, etc.

Small town – a small town has a population of 5,000 to 50,000, e.g., all Class V, Class IV, Class III towns.

Village – a village generally does not have many services, possibly only a small corner shop or post office. A village has a population of 100 to 5,000.

1.2.5 Disaster Risk Profile of Indian Cities

Disaster is a sudden, calamitous event bringing great damage, loss and destruction and devastation to life and property. The damage caused by disasters is immeasurable and varies with the geographical location, climate and the type of the earth surface/degree of vulnerability. This influences the mental, socio-economic, political and cultural state of the affected area. Generally, disaster has the following effects in the areas concerned:

1. It completely disrupts the normal day-to-day life.

2. It activates emergency systems.

3. Normal needs and processes like food, shelter, health, etc., are affected and deteriorate depending on the intensity and severity of the disaster.

It may also be termed as “a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of the affected society to cope using its own resources”.

Normally, disaster may have the following main features:

- Unpredictability
- Unfamiliarity
- Urgency
- Uncertainty
- Speed
- Threat

Generally, disasters are of two types – natural and manmade.[2]

1.2.6 Major Causes of Vulnerability of A City To Disaster

There are various causes and factors which make cities vulnerable to disasters. Sometimes, it may be only one prominent factor or a combination of two or more than two factors. Some of the main factors which can be listed are as follows:

- Rapid growth and inadequate planning
- Ecological imbalance
- Population density
- Poor infrastructure and services
- Concentrated political, economic and other resources
- Inappropriate construction
- Technological disasters

  System failures
  Chemical accidents
  Industrial explosions
  Spillage in ground, water and air

1.2.7 Understanding The Relationship Between Natural And Technological Disasters[3]

There are several examples how natural disasters can lead to technological ones. Earthquakes may cause gas pipelines rupture, causing major fire

[2] Jain R.K. and Sharma Ajay (2008): Understanding Urban Disaster for Safer Cities: The case of Shimla City; Institute of Town Planner, India (ITPI) Journal, Vol. 5 No. 1.
[3] Jain R.K. and Sharma Ajay (2008): Understanding Urban Disaster for Safer Cities: The case of Shimla City; Institute of Town Planner, India (ITPI) Journal, Vol. 5 No. 1.

happened at 1995 Kobe earthquake. During floods in the US mid-west in 1993, liquid gas tanks floated down Mississippi river, posing a major technological threat. Drought and windstorms spread radioactive materials over a wide area in Russia in a 20-year period.

Similarly, there are also examples of how development practices, based on technological innovations can lead to natural disasters. Deforestation is one such example leading to erosion and landslides during heavy rains. In another example, as land in cities is replaced by concrete, the ground's natural ability to absorb water declines, leading to flash floods. These compound disasters are sometimes labeled as "Na-techs (natural/technological disasters). These days 'Na-techs are the clearest evidence of how disasters have become blurred.

While all urban areas have 'Na-techs' risks, those most at risk to Na-techs are rapidly growing cities in developing countries. Often, it is the same rapidly growing cities which are most at risk to natural disasters that are most at risk to technological disasters.

Based on the devastation, these are further classified into major and minor disasters.

Major natural disasters in India are:

- Earthquake
- Cyclone
- Landslide
- Tsunami

1.2.8 Critical Areas Of Concern In Disaster Management

1.2.8.1 Earthquake

An earthquake is a series of vibrations on the earth's surface caused by the generation of elastic (seismic) waves due to sudden rupture within the earth during release of accumulated strain energy. India is integrating disaster mitigation in urban planning practices in the country which has 38 cities in

seismic zone 3, 4 or 5 with more than half million population. According to the latest seismic zone map of India, about 59 per cent of India's land area is vulnerable to moderate or severe seismic hazard, i.e., prone to shaking of MSK intensity VII and above[4]. In the recent past, most Indian cities have witnessed the phenomenal growth of multi-storied buildings, super malls, luxury apartments and social infrastructure as a part of the process of development. The rapid expansion of the built environment in moderate or high-risk cities makes it imperative to incorporate seismic risk reduction strategies in various aspects of urban planning and construction of new structures.

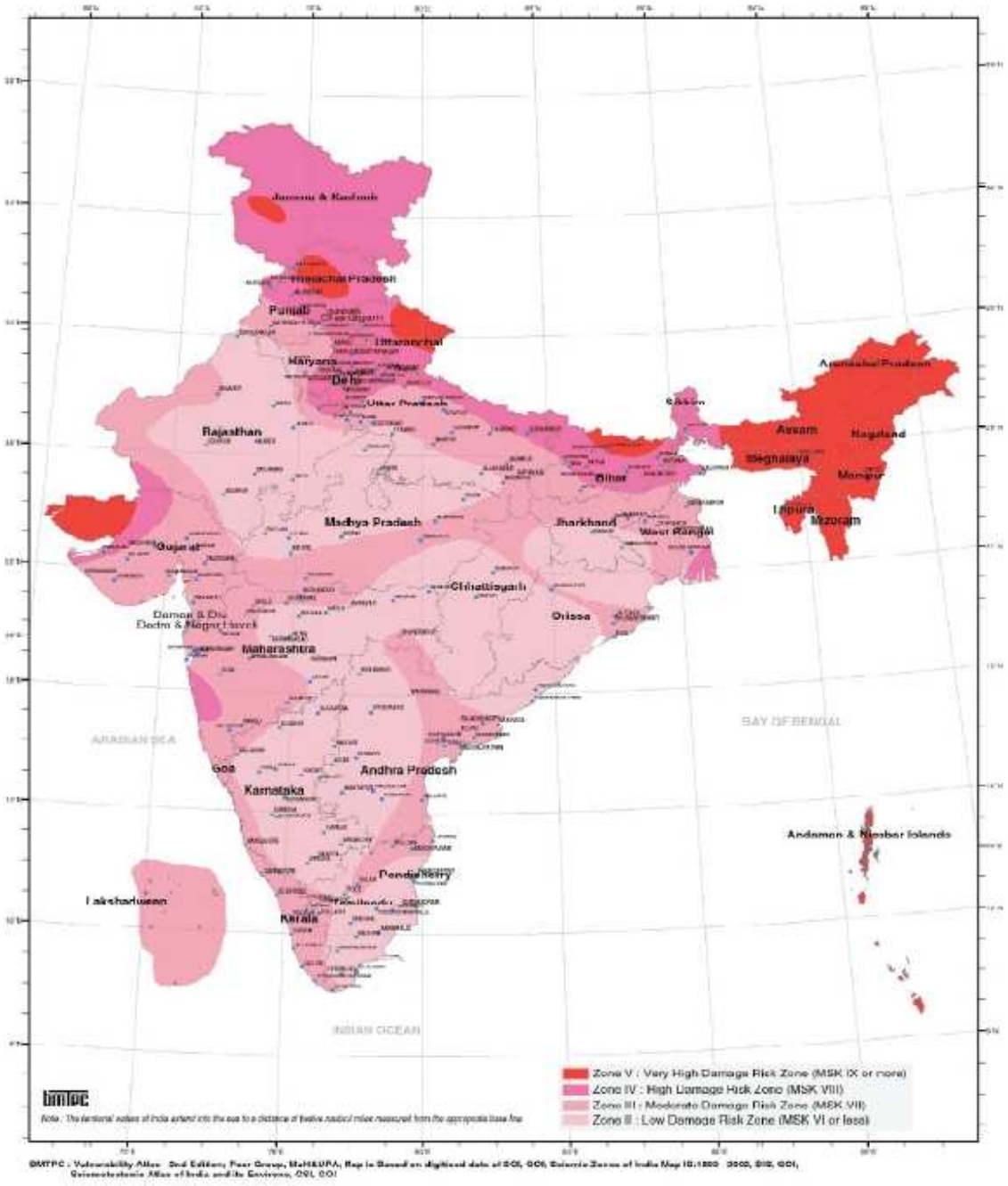
The entire Himalayan region is considered to be vulnerable to high intensity earthquakes of a magnitude exceeding 8.0 on the Richter scale and in a relatively short span of about 50 years, four such earthquakes have occurred: Shillong, 1897 (M 8.7); Kangra, 1905 (M.8.0); Bihar-Nepal, 1934 (M 8.3) and Assam-Tibet, 1950 (M 8.6)[5]. Scientific publications have warned that very severe earthquakes are likely to occur anytime in the Himalayan region, which could adversely affect the lives of several million people in India. National earthquake risk mitigation project has been taken up with the aim of strengthening the structural and non-structural earthquake mitigation efforts and reduces the earthquake risk and vulnerability in the high risk-prone districts/States/UTs involved in the project, which are: Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Chandigarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Sikkim, Uttar Pradesh and Uttarakhand.

Urban concerns: Growing amounts of badly built housing on/below steep slopes, on cliffs or at river mouths of mountain valleys. Often on illegally occupied land, such housing ignores planning/building codes.

[4] *National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines Management of Earthquakes.*

[5] Planning Commission, Government of India (2006): Report of the Working Group on Disaster Management.

Map-1.1: Seismic Zone Map of India (Is: 1893, 2002)



Source: National Disaster Management Guidelines: Management of Earthquake, NDMA

1.2.8.2 Landslide

Landslides are downward and outward movement of slope materials such as rock debris and earth under the influence of gravity. Landslides have affected at least 15 per cent of the land area of our country covering an area of more than 0.49 million sq km. Landslides of different types occur frequently in the geo-dynamically active domains in the Himalayan and North-Eastern parts of the country as well as relatively stable domains in the Western Ghats and Nilgiri hills in the Southern part of the country. Besides, sporadic occurrences of landslides have been reported in the Eastern Ghats, Ranchi plateau and Vindhyanplateau as well. In all, 22 States and parts of the Union Territory of Pudducherry and Andaman & Nicobar Islands of our country are affected by this hazard, mostly during the monsoons.

In addition to landslides, the snow avalanche is another natural hazard involving mass movement that is experienced at high altitudes in the Himalayan terrain during the late winter season when the snow starts melting. Landslides along the National Highway (NH) 1A and NH-1B in Jammu and Kashmir, the Rishikesh-Badrinath pilgrimage route in Uttarakhand, highways and roads in Darjeeling and Sikkim and the Dimapur-Imphal and Shillong-Silchar National Highways in the North-Eastern region have been disastrous and have caused immense economic loss and affected the social fabric for a long time.

Landslides with catastrophic effects include the Varunavat landslide of Uttarkashi, the Malpa landslide along the KailashMansarovaryatra route, the Kaliasaur landslide along the Rishikesh-Badrinath pilgrimage route, the Zubza and Mao Seng Song landslides along the Dimapur-Imphal National Highway, the Sonapur landslide along the Shillong-Silchar National Highway, the Sakinaka landslide in Mumbai, the Konkan landslides of 2005 and the Ghanvi village landslide in Himachal Pradesh in 2007. In the Western Ghats, over 500 lives were lost due to landslides in the Konkan area in Maharashtra during incessant rain in 2005, which accounted for 100 lives in the Mumbai Metropolitan Area alone. Some examples of devastating landslides in the Nilgiris include the

Amboori landslide in Thiruvanantapuram district, Kerala and the Runnymede, Hospital, Glenmore, Coonoor and Karadipallam landslides in Nilgiri district, Tamil Nadu.

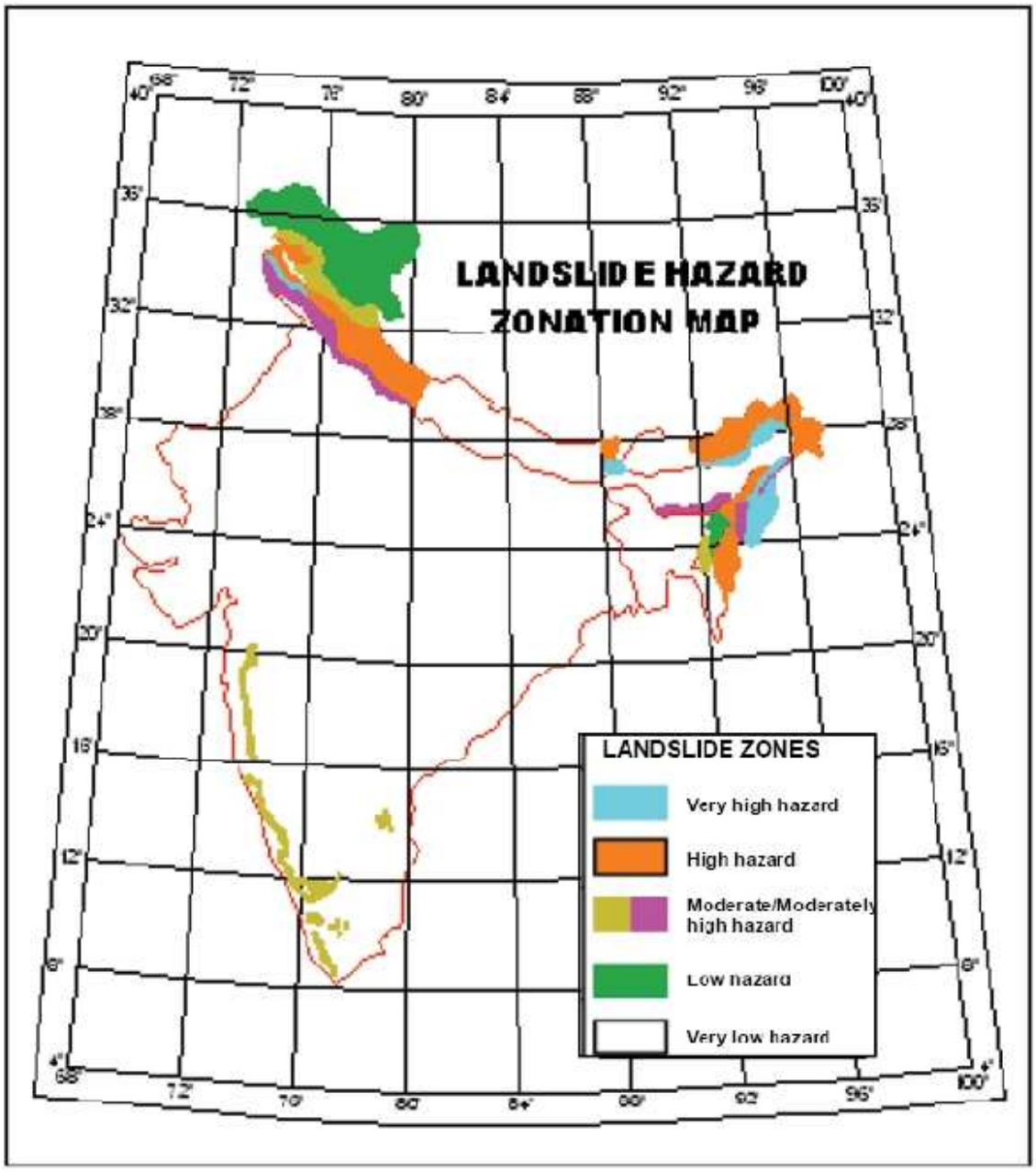
National landslide mitigation project has been taken up with the aim to strengthen the structural and non-structural landslide mitigation efforts and reduce the landslide risk and vulnerability in the hilly districts prone to landslides and mudflows. States/UTs involved in the project are: Aurnachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tripura, Uttar Pradesh and Uttaranchal[6](now Uttarakhand).

Urban concerns: Growing amounts of badly built housing on/below steep slopes, on cliffs or at river mouths of mountain valleys. Often on illegally occupied land, such housings ignore planning/building codes.

Some of the landslides block drainage courses and form natural dams known as landslide dams. A few such landslide dams worth mentioning are the Gohana Gad landslide dam that blocked the river Birehiganga in 1893, the landslide blockage on the Patalganga river in 1970 which led to the Alakananda tragedy, the Naptha-Jhakhri landslide on the Sutlej that caused huge losses to the Naptha-Jhakhri hydroelectric project and the recent landslide that blocked the river Parechhu in Tibet caused large-scale flooding in Himachal Pradesh in June, when this dam was breached.

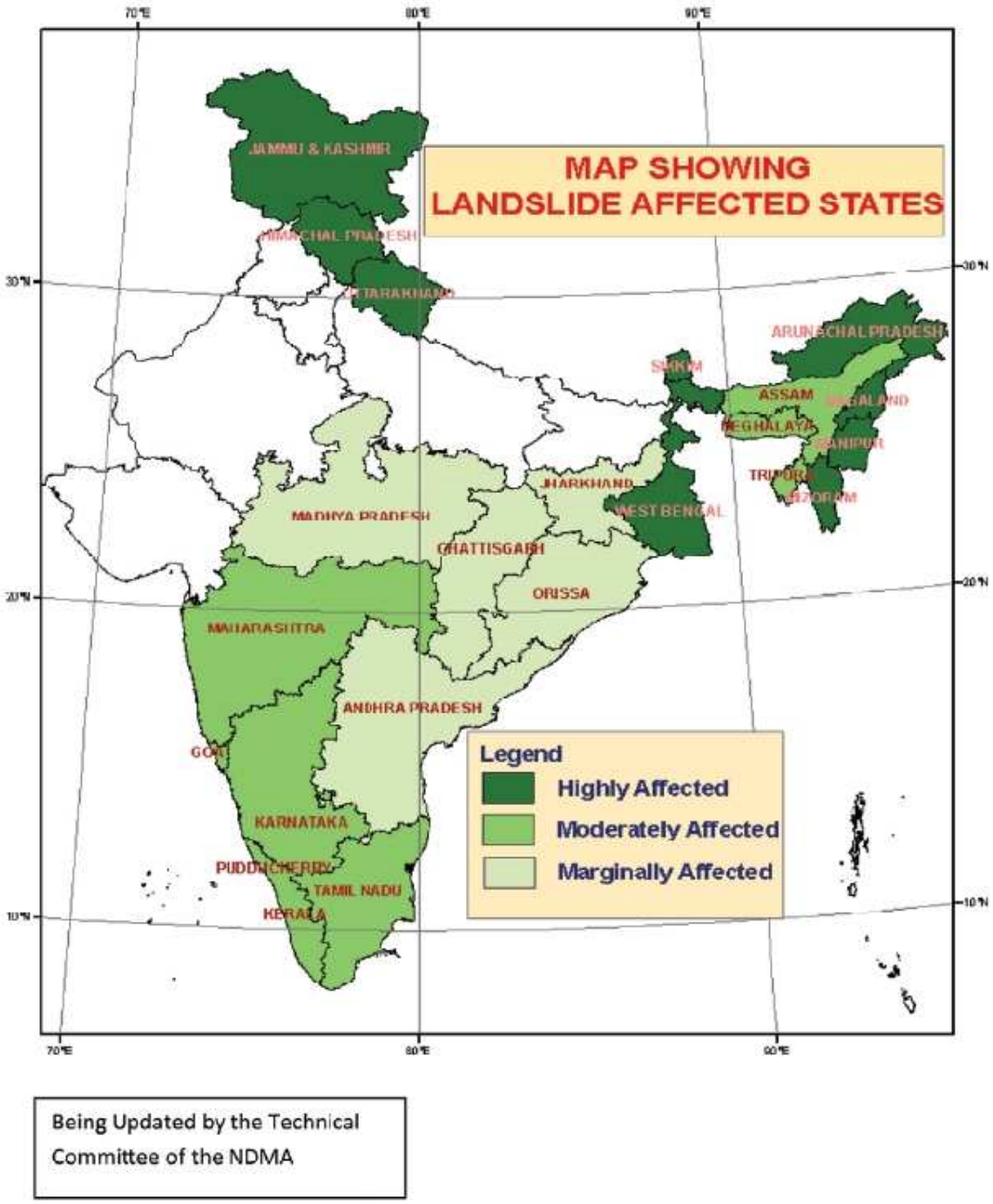
[6] Planning Commission, Government of India (2006): Report of the Working Group on Disaster Management.

Map-1.2: Landslide Hazard Zonation Map of India (Prepared By Gsi)



Source: National Disaster Management Guidelines: Management of Landslide, NDMA

Map-1.3: Landslide-Affected States



Being Updated by the Technical Committee of the NDMA

Source: National Disaster Management Guidelines: Management of Landslide, NDMA

1.2.8.3 Cyclone

A cyclone is a storm accompanied by high speed whistling and howling winds. It brings torrential rains. A cyclonic storm develops over tropical oceans like the Indian Ocean and Bay of Bengal and the Arabian Sea. Its strong winds blow at great speed, which can be more than 118 kilometers per hour.

A long coastline of about 7,516 km of flat coastal terrain, shallow continental shelf, high population density, geographical location and physiological features of its coastal areas makes India, in the North Indian Ocean (NIO) Basin, extremely vulnerable to cyclones and its associated hazards like storm tide (the combined effects of storm surge and astronomical tide), high-velocity wind and heavy rains.

Though the frequency of Tropical Cyclones (TCs) in the NIO covering the Bay of Bengal and the Arabian Sea is the least in the world (7% of the global total), their impact on the east coast of India as well as the Bangladesh coast is relatively more devastating. This is evident from the fact that in the last 270 years, 21 of the 23 major cyclones (with a loss of about 10,000 lives or more) worldwide occurred over the area surrounding the Indian subcontinent (India and Bangladesh). This is primarily due to the serious storm tide effect in the area.

National Cyclone Risk Mitigation Project (NCRMP) with the help of World Bank has been taken up in 13 States categorised under higher and vulnerability zone.They are[7]:

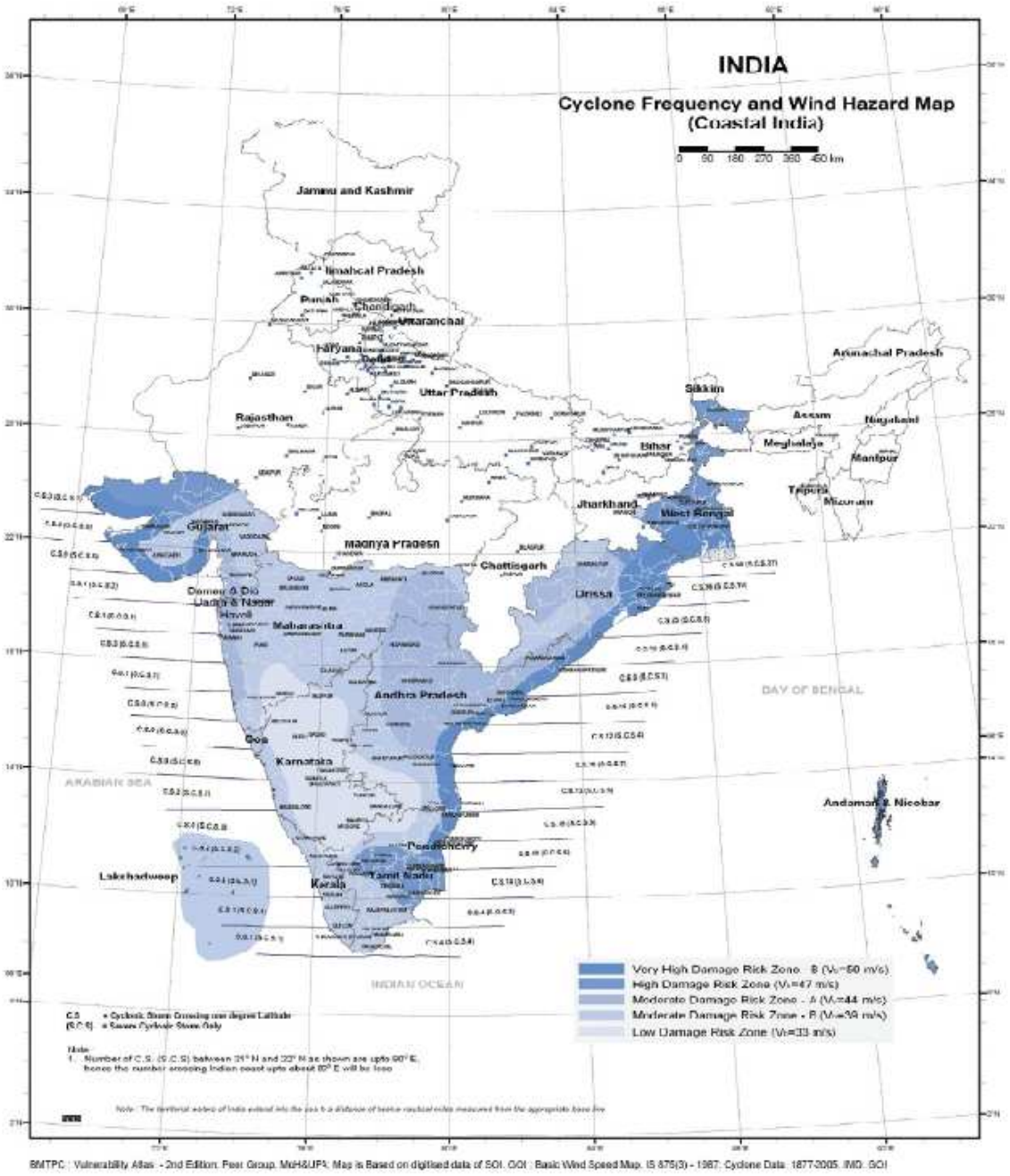
Category 1: Higher vulnerability zone -- Andhra Pradesh, Gujarat, Orissa, Tamil Nadu, and West Bengal.

Category 2: Lower vulnerability zone -- Andaman & Nicobar Islands, Daman & Diu, Goa, Karnataka, Kerala, Lakshadweep, Maharashtra and Pondicherry.

Urban concerns: Shantytowns along coasts are a particularly urban concern. Construction and early warning are concerns for both urban and rural areas.

[7] Planning Commission, Government of India (2006): Report of the Working Group on Disaster Management.

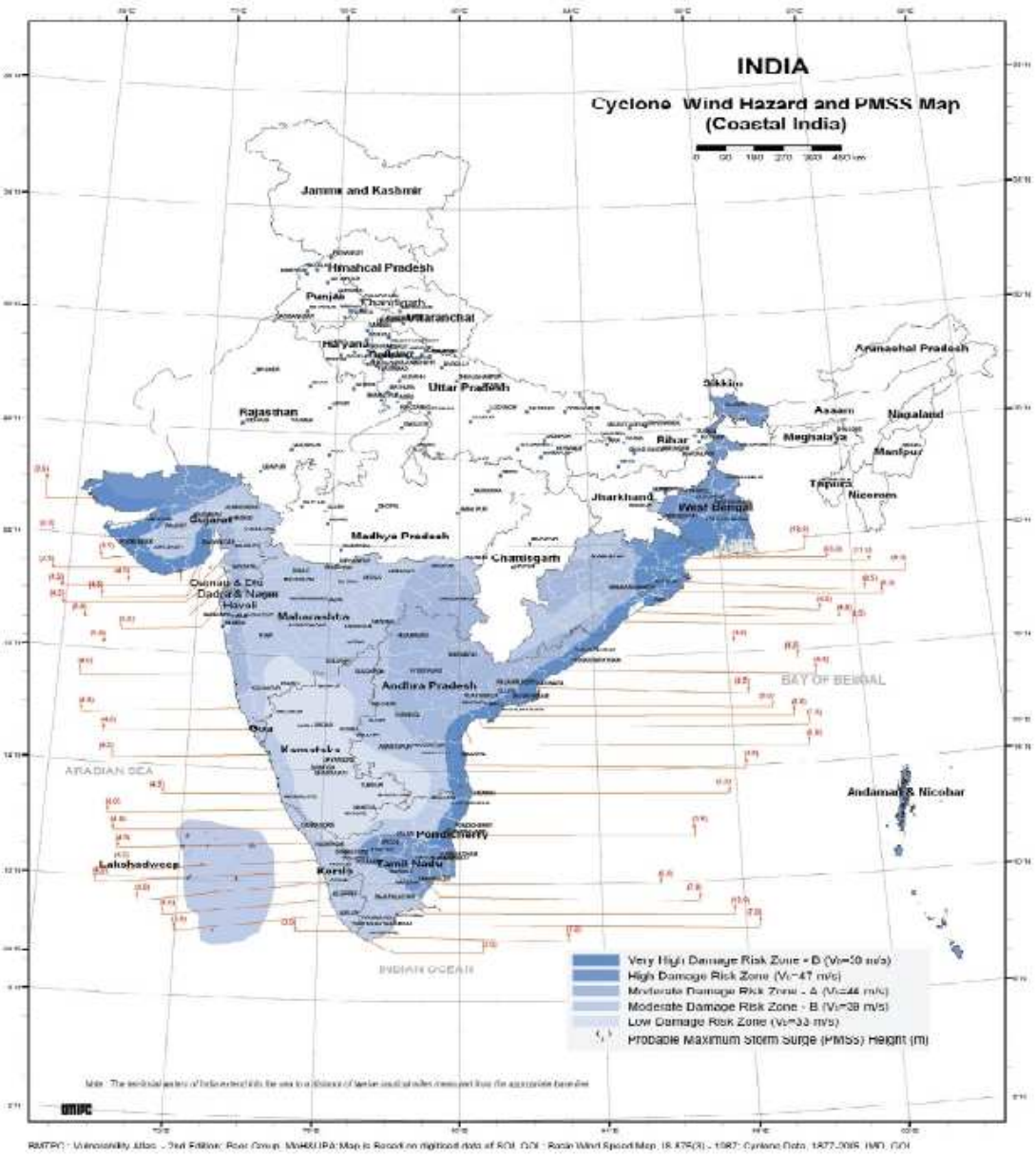
Map-1.4: Cyclone Frequency And Wind Hazard Map



BMTPC : Vulnerability Atlas - 2nd Edition. Peer Group. MoH&UPA. Map is Based on digitised data of SOI. GOI : Basic Wind Speed Map. IS 875(3) - 1987. Cyclone Data: 1877-2005. IMD. GOI

Source: National Disaster Management Guidelines: Management of Cyclone,, NDMA

Map- 1.5: Cyclone Wind Hazard And PMSS Map



Source: National Disaster Management Guidelines: Management of Cyclone, NDMA

1.2.8.4 Tsunami/Floods

A Japanese term meaning "harbour wave", derived from the characters "tsu" meaning harbour and "nami" meaning wave, to describe a system of ocean gravity waves having a long wavelength and period (time between crests), formed as a result of large-scale disturbance of the sea caused by an earthquake.

Till the Indian Ocean tsunami hit the Indian shores on December 26, 2004, people were not aware of the possible tsunami threat in India. Both East and West Indian shorelines are vulnerable to tsunami wave action. It has more than 2,200 km shoreline which is heavily populated. For a tsunami to hit the Indian coastline, it is necessary that a tsunami earthquake of magnitude greater than 6.5 should occur. Actual tsunami hazard of a coastline depends on its bathymetry and coastal topography.

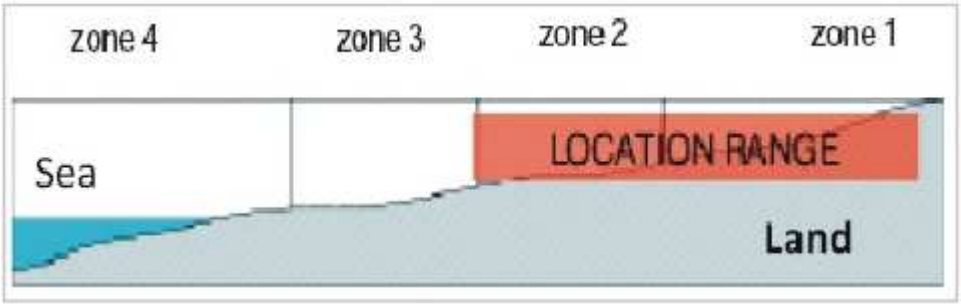
For tsunami mitigation as well as development strategies in rural and urban areas, the coastal areas can be divided into following four hazard zones:[8]

Zone-1 maximum water depth 00-3 m (Less dangerous)

Zone-2 maximum water depth 33-6 m

Zone-3 maximum water depth 66-9 m

Zone-4 maximum water depth > 9 m (Most dangerous)



Source: National Disaster Management Guidelines: Management of Tsunamis, NDMA

Fig 1.1: Tsunami Risk Zoning

[8] Urban Development Plan Formulation and Implementation (UDPFI) Guidelines.

Urban concerns: Shantytowns along coasts are a particularly urban concern.

Construction and early warning are concerns for both urban and rural areas.

1.2.8.4 (i) Floods

Too much water in the wrong place causes both natural and human, including dam, failures, blocked drainage systems, burst water mains and heavy storm rains. Floods are the most frequent disasters and growing more rapidly than other disasters.

Urban concerns: Rapid urbanization is a major factor in the increase of floods. Flash floods a growing concern due to concrete/compacted earth which absorbs little water, the decline of open spaces, engineering works that divert river flows and weak city drainage systems. Inappropriate housing on river banks or near deltas (due to construction and/or location) is a major concern.

1.2.8.4 (ii) Multi-hazard situation in coastal areas of States/UTs

The assessment of vulnerability, risk and their mapping thereof in the tsunami hazard area must be carried out taking various other hazards as applicable. Many of the areas prone to tsunamis are also prone to storm surges caused by tropical cyclones. Hence, a multi-hazard approach needs to be followed for addressing the preparedness, mitigation and emergency response requirements in the coastal areas. The multi-hazard situation on the West & East coast of India is available in the following tables.

Table-1.2: Multi-Hazard Data For West Coast of India

Name of the Coastal State / UT	Seismic Zone	Design Cyclonic Wind [IS:875 (III)] (m/s)	Probable Maximum Storm Surge Heights (m)	Astronomical High Tide above Mean Sea Level (m)	Flood Proneness
Gujarat	V,IV,III	50 & 47	2.5 - 5.0	1.1-4.1	In 5 coastal districts
Dadra & Nagar Haveli	III	44	5	1.9	-
Daman & Diu	III	50 & 44	5	1.1	-
Maharashtra	IV & III	44 & 39	2.9-4.2	1.9	-
Goa	III & II	39	3.4	1	-
Karnataka	III & II	39	3.4-3.7	0.8	-
Kerala	III	39	2.3-3.5	0.8	In 9 coastal districts
Lakshadweep	III	39	**	0.5	-

** Storm surge occurrence of Lakshadweep has not been documented. However, storms originating over these areas are not intense enough to cause significant surges.

Source: National Disaster Management Guidelines: Management of Tsunamis, NDMA

Table 1.3: Multi-Hazard Data For East Coast of India

Name of the coastal state	Seismic zone	Design & Probable Maximum Surface Wind (m/s)	Probable Maximum Storm Surge Heights (m)	Astronomical High Tide (m)	Flood Proneness
Tamil Nadu	III & II	50, 47, 39 (PMWS(PMWS-	2.7 – 7.0 Except 11.0	0.5	-
Puducherry	III	50, 47, 39 (PMWS(PMWS-	3.0 – 4.5	0.5	In 1 coastal district
Andhra Pradesh	II & II	50 (PMWS(PMWS-	3–6	0.68	In 8 coastal districts
Orissa	III & II	50 & 44 (PMWS(PMWS-	2.7 – 9.8	0.9 – 1.40	In 3 coastal districts
West Bengal	IV & II	50 (PMWS(PMWS-	12.0 – 12.5	2.6	In 3 coastal districts
Andaman & Nicobar	V	44	**	1.0	-

**Storm surge occurrence in Andaman & Nicobar Islands has not been documented. However, storms originating over these areas are not intense enough to cause significant surges.

+PMWS=Probable Maximum Wind Speed

Source: National Disaster Management Guidelines: Management of Tsunamis, NDMA

1.2.10 Mega City: Delhi

The exercise is limited to urban planning efforts only. Otherwise, Delhi Government has taken initiatives to prepare State Disaster Management Plan and did Zonation exercise to identify disaster-prone areas. It has also formulated building bylaws related to earthquake resistance and fire safety measures.

1.2.11 Macro City: Vishakhapatnam

The review of Master Plan for Vishakhapatnam Metropolitan Region, Master Plan and zonal development plan has indicated that this area falls under seismic zone–III, exposed to tidal waves, cyclones and flood-prone, high damage risk zone with wind speed of 180 kmph. The M/O Environment has prepared a coastal regulation zone plan under the statutory plan.

1.2.12 Meso City: Nainital

The review of Master Plan of Nainital, the hill town of Uttar Pradesh, and its lake region plan revealed their concern towards landslide hazards. Geological Survey of India had studied and identified instability of slope of the town. Complex folding and faulting has induced brittle ductile shear zones making this hard rock terrain susceptible to high degree of infiltration attendant with poor runoff.

The Master Plan has declared the very high-risk zone as prohibited areas with certain Regulations, like no new construction, no renovation, etc. Even then the whole plan needs systematic efforts to mitigate such disaster, to direct ULB to remain prepared for such event, effective implementation of rules, awareness programmes,financing insurance against disaster and accountability.

1.3 Key Stakeholders In Urban Area For Disaster Risk Reduction

There is a hierarchy of key stakeholders that starts with national level and goes down to town level.

1.3.1 List Of Stakeholders At National Level

This list is only indicative and not comprehensive

- Planning Commission
- Ministry of Environment and Forests
- Ministry of Mines
- Ministry of Home Affairs
- Ministry of Education
- Ministry of Human Resource Development
- Ministry of Defence
- Ministry of Power and Energy
- Ministry of Urban Development and Poverty Alleviation
- Ministry of Surface Transport
- Ministry of Water Resources
- Ministry of Railways
- Ministry of Science and Technology
- Ministry of Earth Sciences
- Ministry of Culture
- Ministry of Tourism
- National Disaster Management Authority

1.3.2 List of Stakeholders At State Level

This list is only indicative and not comprehensive

- Ministry of Housing and Urban Development
- State Disaster Management Authority
- State Disaster Response Force (Police, Fire, Medical, Transport, NGOs).
- Public Works Department
- Electricity Board
- Jal Nigam
- Education Department
- Health Department
- Industries
- Food Supply Department

1.3.3 List Of Stakeholders At Town Level

This list is only indicative and not comprehensive

- Development NGOs
- Disaster Management NGOs/Institutes
- Issue-Oriented NGOs
- Religious Organisations
- Specialised Groups (health professionals, business associations, local civic organisations, academia)
- Community-Based NGOs
- Business Foundations
- Government-Initiated NGOs (relief only)
- Politician-Driven Local NGOs (relief only)
- Private Companies
- Urban Local Body
- Line Department of Ministries, State and District level officer concerned

1.4 Concepts Of Resilient Cities And Safe Cities

1.4.1 Resilient Cities

All urban settlements will be crosschecked whether they are resilient cities on the basis of the following 10 points: (Reproduced from the article “Making Cities Resilient”)

i. Put in place organisation and coordination to understand and reduce disaster risk based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role to disaster risk reduction and preparedness.

ii. Assign a budget for disaster risk reduction and provide incentives for homeowners, low-income families, communities, businesses and public sector to invest in reducing the risks they face.

iii. Maintain up-to-date data on hazards and vulnerabilities, prepare risk assessments and use these as the basis for urban development plans and

decisions. Ensure that this information and the plans for the city's resilience are readily available to the public and fully discussed with them.

iv. Invest in and maintain critical infrastructure that reduces risk such as flood drainage, adjusted where needed to cope with climate change.

v. Assess the safety of all schools and health facilities and upgrade these as necessary.

vi. Apply and enforce realistic, risk-compliant building regulations and land use planning principles. Identify safe land for low income citizens and develop upgrading of informal settlements wherever feasible.

vii. Ensure education programmes and training on disaster risk reduction is in place in schools and local communities.

viii. Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.

ix. Install early warning systems and emergency management capacities in your city and hold regular public preparedness drills.

x. After any disaster, ensure that the needs of the survivors are placed at the centre of reconstruction with support for them and their community organisations to design and help implement responses, including rebuilding homes and livelihoods.

1.4.2 Safe Cities

Main objective of the safer city can be described as following:

- Sustainable development practices
- Revitalisation of deteriorating practices
- Proper land use planning
- Disaster impact assessment
- Plans to cope during emergency situations
- Special programmes for high-risk situation
- Public awareness about possible disaster threats and
- Enforcement of proper construction and planning guidelines

Chapter – 2: Urban Planning Practices in India

2.1 Urban Planning: Need And Nature

A plan is needed to serve as a guideline to promote urban development and it should be dynamic, expeditious, where time taken in plan preparation and approval is drastically reduced, participatory in nature where people, their representatives, policymakers, administrators and experts get opportunity to participate in both the stages of planning and implementation, promote development and provide conducive opportunities for effective private sector participation in implementation process, provide a system that integrates physical and economic planning and development initiatives, incorporate informal sector and the needs of the urban poor and provide opportunities for creation of jobs in both formal and informal sectors, have an active concern for protection of environment and historical and cultural heritage, strive for sustainable urban development, action oriented with adequate fiscal support and resource mobilisation strategy, provide effective mandatory monitoring and review mechanisms and above all provide safe and secured habitat.

Urban planning and development related to DRR has considered the following seven aspects with provision of modification as per new research and development in technology and construction material.

i. Hazard resistant planning, including risk sensitive land use
ii. Selective strengthening & retrofitting of existing infrastructure
iii. Awareness and preparedness
iv. Regulation and implementation
v. Capacity building
vi. Emergency response
vii. Monitoring, R&D, modification planning efforts

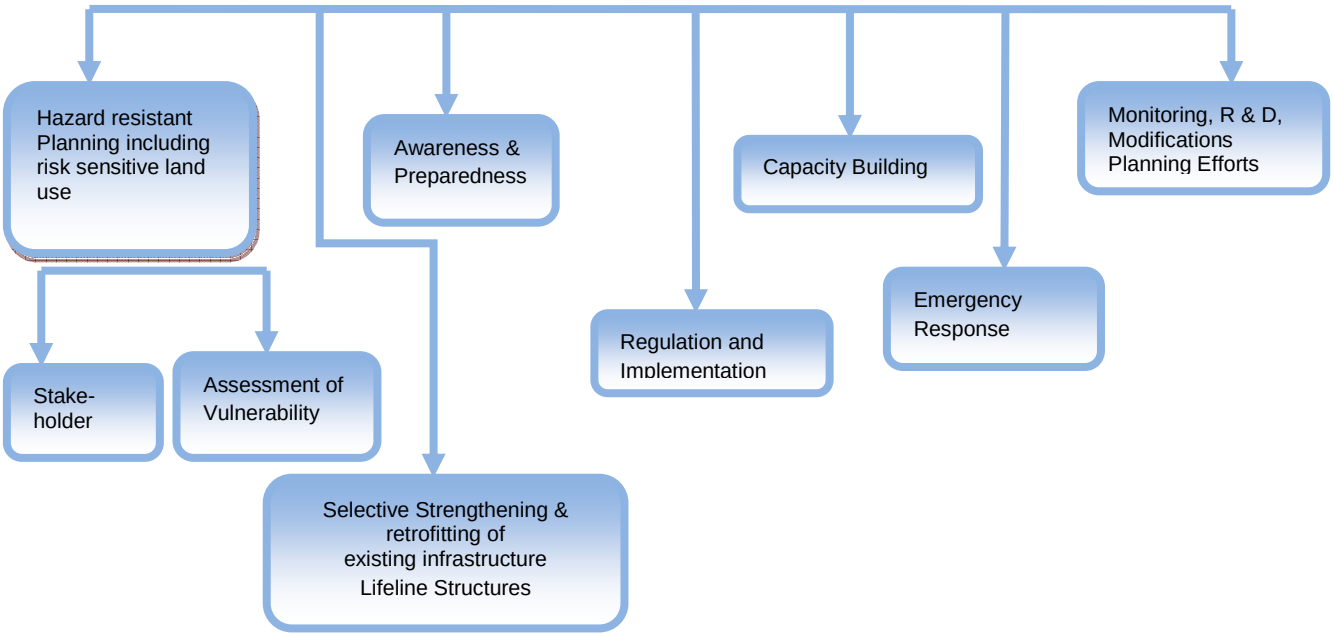


Fig: 2.1- Main Aspects of Risk Sensitive Urban Planning

2.1.1 Urban Planning Issues (Physical)

Planning issues related to natural hazards differ due to locational aspects of towns. The physical locations of these settlements can be characterised as under:

Hilly areas (earthquake, landslide, snow avalanches, storm) Coastal areas (cyclone, tsunami, floods, landslides/mudflow) River basins, wetland &watershed areas (earthquake, floods) Geographical fragile plains (earthquake, floods, landslides/mudflow, snow avalanches) Others (deserts, forest, marshy,etc) (earthquake, floods, storm, fire) Combination of above two or more

Planning considerations have to be guided through their locational characteristics. The natural disaster may hit the towns with one or more than one reason. A hill town may get earthquake, landslide and floods separately or together. Similarly, coastal towns may get cyclone, tsunami, earthquake and flood. Towns located in plain areas may get earthquake, floods, etc. Hence, planning for urban areas also requires separate guidelines for these differently located towns.

2.1.2 Scope For Land Use Planning

Definitions of natural hazards, natural hazard-prone areas, natural disaster, man-made hazard-prone areas, etc., are to be clearly explained before suggesting land use and development control regulations.

Land use zoning is required to suggest desired development of the town and helps in achieving its vision of physical and economic growth. It is supposed to regulate the kind of buildings to be constructed, their shape, size and height. It also protects habitat from non- conforming uses and properly channalise all types of use at their allotted locations. Hence, areas which are vulnerable are designated for other than prioritised uses.

2.2 Earlier Efforts

The expert group considered by the MHA had recommended modifications to the town and country planning laws, land use and zoning regulations, Development Control Regulations (DCRs) and building bylaws and developed a set of model bylaws which are technically rigorous and conform to globally accepted norms. They also prescribed regulatory, quality control and compliance mechanisms. The MHA has circulated these model bylaws to the State Governments for a review of the bylaws currently in force and for ensuring their adoption after revision. Physical planning exercise for urban settlements needs to be guided through proper land use zoning as prescribed in the Model Town and Country Planning Act 1960 (Revised) Section 73(1) or the Model Regional and Town Planning and Development Land (Revised) of UDPFI guidelines. Areas outside Master Plan can be guided through development control regulations or building bylaws. State Government should act on these aspects immediately and direct ULBs for amendments in their bylaws.

2.2.1 Existing Base Map And Location of Hazard-Prone Areas

Prior to distribution of risk sensitive land uses, the Master Plan must identify natural hazard areas within its administrative jurisdictions and also the possible

influence zone of the natural disaster area identified by the Vulnerable Atlas of India and micro-geo-mapping.

Separate maps need to be prepared for the identified town and its region for earthquake- prone, cyclone-prone, flood-prone, landslide-prone and tsunami-prone areas. If the town has multi-hazard characteristics, than these hazard-prone areas need to be superimposed to identify actual area of their influence. Only after this, risk-sensitive land use zones need to be worked out. Sometimes natural hazards occur due to trigger effect of another natural factor like rainfall, earthquake, anthropogeny. In urban planning, strengths of such factors are also to be measured at their peak strength and then decisions regarding different uses need to be taken.

Areas having one or more hazards are to be marked on the base map of the town. In case more than one hazard, they need to be superimposed and finally marked as landslide-prone areas. Finally, either they have to keep them as unprotected and in natural form for allied uses or they can be used with protective methods and precautions for other uses for limited purpose. These uses can be selected based on the impact of damage which may be caused by such hazards.

2.2.2 Development Policies That Reduce Vulnerability To Disasters Need To Be Encouraged[9].

Introduce/update regulations for faults, slopes, wetlands and other disaster-prone areas. Ban dense settlements and infrastructure development in hazard-prone areas and replace them with urban agriculture and/or recreation areas.

2.2.3 Physical Surveys Of Existing Structure

Further, for existing buildings and structures, a detailed survey be conducted and buildings be earmarked for retrofitting for demolition, repair or fit for use (with indication of life span).

[9] Adapted from: Disaster Reduction in Urban Areas IDNDR Secretariat policy paper November 1995

2.2.4 Options For Efficient Land Use Practices

- Encourage agro-forestry, organic farming, environmentally-sustainable cropping patterns and adoption of efficient irrigation techniques.
- Funding of green belt creation and conservation of mangroves, most of which are on common property and will have to continue to receive budgetary support.
- Such support today is inadequate and has to be enhanced in the interest of creating life and livelihood security in the coastal zones. Innovative funding mechanisms should also be evolved by levying either a charge or a cess for all development activities on the coastal area which would be pooled to reverse degradation and enhance conservation of green belts. It is also necessary to give some incentives to private land owners and fishermen to adopt sustainable practices.
- Planting of seedlings obtained from nurseries (seasonal effort and in small quantities). Nurseries are developed in upper parts of inter-tidal zones for 6-12 months and then transplanted to the field according to their zonation pattern.
- Species selection is to be made based on the availability and maturity of planting materials from the locality.
- Zonation pattern is to be considered primarily in restoration work.

The following codes and guidelines related to landslides have been finalised and published by the BIS. These need to be followed in landslide-prone areas.

i. IS 14496 (Part 2): 1998 Guidelines for the preparation of LHZ maps in mountainous terrain: Part 2: Macro zonation.

ii. IS 14458: Guidelines for retaining walls for hilly areas

   a. Part 1: Selection of the type of walls

   b. Part 2: Design of retaining/breast walls

   c. Part 3: Construction of dry stone walls

iii. IS 14680:1999: Guidelines for landslide control

iv. IS 14804:2000: Guidelines for siting, design and selection of materials for residential buildings in hilly areas

v. National Building Code (NBC) 2005

2.2.5 Safeguard For Buildings And Land Uses[10]

Land use which cannot be avoided in natural hazard areas, then its building structure needs to have safeguards based on the following already prescribed building codes:

Generally, the structural design of foundations, elements of masonry, timber, plain concrete, reinforced concrete, pre-stressed concrete and structural steel shall conform to the provisions of part VI Structural Design Section – 1 Loads, Section – 2 Foundation, Section – 3 Wood, Section – 4 Masonry, Section – 5 Concrete & Section – 6 Steel of National Building Code of India (NBC), taking into consideration the Indian Standards as given below:

2.2.6 General Structural Safety

1 IS: 456:2000 “Code of Practice for Plain and Reinforced Concrete”

2 IS: 800-1984 “Code of Practice for General Construction in Steel”

3 IS: 801-1975 “Code of Practice for Use of Cold Formal Light Gauge Steel Structural Members in General Building Construction”

4 IS 875 (Part 2):1987Design loads (other than earthquake) for buildings and structures Part2 Imposed Loads

5 IS 875 (Part 3):1987Design loads (other than earthquake) for buildings and structures Part 3 Wind Loads

6 IS 875 (Part 4):1987Design loads (other than earthquake) for buildings and structures Part 4 Snow Loads

7 IS 875 (Part 5):1987Design loads (other than earthquake) for buildings and structures Part 5 special loads and load combination

8 IS: 883:1966 “Code of Practice for Design of Structural Timber in Building”

[10] As per revised Model Town Planning By--Law, Ministry of Home Affairs(MHA)

9 IS: 1904:1987 “Code of Practice for Structural Safety of Buildings: Foundation”

10 IS1905:1987 “Code of Practice for Structural Safety of Buildings: Masonry Walls”

11 IS 2911 (Part 1): Section 1: 1979 “Code of Practice for Design and Construction of Pile Foundation Section 1”

Part 1: Section 2 Based Cast-in-situ Piles

Part 1: Section 3 Driven Precast Concrete Piles

Part 1: Section 4 Based precast Concrete Piles

Part 2: Timber Piles

Part 3 Under Reamed Piles

Part 4 Load Test on Piles

Cyclone/windstorm protection

12 IS 875 (3)-1987 "Code of Practice for Design Loads (other than Earthquake) forBuildings and Structures, Part 3, Wind Loads"

13 Guidelines (Based on IS 875 (3)-1987) for improving the Cyclonic Resistance of low-rise houses and other buildings

For earthquake protection

14 IS: 1893-2002 "Criteria for Earthquake Resistant Design of Structures (Fifth Revision)"

15 IS:13920-1993 "Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces -- Code of Practice"

16 IS:4326-1993 "Earthquake Resistant Design and Construction of Buildings -- Code of Practice (Second Revision)"

17 IS:13828-1993 "Improving Earthquake Resistance of Low Strength Masonry Buildings-- Guidelines"

18 IS:13827-1993 "Improving Earthquake Resistance of Earthen Buildings -- Guidelines"

19 IS:13935-1993 "Repair and Seismic Strengthening of Buildings -- Guidelines" Protection of landslide hazard

20 IS 14458 (Part 1): 1998 Guidelines for retaining wall for hill area: Part 1 Selection of type of wall

21 IS 14458 (Part 2): 1997 Guidelines for retaining wall for hill area: Part 2 Design of retaining/breast walls

22 IS 14458 (Part 3): 1998 Guidelines for retaining wall for hill area: Part 3 Construction of dry stone walls

23 IS 14496 (Part 2): 1998 Guidelines for preparation of landslide – Hazard zonation maps in mountainous terrains: Part 2 Macrozonation

Note: Whenever an Indian Standard, including those referred in the National Building

Code, the latest revision of the same shall be followed except specific criteria, if any, mentioned above against that code.

2.2.7 Structural Design Basis Report

In compliance with the design with the above Indian Standard, the structural engineer on record will submit a structural design basis report in the proforma attached herewith covering the essential safety requirements specified in the standard.

(i) The Structural Design Basis Report (SDBR)"consists of four parts(FormNo.6)

Part-1 – General Information/Data

Part-2 – Load Bearing Masonry Buildings

Part-3 – Reinforced Concrete Buildings

Part-4 – Steel Buildings

(ii) Drawings and documents to be submitted for approval of appropriate authorities shall include SDBR as detailed below:

Part – 1 Completed

Part – 2 (if applicable) – completed

Part – 3 (if applicable) – undertaking that completed Part 3 will be submitted before commencement of construction.

Part– 4 (if applicable) – undertaking that completed Part 4 will be submitted before commencement of construction.

(iii) SDBR as detailed below shall be submitted to the appropriate authority as soon as design of foundation is completed, but not later than one month prior to commencement of construction.

Part – 1 Completed

Part – 2, Part – 3 or Part – 44 (if applicable) Completed

2.2.8 Seismic Strengthening/Retrofitting

Prior to seismic strengthening/retrofitting of any existing structure, evaluation of the existing structure as regards structural vulnerability in the specified wind/seismic hazard zone shall be carried out by a RSE/RSDA. If as per the evaluation of the RSE/RSDA the seismic resistance is assessed to be less than the specified minimum seismic resistance as given in the note below, action will be initiated to carry out the upgrading of the seismic resistance of the building as per applicable standard guidelines.

Note: (a) for masonry buildings reference is to be made to IS: 4326 and IS: 13935 and (b) for concrete buildings and structures reference is to be made to BIS code on evaluation and seismic strengthening for retrofitting of RCC buildings under preparation at present.

2.2.9 Review of Structural Design

(i) The competent authority shall create a Structural Design Review Panel (SDRP) consisting of senior SERs and SDARs whose task will be to review and certify the design prepared by SER or SDAR whenever referred by the competent authority.

(ii) The reviewing agency shall submit addendum to the certificate or a new certificate in case of subsequent changes in structural design.

(iii) Requirements of SDRP for different seismic zones namely III, IV and V and for structures of different complexities.

i.) In seismic Zone II, buildings & structures greater than 40m in height will require proof-checking by SDRP.

2.2.10 Certification Regarding Structural Safety In Design

Structural Engineer on Record (SER) or Structural Design Agency on Record (SDAR) shall give a certificate of structural safety of design at the time of completion.

2.2.10.1 Constructional Safety

- All construction except load bearing buildings up to three story's shall be carried out under supervision of the Construction Engineer on Record (CER) or Construction Management Agency on Record (CMAR) for various seismic zones.
- Certification of structural safety in construction CER/CMAR shall give a certificate of structural safety of construction at the time of completion.

2.2.10.2 Quality Control And Inspection

- Inspection

All the construction for high-rise buildings higher than seven storeys, public buildings and special structures shall be carried out under quality inspection programme prepared and implemented under the Quality

Auditor on Record (QAR) or Quality Auditor Agency on Record (QAAR) in seismic zones IV & V.

- Certification of safety in quality of construction

Quality Auditor on Record (QAR) or Quality Auditor Agency on Record (QAAR) shall give a certificate of quality control as per proforma given in Form-15. Quality inspection programmeto be carried on the site shall be worked out by QAR/QAAR in consultation with the owner, builder, CER/CMAR.

2.2.11 Type of Structure

1. Steel fabricated tower or antennas on M.S. pole.
2. Pre-fabricated shelters of fibre glass or P.V.C. on the building rooftop/terrace for equipment.
3. Masonry structure/shelter on the ground for equipment.
4. D.G. set with soundproof cover to reduce the noise level

2.3 Planning Rules And Regulations, Tools, Acts And Bodies

A. Planning Function At The National Level

The Planning Commission at the Centre exercises the planning functions.It does not, however, do broad coordination of development on the physical plan which is very essential.

- In view of the large number of national and regional factors which regional planning involves, the felt need is that the subject of regional; survey, planning and development should come under the purview of a Central Advisory Board for Town and Regional Planning under the Planning Commission or Ministry of Urban Development, Government of India.
- Regional Planning Body needs to be set up by the Central Advisory Board in regions which encompass more than one State in order of priority, supported by a technical planning department to conduct regional surveys, prepare regional plans and superintend their implementation.

2.3.1 Amendment In The Town And Country Planning Act

Model Town and Country Planning Act was prepared in 1960 and revised in 1985 by the Town and Country Planning Organisation (TCPO). Ministry of Urban Development (MoUD), Government of India needs to be further amended as per the proposed amendment by the committee of experts constituted by the MHA, National Disaster Management Division in the year 2004. The Central Government shall ensure that there amendments are fully incorporated in respective State Town Planning Acts. These amendments are under section 2chapter 1 preliminary, section 4 (2) (a) chapter II State Planning Board, section11 chapter III. Local Planning Areas and Local Planning Authorities, section18, 19, 20, chapter V Development Plans, section 29 (a) chapter VII Control of Development and use plans, section 73 chapter X Supplemental and Miscellaneous Provisions.

2.3.2 Amendment To The Regional Town Planning Act

Amendments are proposed for safe and secured urban settlements and adequate provision in urban planning practices to take precaution of disastrous events, especially in disaster-prone areas. Amendments are also proposed in Model Regional and Town Planning and Development law 1985. These amendments should also be taken care of by all State Governments while finalising their Regional Town Planning Act.

2.3.3 Central Government Policies And Projects

The Central Government has already formulated its urbanization policy, transport policy, housing policy and sanitation policy. All these policies are prepared with the basic aim to benefit all sectors of the country and all sections of the society. There are basic guidelines which all States and Union Territories of India require to implement in their respective jurisdictions. The Central Government has also various schemes related to above policies and under their schemes various projects are finalised for implementation. State Governments are given financial assistance to implement their schemes like Jawaharlal Nehru Urban Renewal

Mission (JNNURM), Basic Services to Urban Poor (BSUP), Environmental Improvement of Urban scheme, Integrated Development of Small and Medium Towns (UDISSMT) are some such schemes which are being implemented through Central assistance. Projects are required to be submitted by the State/UT Governments along with the City Development Plan (CDP) or City Mobility Plan (CMP) or Master Plans. Till now guidelines prepared by the Central Government and circulated among State/UT Government for preparation of CDPs, CMPs and Master Plans do not have specific guidelines for disaster-prone areas. Hence, State Government and urban local bodies were loosely following prevalent practices and guidelines available on the subject like coastal area zones or landslide zones or earthquake-prone zones, fire safety norms, etc.

Now, the Central Government while asking projects from State/UT Governments should clearly indicate preparation of projects keeping in view the natural hazard proneness of the area. If the project area is within the hazard-prone zone than the project should also specify existing and proposed infrastructure for preparedness, response, mitigation and management of those hazards.

The Jawaharlal Nehru National Urban Renewal Mission provides an opportunity for improving safety of our cities with regard to natural hazards which often tend to become disasters as experienced in many parts of the country in the recent past. It is required to be considered that each project, when sanctioned specifically in disaster-prone region, should include an element for the assessment of impact of natural hazards that may occur in the area and the probable damage it may cause to life and property to be built in to the scope of the project to address mitigation schemes.

2.3.4 Existing Challenges

2.3.4.1 Integrated Approach

In developmental planning process, for mainstreaming disaster management it is necessary to look at each activity that is being planned critically with the vision of not only reducing the disaster vulnerability of that activity but also minimizing that

activity's potential contribution to the hazard. There should be an integrated approach in every development plan of each Ministry and Department which should incorporate elements of impact assessment, risk reduction and the `do no harm' approach.

2.3.4.2 Location Of Early Warning System

At the national level, National Early Warning System needs to be set up for operation on 24X7 basis for generation of timely advisory for cyclone, tsunami, landslide, snow avalanches and possible earthquakes. The location of such system be strategically planned and marked on the utility map of the town/district and roadmap of the State/UT.

2.3.4.3 Training And Refreshing Courses

The NIDM at the national level shall impart training short-term DRR courses to Central/State/ULB officers in urban planning in disaster-prone areas through Institute of Town Planning (India) and its regional chapters located in different States. Special training course be planned for civil engineers, infrastructure engineers for construction projects in urban settlements in hazard-prone areas.

B. Planning Function At State Level

The town planning function at the State level is broader in scope than at the local level though it follows very much the same pattern as at the local level. Instead of departments, the coordination will be among several ministries, the factors being more complex and involved. The function is best exercised through the agency of the State Planning Board established again by the State statue and composed of the representatives of the various Ministers of the State and presided over either by the Minister of Planning and Development, or that of local self-government.

The State Planning Department should again be independently placed either under the Minister of Planning and Development or the Minister of Local Self-Government, preferably the former.

The functions of the State Planning Board and the State Planning Department will include coordination of planning and development activities within the entire State, broken up into regions where regional differentiations exist. In addition to broad co ordination at the State level, the State Planning Board will also have to supervise the city planning activities taking place at the local level and guide them to the extent desirable for coordinating activities adjacent to local bodies in the overall interest of the State.

At State level Development Integration Committee is constituted consisting of the following:

a) Chairperson
b) Heads of relevant Central and State Government departments functioning or having jurisdiction over the local planning area
c) Six non-official members from amongst the residents and representatives of non- government and community-based organisations
d) Representative from SDMA
e) Chief town planner – member secretary

The function of this committee will be:

Discuss and advice on development aims and objectives.

a) Provide input on existing conditions, projections, priorities and major programmes of each department to form part of projected requirements.
b) Ensure coordination of inter-departmental interactions and cooperation pertaining to plan formulation and integration.
c) Ensured safe and secured urban development.

The committees will also discuss and evaluate the alternatives having regard to achievement of aims and objectives, judicious utilisation of land resources, environmental and fiscal resources sustainability and urban design quality. This leads to the selection of a preferred alternative for further detailing as the proposed plan for the settlement. This plan could be further divided into private and public sector programmes of action classified by priorities, operators and the

time frame. Among all these, the most important decision is related to risk sensitive judicious utilisation of land resources and environmental sustainability. This will help the community to mitigate disaster impact on their habitat.

C. Planning Functions At Town Level (Local Level)

Several departments in the local body will prepare plans for improvements concerned with their individual functions and send them to the town planning organisation which will put these improvements together and so phase them as to bring out department in different aspects in any area in relation with each other. The town planning department will see that in a State housing project, construction of houses is always undertaken after the roads and services are laid and while laying services, there is coordination between the water supply authorities, the road authorities and the electrical supply authorities and that their respective lines do not run to cross purposes. If the community should benefit in a lasting manner from town planning, it is necessary that the town planning organisation must be made independent of the day-to-day administration of the city and must be so constituted that the full cooperation of political parties and citizens interested in the welfare of the community is obtained. Every local authority shall also constitute a Standing Planning Committee for the purpose of preparation of various development plans. This committee shall comprise (a) the chairperson of the local authority as chairperson; (b) two members nominated by the local authority from among the elected members, representative of SDMA and DDMA, chief administrative officer and the municipal planner as the member secretary. Most vulnerable groups especially slum projects should be given special attention in planning.

2.3.5 BMPTC Efforts

Building Materials and Technology Promotions Council (BMPTC) has formulated regulations for land use zoning especially for natural hazard-prone areas. These guidelines are also adopted by respective State Governments while notifying Master Plan or Development Plan for their town.

2.3.6 Preparation Of Base Maps

Detailed plot level micro-zonation is an important aspect for specific hazard consideration and its mitigation in land use. After micro-zonation, detailed plot-wise guidelines or planning norms could be prescribed for land use zoning in that area. Central Government/State Governments should sponsor micro-zonation of all cities and help ULBs in this matter.

Base maps of all urban settlements need to be upgraded with latest data of their existing land uses, types of installations, their structure and vulnerability to natural and human disaster. Installations of nuclear establishment and their power needs to be clearly indicated to prepare their mitigation, preparedness and response effects.

2.3.7 Disaster Impact Assessment

For all big projects, disaster impact assessments need to be done for clearance of projects just like environmental assessments. The disaster impact assessment needs to be examined by District Disaster Management Authority or State Disaster Management Authority as the case may be (based on the size and location of the project).

2.3.8 Planning For Social And Physical Infrastructure

Social and physical infrastructures are to be constructed with proper planning standards and material, especially in disaster-prone areas. Strategic planning of social and physical infrastructure, their location, type and maintenance are very important to keep them working and make them available even during disaster events. Impact on infrastructure can be reduced through proper coordination among different authorities and periodical maintenance. Even incentives/awards to authorities or individuals concerned can be added in the plan to keep their infrastructure working. Urban planning should have inbuilt process to introduce regular maintenance together with network mapping, active coordination among authorities concerned, awareness campaign and sense of accountability to help in reducing impact of disaster on all infrastructure facilities.

2.3.9 Priorities of Building And Its Land Uses

Priorities have been fixed for protection of buildings based on their importance i.e. top priority is given to defense installations, public utilities, lifeline structures like hospitals, electricity, water supply, airports, railway stations, commercial centres and buildings with contents of high strategic/economic value followed by priority and establishment of public and semi-public institutions, Govt. offices and residential areas. Last priority is given to parks and playgrounds, wood land, gardens, greenbelts and recreational areas.

Chapter – 3: Strategy, Action and Challenges to integrate DRR into Urban Planning

3.1 Integration of DRR Into Urban Planning At National Level

3.1.1 Earthquake-Prone Settlements[11]

In recognition of the importance of a techno-legal framework for regulating the built environment, the MHA had constituted a national level expert group to recommend modifications of existing regulations to ensure structural safety. This group recommended modifications to the Town and Country Planning Acts, land use and zoning regulations, DCRs and building bylaws and developed a set of model by- laws which are technically rigorous and conform to globally accepted norms. They also prescribe regulatory, quality control and compliance mechanisms. The MHA has circulated these Model bylaws to the State Governments for review of the bylaws currently in force and for ensuring their adoption after revision. **The State Governments will review and adopt the Model Town Planning bylaw by June 30, 2007.**

Design provisions are required on many topics that have not been addressed fully in the existing codes or guidelines in India. Such topics include:

- Seismic design of non-structural elements and components of buildings and structures.
- Seismic design of reinforced masonry structures.
- Seismic evaluation and strengthening of structures.
- Seismic design of buried and above ground pipelines/other structures.
- Seismic design and ductile detailing of steel structures.
- Seismic design and ductile detailing of bridge piers.
- Seismic design, construction and manufacture of facilities, structures and components related to electrical power generation, transmission and distribution.

[11] National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Earthquakes.

- Seismic design of tunnels.

3.1.2 Cyclone-Prone Settlements

Coastal areas are generally densely populated. It is estimated that about 32 crore people, which accounts for almost a third of the country's total population, are vulnerable to cyclone related hazards. These areas are vulnerable to inundation of various degrees depending upon the frequency of cyclone, coastal bathymetry and coastal inland topography of the place. Cyclone related rainfall and storm surges are mainly responsible for such coastal inundation that at times cause enormous loss of life and property.

1. Cyclone resistant design standards need to be incorporated in the housing schemes like Jawaharlal Nehru National Urban Renewal Mission (JNNURM) projects planned for coastal urban areas. Cyclone resistant design and material need to be used for all types of structures in cyclone-prone areas. Higher cost, if any, should be allowed especially to cover such risk in future. These measures have to be inbuilt in the project cost itself.
2. Housing schemes under different Central/Sate Government programmes need to obtain clearance from competent authorities, who will take into consideration all DM-related aspects.
3. All-weather road links need to be built in all coastal habitations, between habitations and cyclone shelters covering all 84 coastal districts vulnerable to cyclones.

3.1.3 Coastal Regulation Zone (CRZ), 1991

CRZ regulations (amended, September 2010) need to be followed in urban planning. Beside, Disaster Impact Assessment needs to be submitted before asking for clearance to any urban development project/scheme.

3.1.4 Tsunami-Prone Settlements

i.) The MoEF jointly with State Government departments should take leadership and commission a state-wise survey of conserved areas which would be appropriately designated as community reserves and have been notified by the respective State Governments for preparation of management plan. These notified areas should not be used for urbanization. These areas should be specially demarcated on the proposed micro-zonation map of the State.

ii.) An institutional mechanism to empower coast guards to enforce the Wildlife (Protection) Act, 1972, and to demolish illegal constructions up to 500m of coastal stretches must be considered.

3.1.5 Landslide-Prone Settlements

Projects like the Prime Minister's Grameen Sadak Yojna and the Jawaharlal Nehru National Urban Renewal Mission, envisaging wide coverage and huge investment, provide a great opportunity for improving the safety of constructions against landslides in hilly areas.

Settlements in hilly regions, especially in the States of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Arunanchal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Assam, Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu and the Andaman and Nicobar group of islands experience various problems of staggering imbalances in growth patterns, varying levels of natural hazards, environmental degradation, degree of deforestation, high cost of construction, paucity of building materials, uneasy access to appropriate technologies, etc. Awareness of these hazards and preparedness for response is at a very low stage due to many reasons. Hence,

i. The BIS and IRC shall place all Indian standards related to building and infrastructure in the public domain, including the internet for free download.

ii. A periodic revision of the codes and standards relating to building and infrastructure shall be undertaken by drafting groups within a fixed time frame of five years or even earlier on a priority basis.

iii. BIS and IRC shall expedite the finalisation, revision and formulation of all pending codes and guidelines.

iv. States may be advised to carry out vulnerability and hazard assessment of various cities and towns on priority basis.

v. Structural and non-structural measures are required to be implemented on the basis of vulnerability and hazard assessment of States.

vi. States may be advised that natural hazard-prone areas of cities and towns are to be marked on a big scale like 1:5000 or in 1:2000 to spread awareness among people to avoid these areas for habitation.

3.2 Integration Of Drr Into Urban Planning At State Level

3.2.1 State Disaster Management Plan

As per guidelines and laws from the National Disaster Management Authority (NDMA), State Governments should prepare State disaster management plan keeping in view all natural and potential manmade disaster-prone areas.Most of the Sates have already prepared their SDMP while for some States, SDMP is under preparation. The urban planning and development process at State level is almost same as at national level. Since the land is under the State Government, the implementation process is faster than that of the national level.

3.2.2 Expert Committee Of MHA

To review Town and Country Planning Act in the light of Disaster Management efforts the Ministry of Home Affairs, Government of India, has constituted a committee of experts and had requested to suggest amendments by incorporating various terminologies pertaining to natural hazards, their preparedness, mitigation and response steps while preparing development plans at various level for urban settlements. In addition, the committee of experts has to suggest provision for formulating the regulations for landuse zoning and

development control building regulations with regard to natural hazards. This committee has suggested certain amendments in its report. Now, these amendments have to be made in the Town Planning Acts, Regional and Town Planning Development laws, Urban Development Plan formulation and implementation Guidelines of respective States.

3.2.3 Development Control Regulations

Beside, State Governments should also add provisions in Development Control Regulations for human safety in natural hazard-prone areas and provisions in building regulations, bylaws for structural safety in natural hazard-prone areas. There amendments and their implementation are to be ensured by the State Government for urban planning practices and development in their administration jurisdiction.

Building regulations/bylaws for structural safety in natural hazard-prone areas are to be notified by the State Government. These deemed to be applicable in the State irrespective of the location of project in urban or non-urban areas.

3.2.4 Peri-Urban Areas

State Government should also ensure safe and secure peri-urban areas and urban hinterland before sanctioning projects or development in or near natural hazard-prone areas. The checklists for site selection and building regulations as per hazard-prone zone are to be strictly followed to mitigate future disaster in that area. It would have been better if norms/standards applicable to nearby urban settlements are followed for these areas also.

Thus, the State Government shall direct the preparation of development plans/project plans keeping in view its natural hazards proneness of the area by local planning authorities/consultants or individuals.

3.3 Integration of DRR Into Urban Planning At Town Level

3.3.1 City Development Plan

City development plans indicate location of major land uses, mobility network, building bylaws and regulations. Besides this, the most important attribute, that is disaster management of the city, has been lacking in the CDPs. This lacuna creates hazardous conditions in the city which later lead to disaster for the people of that area. Most of these plans are outdated and do not respond to aspiration and vision of residents. Insufficient database and weak institutional setup, both in technical manpower and financial resources, require more attention. Multiple authorities with limited power, jurisdiction and lack of coordination also create problem of implementation.

Urban planning also relates to planning interventions in housing, especially urban poor, comprehensive planning for water supply, sanitation, power, drainage and solid waste, environment management plan, urban mobility plan, livelihood and poverty alleviation plan, comprehensive urban information plan, heritage conservation tourism development plan, local economic development plan for service, commercial and industrial sectors, capacity buildings plan, financial operating plan, social infrastructure like education, medical, fire service, security (police), recreation, parks, community halls,etc, are also to be planned for getting maximum benefit and minimum disaster risk guidelines, tools,etc, for DRR have to take into consideration all the above planning exercise individually and collectively.

When crisis and negative trends persist, it is because the solutions may not be easy and require tradeoffs. Each year, building codes are ignored and zoning laws are overlooked as communities continue to expand in areas prone to earthquakes, landslides, floods, tidal surges, volcanic eruptions, high winds and other natural hazards. Already a large number of population lives in high-risk

areas. Each year, choices are made at many levels in society that make people evermore vulnerable to disasters[12].

3.4 Role To Be Played By Various Ministries, Departments, Ulbs And Other Stakeholders

Role of Ministries

At State level, the coordination for DRR will be among several ministries as the factors are more complex and involved. The function is best exercised through the agency of the State Planning Board established again by the State statute and composed of the representatives of the various Ministers of the State and presided over either by the Minister of Planning and Development or that of local self-government.

The State Planning Department should again be independently placed either under the Minister of Planning and Development or the Minister of Local Self-Government, preferably the former.

The functions of the State Planning Board and the State Planning Department will include coordination of planning and development activities within the entire State, broken up into regions where regional differentiations exist. In addition to broad co ordination at the State level, the State Planning Board will also have to supervise the city planning activities taking place at the local level and guide them to the extent desirable for coordinating activities adjacent to local bodies in the overall interest of the State.

Role of Departments and ULBs

At local level, the coordination for DRR among several departments. Urban

development plans formulations and implementation (UDPFI) guidelines prepared and circulated by the Government of India. Ministry of Urban development has suggested ensuring participation and commitments of various

[12] Adapted from: Disaster Reduction in Urban Areas IDNDR Secretariat policy paper November 1995.

Government departments, NGOs and public representatives in urban plan formation exercise. It has suggested formulation of development interaction committees to advise on aims and objectives, priorities and major requirements of all section of society for secured and safe development of the community.

The regional approach for urban planning is further considered necessary because natural disasters are regional in nature and not bound within municipal boundaries. Now even manmade disasters are also regional in nature and not limited within administrative boundaries of urban settlements.

Urban local bodies are not well equipped, both administratively and financially, to mitigate any natural or manmade hazard. Hence, they require help from the State Government to deal with the hazard.

Sometimes, these natural hazards spread to more than one State like cyclone or tsunami or even earthquake. In this event, help from the Central Government is required to organise hazard response and maintain peace and security. The help of Central Government is also required in channelising international help and expertise to tackle the hazard and its side-effects.

Role of stakeholders

Keeping in view the disaster proneness, various stakeholders should follow and implement the development of toolkit for strengthening disaster management. Representatives from Government departments and agencies, academics, professionals, multilateral and humanitarian agencies and corporate sector should participate in stakeholder meetings to discuss pros and cons of big project. Communities and other stakeholders will ensure compliance to the town planning zoning regulations bylaws, disaster-resistant building codes and other safety regulations, as well as their effective enforcement. The district-level Government/DDMAs and ULBs will be responsible for reviewing and monitoring the implementation of the DM plans at project level.

3.5 Measures To Protect Urban Infrastructure

3.5.1 Earthquake-Prone Settlements

Local planning authority should assess project on the following basis:

- Location and extent of known seismic hazard zones, epicenters, faults, fault systems, etc.
- Magnitude (energy release at epicenter) and intensity (severity of ground shaking) of earthquakes in the area.
- Other geological, geotechnical, geomorphologic, hydrological features that influence ground shaking and deformation.
- Potential secondary effects: landslides, mudslides, avalanches, floods resulting from dam failures or tsunamis, fires, pollution from damage to industrial plants.
- Frequency of events.

Vulnerability assessment will be based on following information

- Zoning and micro-zoning (mapping/recording all seismological, geological, Hydro-geological parameters needed for project planning in a given area, based on sources below).
- Maps of seismic sources (faults, fault systems).
- Geological, geomorphologic maps and surveys (see also landslides).
- Data on past occurrence of earthquakes, their location, characteristics (magnitude, intensity, etc.) and effects.
- Calculations of maximum ground accelerations.
- Liquefaction susceptibility.

Site selection

The project site should be away from the active fault lines.It should be done with he help of GIS seismic mapping.

Structure of earthquake-prone areas

Following code need to be followed till they are revised

Priority for finalising earthquake-resistant design and construction related codes by the BIS:

- IS:1893 (Part 2) :: Elevated and Ground Supported Liquid Retaining Structures, (Part 3) :: Bridges and Retaining Walls, and (Part 5) :: Dams and Embankments
- IS:4326 :: Earthquake Resistant Construction
- IS:13920 :: Ductile Detailing of Reinforced Concrete Structures
- IS:13827 :: Earthen Dwellings
- IS:13828 :: Low Strength Masonry Structures
- IS:13935 :: Seismic Strengthening of Structures

BIS codes are already mentioned in the Model Town Planning Act. Now, it is required that codes related to construction activities in earthquake zones should be strictly incorporated in the project. It should be supervised by the ULB/DDMA based on the extent of the project. While preparing for a project in a earthquake-prone area, following points should be checked by the ULB/DDMA regarding structure of building and other infrastructure:

- No relaxation in building plans which violate safety parameters in relation to earthquake safety will be permissible.
- While revising the DCRs and master plans, special attention should be paid to ensure that the seismic risk and vulnerabilities of existing buildings to withstand high-intensity earthquakes before allowing any relaxation relating to approvals for additional floors.
- Design provisions are required to be addressed for any urban project in the existing codes or guidelines in India are:

  Seismic design of non-structural elements and components of buildings and structures.

  Seismic design of reinforced masonry structures.

  Seismic evaluation and strengthening of structures.

Seismic design of buried and above ground pipelines.

Seismic design and ductile detailing of steel structures.

Seismic design and ductile detaining of bridge piers.

Seismic design, construction and manufacture of facilities, structures and components related to electrical power generation, transmission and distribution.

Seismic design of tunnels.

3.5.2 Cyclones

Local planning authority should acquire the following information to assess project Viability:

- Locations and extent of areas likely to be affected.
- Frequency of occurrence (including seasonality) and directional patterns.
- Velocity and direction of wind, wind and gale severity scales (e.g., Beaufort), local hurricane/typhoon scales.
- Associated pressure conditions, rainfall and sea/storm surges.
- Historical and climatological records of frequency, location, characteristics (including cyclone and tornado paths) and impact of past events on the project area and neighboring areas (or countries) facing similar conditions.
- Meteorological records of wind speeds and direction at weather stations.

Site selection

The project site should be 500m away from the high tide line of the coast. Areas of high frequency of cyclones should be avoided for any form of development. It should be rather used for mangrove plantation to resist high speed wind velocity. In the high frequency cyclone zone the development could be taken place 1km away from the high tide zone. Rules and guidelines given under Coastal Regulation Zone (CRZ) should be followed:

Structure of cyclone-prone areas[13]

At project level, it should be checked by the ULB/DDMA that buildings, shelters and lifeline structures will be designed on the basis of existing codes and standards. The material and design specifications and their criteria will be such that minimum maintenance is needed and the structures can withstand adverse weather conditions.

For any national heritage structure, it should be necessary for the ULB that the project should not harm the heritage in any way and they should have close interaction with agencies like the ASI, Indian National Trust for Archaeological and Cultural Heritage (INTACH) and archaeological departments of the States should be developed to prepare lists of structures/sites which are at risk due to landslides/slope stability problems and to priorities them.

Based on this priority list, further studies and works for hazard mitigation should be taken up as a project under ULB in collaboration with the ASI, INTACH and the archeological departments of the State Governments.

- The design to be carried out for 1.3 times the basic wind speed as recommended in the IS 875 - 1987 part 3. The basic wind speed as per the code in most parts of the coastal zone is 50 m/s (180 km/hour) up to 10 m above ground level. Further, a number of corrections are to be applied based on the importance of the structure (risk assessment), topography, size and shape of the building.
- Building should be made with sloping RCC roofs (say 1 in 5 or 6 slope) and will be used to provide quick rain water drainage and avoid any seepage or leakage.
- Minimum M30 concrete grade (concrete having a characteristic strength of 30 N/mm2) and reinforcement steel of Fe415 grade will be used in the construction. A design concrete mix as specified by IS Code 456 will be adopted.

[13] National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Cyclones

- An extra cover of 5 mm beyond that specified in IS: 456 for the relevant exposure condition is to be provided for steel reinforcement.
- It should be checked by the ULB/DDMA quality control board that the materials used for construction, viz. reinforcement, aggregates and water will be tested as per the codes provided before their use. The durability of the structure depends on the quality of the basic materials and quality assurance of the construction.
- The walls and all the RCC work will be plastered with cement mortar of 1:4. The outside plaster can be in two coats. The building will have suitable cement plaster coating, both outside and inside.
- The doors and windows will be of aluminum with anodised fixtures. The size and thickness of the doors and windows must be of heavy gauge quality. All inserts and fittings will be of structural aluminum.

3.5.3 Landslide

Local planning authority should assess viability of the project on following aspects:

Volume and type of material dislodged, area buried or affected velocity.

Natural conditions affecting slope stability (composition and structure of rock and soil, inclination of slopes, groundwater levels).

- Other external triggers: seismicity, rainfall, vegetation and other land use (including building activities, landfill, manmade mounds, garbage pits, slag heaps, etc.).
- Identification of location and extent of previous landslides or ground failures by surveys, mapping, aerial photography.
- Mapping/surveys of rock formations and characteristics, surface geology (soil types), geomorphology (slope, steepness and aspect), hydrology (esp. groundwater and drainage).
- Historical records of frequency, location, characteristics and impact of past events.

- Identification of probability of triggering events such as earthquakes, cyclones, volcanic eruptions.
- Vegetation and land use mapping and surveys, zoning maps, based on the above.

Site selection

Site should not be near loose slopes and sharp angles.

3.5.4 Floods/Tsunamis[14]

Local planning authority should assess viability of the project on following aspects:

- Extent and location of flooded or flood-prone area.
- Depth and duration of flood.
- Velocity of water flow.
- Rate of rise in water level and discharge.
- Amount of mud deposited or held in suspension.
- Frequency and timing of occurrence (including seasonality).
- Rainfall (and snowmelt) volumes and intensities in flood-prone areas and their surroundings.
- Natural or manmade obstructions to flows and flood-control structures.
- Warning period.
- In coastal areas: tidal ranges and patterns of on-shore winds, height of seasurges induced by cyclones.
- Historical records of frequency, location, characteristics and impact of past events.
- Meteorological data: rainfall (and snowmelt) records and monitoring (e.g., rain gauges).

[14] National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Tsunamis.

- Topographic mapping and height contouring around coastlines, river systems and catchment areas, geomorphologic mapping, sequential inundation stages mapping.
- Natural resources and land use mapping.
- Estimates of capacity of hydrology system and catchment area.
- Hydrological data on flows, magnitude (including flood peak discharges) and frequency of floods, river morphology, infiltration properties of soil.
- Hydrological estimates of future flood discharges, flows and associated characteristics, flood frequency analysis.
- In coastal areas: tidal and sealevel records, meteorological data on wind speeds and directions.
- Long-term and seasonal weather forecasts, climate change models.

Site selection

Selection of site for the project ina flood-prone area should be 500m away from the floodplain or modified floodplain affected by dam in the upstream or by flood control system. In tsunami-prone areas, same instruction should be followed as in cyclone-prone areas.

Structure of flood/tsunami-prone areas

It should be supervised by the ULB/DDMA that buildings, shelters and lifeline structures will be designed on the basis of existing codes and standards required for tsunami/flood resistance. The following precautions need to be taken for any urban development project in flood/tsunami-prone area:

- Avoiding the impact of tsunami by building on high ground – necessary for vital installations.
- Slowing the tsunami wave by frictional techniques – forests, ditches, slopes and berms.
- Deflecting the tsunami away by using angled walls – suitable for important installations or fishermen habitat.

- Brute resistance through stiffened strong structural design – costly buildings.
- High-rise buildings with open ground storey, designed for wave forces – hotels, offices, etc. Stilted buildings for various uses.
- Protection of existing buildings and infrastructure – assessment, retrofit, protection measures

  Inventory of existing assets.

  Assessment of vulnerability and deficiencies to be taken care of through retrofitting.

  Methods of retrofitting and use in design.

  External protection methods from the onslaught of tsunami.

- Performance level to be followed

  Minimum – Non-collapse though structurally damaged.

  Safe – Damaged but without significant structural damage.

  Operational – Capable of avoiding/resisting all expected hazards & forces.

3.5.5 Phenomenon of Inundation

i. Inundation creates certain problems at different levels. Hence specific steps and precautions are to be taken accordingly:
ii. Flooded basement: Choose sites at higher elevations.
iii. Flooding of lower floors: Raise the buildings above flood elevation/stilted type construction.
iv. Flooding of mechanical, electrical, communication system and equipment system: Do not stock or instal vital material or equipment on floors or basement lying below tsunami inundation level.
v. Damage to building materials and contents: Protect hazardous material storage facility located in tsunami-prone areas.
vi. Contamination of affected areas with water: Locate mechanical systems & equipment at higher locations in the building

vii. Hydrostatic forces (Pressure on walls by variation in water depth on opposite sides:
   - Elevate buildings above flood level.
   - Provide adequate openings to allow water to reach equal heights inside & outside of buildings.
   - Design for static water pressure on walls.
   - Consider suction tensions on walls under receding waters.

viii. Buoyancy floatation or uplift forces caused by buoyancy:
   - Elevate building to avoid flooding.
   - Anchor building to foundation to prevent floatation.

ix. Saturation of soil causing slope instability and/or loss of bearing capacity:
   - Evaluate bearing capacity & shear strength of soil that support building foundation and embankment slopes under condition of saturation.
   - Avoid slopes or setbacks from slope that may be destabilised when inundated.

Currents, wave breaks & bore also create effects.They can be dealt in the following manner:

i. Hydrodynamic forces (pushing forces on the front face of the building and drag caused by flow around the building:
- Elevate building to avoid flooding
- Design for dynamic water forces on walls & building elements
- Anchor building to foundation.

Similarly,drawdown and fire also affect their influence area by:

i. Embankment instability:
- Design water front slopes, walls & buttresses to resist saturated soils without water in front.
- Provide adequate drainage.

ii. Waterborne flammable materials and ignition increase in buildings:

- Use fire resistant materials
- Locate flammable materials storage outside of high hazard areas.

3.5.6 RCC Design Criteria Are Suggested For All Coastal Areas

- Concrete (Exposed to coastal Environment, taken as 'severe') Plain: - Min M20, Cement: min 250 kg/ m3, max water cement ratio 0.5
- RCC: - Min M30, Cement: min 320 kg/ m3, max water cement ratio 0.45, max aggregate 20 mm.
- Reinforcement: TMT - HCR (High Corrosion Resistant steel bars) Fe 415 for up to 2 storeys and Fe 500 for frames in taller buildings.
- Min cover to HCR Reinforcement Slabs: 20 mm, Beam: 30 mm, Column: 40 mm.
- HCB (Hollow Concrete Blocks): - To be cast using M 20 concrete with flyash.
- Reinforcement TMT - HCR Fe 415 bars, concrete filling M 20 grade.

3.5.7 Planning For Industries And Fire Hazards[15]

In order to help the authorities and the entrepreneurs concerned, it is necessary to frame certain broad guidelines for siting an industry. It is also necessary to identify the parameters that should be taken into account while setting up an industry. With this in view, the following environmental guidelines are recommended for siting of industries to ensure optimum use of natural and manmade resources in sustainable manner with minimal depletion, degradation and/or destruction of environment. Those are in addition to those directives that are already in existence under the Industries (Development and Regulation) Act Transportation facility: distance from existing railway line and highway.

[15] Source: http://moef.gov.in/citizen/specinfo/enguin.html, Government of India, Ministry of Environment & Forests Environmental Impact Assessment Division Paryawaran Bhawan, CGO Complex, Lodi Road, NEW DELHI - 110 003 INDIA

State and Central Governments are required to identify such areas on a priority basis for future industrial planning.

- Ecologically and/or otherwise sensitive areas: at least 25 km depending on the geo-climatic conditions the requisite distance hall have to be increased by the appropriate agency.
- Coastal areas: at least 1/2 km from high-tide line.
- Floodplain of the riverine systems: at least 1/2 km from floodplain or modified floodplain affected by dam in the upstream or by flood control systems.
- Transport/Communication System: at least 1/2 km from highway and railway.
- Major settlements (3,00,000 population):distance from settlements is difficult to
- Maintain because of urban sprawl. At the time of siting of the industry if any major settlement's notified limit is within 50 km, the spatial direction of growth of the settlement for at least a decade must be assessed and the industry shall be sited at least 25 km from the projected growth boundary of the settlement.

Site selection

Economic and social factors are recognised and assessed while siting an industry. Environmental factors must be taken into consideration in industrial siting. Proximity of water sources, highway, major settlements, markets for products and raw material resources is desired for economy of production, but all the above listed systems must be away for environmental protection. Industries are, therefore, required to be sited, striking a balance between economic and environmental considerations. In such a selected site, the following factors must be recognised.

- No forest land shall be converted into non-forest activity for the sustenance of the industry (Ref: Forest Conservation Act, 1980).

- No prime agricultural land shall be converted into industrial site.
- Within the acquired site, the industry must locate itself at the lowest location to remain obscured from general sight.
- Land acquired shall be sufficiently large to provide space for appropriate treatment of waste water still left for treatment after maximum possible reuse and recycle. Reclaimed (treated) wastewater shall be used to raise green belt and to create waterbody for aesthetics, recreation and if possible, for aquaculture. The green belt shall be 1/2 km wide around the battery limit of the industry. For industry having odour problem, it shall be a kilometre wide.

The green belt between two adjoining large-scale industries shall be one kilometre.

- Enough space should be provided for storage of solid wastes so that these could be available for possible reuse.
- Lay out and form of the industry that may come up in the area must conform to the landscape of the area without affecting the scenic features of that place.
- Associated township of the industry must be created at a space having physiographic barrier between the industry and the township.
- Each industry is required to maintain three ambient air quality measuring stations within 120 degree angle between stations.

3.5.7.1 Precautions From Fire Hazards In Industries

I. Safety measure for design of factory premise
   - Adequate layout
   - Emergency exit
   - First aid
   - Arrangements

II. Safety measures against machine accident

- Provision of interlock guard
- Enclose dangerous parts with suitable casing
- Dangerous parts should be out of reach during operation

III. Safety measures against fire

- Fire-fighting equipment
- Proper storage of explosives
- Adequate exits

IV. Safety measures against electric hazards

- Warning signals
- Underground cables
- Safety fuse should be there

3.6 Urban Infrastructure

3.6.1 Transport Planning And Management Measures In Disaster Management

Transport Planning and Traffic management is an important requirement at the time of disaster as it controls the flow of public and private transport. At the time of disaster, traffic managers are the key players in traffic management. Qualitative assessments are most commonly used by traffic managers due to its advantage of providing an immediate feedback. The knowledge of effective and readily applicable measures is important for traffic managers. Simultaneously, the knowledge of other effective but non-applicable measures in existing local environment is also important for traffic managers. This knowledge helpsin improving the applicability of TM measures in formulation of TM strategies.

3.6.1.1 Public transport measures (PT)

The implementation of public transport measures are advocated in urban settlements which experience a high use of IMT modes and a heterogeneous mix of traffic through:

Public Transport Network Improvement

Public Transport Scheduling Improvement

Public Transport Accessibility Improvement

Public Transport Capacity Improvement

Special Disaster Transport Services

Public Transport Right-of-Way Prioritisation

Public Transport Information Services

Public Transport Management Centre

3.6.1.2 Non-motorised transport measures (NMT)

The NMT measures include the provision of adequate facilities and the safe environment for the operations of both pedestrian and bicycle traffic. Such measures are implemented to harness the potential of cycling and walking to limit the use of individual motorised transport modes for short trips. It could be done through:

Establishment of pedestrian routes & facilities

Establishment of bicycle routes and facilities

3.6.1.3 Individual motorised transport (IMT)

It is aimed at improving the traffic flow conditions and efficiency of private transport. IMT measures improve traffic safety, transport economy and transport environment. These measures could be taken through:

Carpooling & other ride sharing programmes

Car rental services

Automobile roadway repair services

Special traffic rules enforcement

3.6.1.4 Multi-modal and inter-modal transport (MIM)

Multi-modal transport measures are aimed at the improvement of the traffic flow conditions by the multiple modes by a single application of measure. Inter-modal transport measures are aimed at the provision and organisation of inter-modal facilities, especially the parking and the transfer points for the purpose of promoting the use of high capacity or high occupancy transport modes (PT and IMT). These measures include:

Economic or preferential incentives

Trip reduction & land use modification ordinances

Road network control

Road section control

Signalised traffic control

Non-signalised traffic control

Inter-modal and parking facilities

Traffic &disaster information service

Disaster traffic management center

Work-zone coordination & management center

3.6.1.5 Freight transport (FT)

It is aimed at minimizing the conflicts between FT and other modes. This category also involves the use of available capacities of FT modes by coordinating different FT operations. In addition, the measures that reduce the environmental impacts of freight transport are also covered in this category. It could be done through:

City logistics system

Household goods delivery transport system

Freight traffic operations control

The traffic managers should take the above mentioned one or the mix of traffic management measures on the basis of following characteristics:

a) Administrative and organisational requirements: It includes organizational measures that improve the public acceptance and institutional participation.
b) Economic requirements: The economic measures are focused on economic incentives or disincentives to control particular transport modes.
c) Technical and operational requirements: It is focused on implementing appropriate traffic control or traffic information dissemination to influence the traffic flow, road users or traffic and transport processes. It mainly relies on traffic engineering methods.
d) Information requirements: These are focused on changing the travel decisions of road users such as time of travel, mode of travel, route of travel, destination of travel and travel speeds through the dissemination of pre-trip or on-trip traffic information.
e) Infrastructure requirements: These are taken on the basis of the above mentioned traffic management measures. In this, traffic managers should be focused on the required traffic infrastructure at the time of disaster.It could be one of the above mentioned measures or a mix of all. Hence, these should be properly planned to cover the area of the town plus its immediate region.

3.6.2 Water Supply

An adequate supply of clean, safe drinking water is very important for theproper health and well-being of the community. When water and sanitation facilities break down, public health is at risk. The chances of breakdown of water supply during an emergency situation cannot be ruled out.

3.6.2.1 Mapping and zoning

Water supply is one of the most important basic infrastructures for the human being. For this, there is a need to protect the water supply system at the time of

disaster. There is a need of maps and data on the existing infrastructure networks. Further, with the help of GIS mapping the various hotspots of degrading water supply network could be identified and accordingly plan should be made to overcome so that at the time of disaster it should not create any havoc. Zoning in the distribution system ensures the equalisation of the supply of water throughout the area. The zoning depends upon (a) density of population (b) type of locality (c) topography and (d) facility for isolating for assessment of waste and leak detection. This will help in identifying the vulnerable group at the time of disaster.

3.6.2.2 Underground source

Underground sources are usually free from disaster related contamination and may not require any treatment. When springs are being used as a source after a disaster, certain changes in the water quality may take place after earthquake or floods.

Hence, proper testing for water quality is required before restoration of supplies. As far as wells as the potential water sources are concerned, the location of these should be at least 30 meters away from the potential source of contamination like latrines and should be at a higher elevation. The wells must be properly covered. For additional precaution, drinking water from these sources must be boiled or disinfected prior to use.

3.6.2.3 Surface water

The usage of surface water as a water supply source should be the last option. Muddy, coloured, polluted water should not be consumed. The water from the surface sources should be treated to remove turbidity, colour and other impurities and should be disinfected. For this purpose, mobile water treatment plants as an adhoc measure could be pressed into service. Mobile plants are available mounted on a truck along with all accessories, which include a centrifugal pump run by engine, a rapid sand filter unit, chemical solution tanks, chlorine salutation tank and other necessary accessories.

In the aftermath of an earthquake, flood or cyclone, there could be a serious water crisis. It, therefore, becomes very necessary to develop contingency action plans for meeting any emergency arising due to any of the natural or manmade disasters. These contingency action plans should include:

- Coordinating measures to be taken up to ensure safe water supply.
- A communication plan to alert and inform users of the supply.
- Detailed plans to provide and distribute emergency supplies of water.

Alternative safe water supply means have to be developed in the case of water supply system becoming inoperative due to any disaster. Various practical and social considerations must be taken into account prior to assessing the emergency needs of the affected community, such as:

- Number of people to be served
- Quantity of water can be calculated by taking at least 15-20 litres per person per day for needs like drinking, cooking, personal hygiene, etc.
- Quality of available water and level of contamination
- Availability of water in the nearest source

3.6.2.4 Water storage in emergency situation

Emergency storage of water can be done in canvas, rubber-coated nylons and plastic containers. Polyethylene containers erected in pits dug to size can also be used for storage. The total storage capacity for water distribution should be equal to the amount required for 24 hrs.

Elevated water tanks must be erected using drums, iron sheeting and wooden poles. For long-term emergency camps, all the storage tanks must be covered to protect from dust and other contaminations. Special attention must be paid to proper sanitation near these tanks.

3.6.2.5 Urban water supply system

If the disaster has affected an urban centre and a disruption to water supply scheme has taken place, the first priority should be to put the system back into operation. Damaged portion must be replaced or repaired and the supply must be quickly restored.

In the aftermath of the disaster, the water pressure and the chlorine concentration must be increased to avoid any contamination from polluted water. In case any of the portions of treatment plant gets affected by the disaster, it should be repaired and proper disinfection must be done prior to putting it back into operation.

3.6.2.6 Distribution of water

In emergency situations, water is usually distributed through tankers. The individual families and local groups must be provided with water containers to store water. Special case has to be taken in checking the quality of water prior to transporting the water for distribution. In long-term camps, distribution pipes with community taps must be installed for water supply.

3.6.2.7 Design plan

If there is an average elevation difference of 15 to 25m between zones, then each zone should be served by a separate system. The neighboring zones may be in turn connected to provide emergency supplies. The valves between the zones, however, should normally be kept closed and not partially opened. The layout should be such that the difference in pressure between the same zone and same system does not exceed 3 to 5m.

For the construction of water supply system network, BIS codes need to be followed for design considerations.

3.6.3 Drainage System

The preparation of drainage network plan includes consideration of vulnerable areas major and minor drainage systems and should consist of preliminary activities related to identification of space inlets, main outfall, storm mains and other conveyance elements and detention strategy and storage locations, water

quality control strategy and facility locations and elements of major drainage system. The base map of the settlement will identify the watershed areas and subareas, land use and cover types, soil types, existing drainage patterns and other topographic features. With the preliminary base map completed and the difference between the major and minor system components determined, a conceptual storm drainage plan need to be prepared.

3.6.3.1 Storm water collection

Storm water collection is a function of the minor storm drainage system which is accommodated through the use of roadside and median ditches. Storm water collection systems must be designed to provide adequate surface drainage. Rapid removal of storm water from the pavement minimises the conditions which can result in the hazards of hydroplaning. Surface drainage is a function of transverse and longitudinal pavement slope, pavement roughness, inlet spacing and inlet capacity.

3.6.3.2 Operation and maintenance of storm water drainage system

This provides requirements to ensure successful performance of storm water control facilities once they have been constructed. At a minimum, maintenance plans for storm water controls shall include a method and frequency for the following activities:

- Inspection of all permanent structures
- Debris/clogging control through appropriate removal and disposal
- Vegetation control (mowing, harvesting, wetland plants)
- Erosion repair and sediment control
- Pollutant and sediment removal and the “rejuvenation” or replacement of filters and appropriate soils
- Maintenance inspection and reporting requirements

In urban planning with consideration of DRR the planner should consider the drainage network in accordance with following factors:

- Considering maximum rainfall of 100 years and taking one third more of the maximum rainfall value while designing drainage network system.
- There are two methods which can be followed for draining out water – surface drains and underground system.
- Surface drains system will contain slopes on road sides to drains out rainwater along with gradient.
- Underground system has underground pipe system and the diameter of the pipe is considered taking 3" rainfall/sq.ft. area.
- Performance of drainage system can be measured during heavy rains, cyclone or flood situation.

3.6.4 Solid Waste Disposal And Management System

Solid waste management system should be flexible enough to serve during natural hazard conditions. To plan, design and operate a solid waste management system, a thorough knowledge of the quantities generated by the composition of wastes and its characteristics are essential.

3.6.4.1 Per capita quantity of municipal solid waste in Indian urban centres

On the basis of quantity transported per trip and the number of trips made per day the daily quantity was determined. The quantity of waste produced is normally observed to vary between 0.2-0.6 kg/capita/day. Up to 0.6 kg/capita/day in metropolitan cities. The factors promoting change in waste composition are equally relevant to changes in waste generation. The density of the waste is to be noted as the waste moves through the management system, from the source of generation to the point of ultimate disposal. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste density. During hazard conditions, effective and efficient disposal of solid waste is very important as it prevents environmental pollution and resultant diseases.

3.6.4.2 Estimation of future per capita waste quantity

The expected municipal refuse generation rates are: Residential refuse: 0.3 to 0.6 kg/cap/day; Commercial refuse: 0.1 to 0.2 kg/cap/day; Street sweepings: 0.05 to 0.2 kg/cap/day; Institutional refuse: 0.05 to 0.2 kg/cap/day. If industrial solid waste is included in municipal refuse for collection and/or disposal purposes, from 0.1 to 1.0 kg/cap/day may be added at the appropriate step where the municipality must estimate service delivery requirements. These generation rates are subject to considerable site-specific factors and are expected to increase manifold during hazard events. Hence, appropriate system for collection, segregation, transportation or disposal is planned in each urban settlement.

3.6.5 Electricity System

In times of disaster, the supply of electricity from the power stations generally gets disrupted as electric poles and other electric equipment get damaged. The supply of power becomes a major issue in the disaster management system. Breaking down of electricity can create chaos, robberies and other problems because of lack of visual clarity.

Following measures may be adopted during emergency period until normal power supply is restored:

- The base of tower and other electric pole should be strictly made as per soil conditions similar to telecommunication towers.
- Solar and wind energy system should be used which can supply electricity when other power station got damaged due to disaster event.
- Optical fibre cable and trunk working should be minimum 25km away from sea coast and riverbeds in coastal areas.
- Emergency backup light should be put up on the top of buildings through solar and wind energy system.

3.6.6 Telecommunications

Considering that the telecommunication is the lifeline during rescue and relief operations, the telecom infrastructure should be planned taking into account a long term perspective to withstand the effect of disaster so as to provide uninterrupted service. This may require broad conformance with a number of planning measures as well as optimal capacity utilization and redundancy in the network.

As careful planning of telecommunication network can avoid severe damages, telecommunication in the country should be well planned taking into account all precautionary measures which will reduce and mitigate the effect of disasters. Thus, the planner should study the possibility of natural disaster in the area of concern before planning for telecommunication network.

Amateur radio services shall be part of telecommunication assistance information services to disseminate knowledge about vulnerability in the area. It may be through MoU or incentives. During and in the aftermath of disasters, the amateur services may be utilised for disaster welfare traffic to relay messages on behalf of concerned relatives and friends of people in the affected area.

Single national disaster telecommunication preparedness plan to be developed to identify existing resources to provide emergency communication, to mitigate damage and make provisions for disaster recovery.

3.6.6.1 Transmission, access planning and construction

In coastal areas, optical fibre cable for junction and trunk working should be sufficiently away (say 25 km) from sea coast and riverbeds and should be laid at proper depth. The microwave routes in cyclone-prone areas should be avoided and in unavoidable circumstances, should be placed far from the coastal line (say 25 km). Further, the microwave tower base foundation should be strictly made as per soil conditions. The building structure should follow the norms for seismic resistance depending on seismic zones as well as proper building codes. The plinth should be kept high in coastal and flood-prone areas. Building should be made earthquake resistance ones. The equipment should be installed at

adequate height in the building especially in coastal and flood-prone areas. The drop wire should be avoided as far as possible and DP should be indoor.

Service operators should avoid congestion during overload periods at the time of disaster. The incoming and outgoing cable for a station should be laid on different roads and if it is not possible than at least on different sides of the road.

3.6.7 Security And Safety Management

Security and safety is a very important aspect for the community, both before and after the disaster event. Police has to be on alert in these areas and an emergency helicopter landing space has to be identified and constructed at public utility building complex. This space can be near any institutional building complex or on any building terrace. These buildings should be designed considering the load bearing capacity of the helipad.

SDMA/DDMA/LDMA should develop plans of action to manage and counter their risks and take action to build the necessary capabilities needed to implement such plans. Like early warning methods combined with emergency shelters and evacuation plans. Stockpiling, inventory and maintain disaster supplies and equipment. Develop organisations of trained volunteers among civilian populations, professional emergency workers and organised responsible volunteers core emergency services, such as firefighters, police and ambulance crews.

3.6.8 Slums, Informal Settlement, Resettlements Colonies And Vulnerable Groups

Poor and socially disadvantaged groups are among the most hazard vulnerable, reflecting their social, cultural, economic and political environments – for instance, the substandard quality and often, dangerous location of housing (e.g., on floodplains, riverbanks or steep slopes), lower levels of access to basic services, particularly for the urban poor and illegal squatters, uncertain ownership rights, reducing incentives to manage resources sustainably or invest in structural mitigation measures, often more vulnerable livelihoods and limited access to financial resources, constraining their ability to diversify livelihoods and

recover post disaster. The poor can also exacerbate their own risk where limited livelihood opportunities force over exploitation of the local environment. Meanwhile, the covariate nature of natural hazards implies that there is limited scope for formal and informal community-based support systems in the aftermath of a disaster.

3.6.8.1 Steps for integrating DRR and urban poor

Step 1

As a first step it may be helpful to superimpose spatial hazard maps on poverty maps, assuming both are available.

Step 2

Second step to identify factors contributing to vulnerability (e.g., occupation, type and location of housing, access to credit and social safety nets). The analysis should differentiate between groups because forms and levels of vulnerability can vary enormously (for instance, between income groups, geographical areas, male and female headed households, ethnic groups and communities facing different types of hazards).

Step 3

Third step is to consolidate actions to reduce vulnerability to natural hazards in designing macroeconomic, structural and social policies and programmes to reduce poverty and promote pro-poor growth, impacts of related initiatives on the poor and on reduced vulnerability rather than reduced losses.

Urban Planner should determine whether and how to build disaster risk reduction efforts into the key medium and long-term objectives. A wide, diverse range of factors can determine vulnerability to natural hazards and for this broad perspective should therefore be maintained in trying to explore the best ways of tackling urban poor.

In high-risk zones, consider actions for designing macroeconomic, structural and social policies and programmes to reduce poverty and promote pro-poor growth.

It is important to consider whether they will be pro-poor – for instance, whether sea defences will favour locations occupied by lower income groups or they have the skills and resources to access and utilise warning systems effectively.

3.6.8.2 Social safety net

Publicly funded social safety nets are needed to support poor households during and after a disaster, providing humanitarian relief, supporting the recovery of livelihoods and helping to ensure that poor households are not forced into further poverty. These safety nets should be established ahead of time, carefully targeted towards the poor and designed to support rapid recovery and where possible, enhanced resilience to future hazard events.

Monitoring and evaluation procedures should include relevant short- and long-term targets and indicators and related systems for monitoring and evaluating implementation and achievements, particularly impacts on the poor.It should include: planned expenditure on resettlement, training, rescue measures, preparedness, insurance and social networking.

3.6.9 Financing For Disaster Risk Reduction

In the financial plans, specific allocations should be made for carrying out disaster risk reduction programmes, maintaining steps. The corporate sector should also be involved in supporting disaster risk management efforts. They may be encouraged through specific incentives and rights.

- Already at national level, Calamity Relief Fund (CRF) is functioning. Purchase of equipment for landslide preparedness and mitigation and for rescue and relief operation.
- Landslide management schemes should be planned, funded, executed and maintained by the State Government themselves as per their own priorities.
- From the funds available with the district planning and development council, a part will be allocated for the implementation of disaster management schemes in the district.

3.6.9.1 Financial support for DDR management

Every contributing department/agency is expected to spend its own money and manpower if required for discharging its function as member of the Development Integration Committee.

It has to make mandatory for every development project to allocate pay 1% to 3% of the total project cost of every project towards DRR, especially in natural disaster vulnerable areas. The percentage can differ with the size of the project. Larger scale project only 1% and small scale project may go up to 3%. It will be a separate account for DRR and will be used for such DRR related activities which are duly sanctioned by local DMA. Local authorities have limited control over urban expansion. Urban areas are growing so fast that authorities have difficulty in providing basic minimum services. With scarce resources, disaster threats are just one of panoply of urgent problems facing city authorities. Yet the way a city develops determines whether disaster risks will rise or fall. If urban risk assessments are used to guide future development projects, development investments will become more sustainable. Even with only limited additional resources, urban managers can considerably reduce risk profiles of their cities.

3.7 Strengthening Community-Based Disaster Preparedness

Without people's involvement in the urban planning DRR process, a community will not be self confident. Therefore, people's participation is essential and must be introduced at relevant stages of the urban planning process. People's involvement at all levels includes preparedness, response and rehabilitation for disaster management. At all stages, i.e. from planning to implementation and maintenance, public participation is a must for the success of urban planning exercise, especially in vulnerable areas. Taking into account the interest, attitude and behaviors of the people, a system of direct and indirect participation has to be ensured.

3.7.1 Participatory techniques in planning

1. Residents of urban settlements are the center of development. They may participate in the development process in the following senses:
    a. In identifying development priorities
    b. In implementing development programmes
    c. In monitoring and evaluation of development programmes and projects
    d. In sharing and managing the benefits of development

Various techniques for soliciting people's participation like public opinion polls and other survey, referenda, ballot box, public hearings, advocacy planning, letters to editors or public officials, representations of pressure groups, protests and demonstration, court action, public meeting, workshop or seminar and task force may be adapted at different levels in the planning process itself. Consultation with beneficiary groups such as landless labourers, tribal, schedule castes and artisans, businessmen, politicians, Government officials, etc., is required with age and gender specific group specific group of people to ascertain their needs.

In the initial stage of generating urban development scheme, participation of public is essential:

a. To understand the needs of people and perceptions of their problems and priorities, adoption of schemes and identification of beneficiaries and
b. To spread awareness, preparedness and emergency action at the time of disaster.

The National Commission on Urbanization (NCU) in its report had recommended for setting up of National Urban Council of Citizen Action (NUCCA), State Urban Council for Citizen Action (SUCCA) in each state and Forums for Citizen Action (FCA) at the city level to activate citizens' participation in the field of urban development. But this needs to be implemented through an act of Parliament and Legislative Assembly of different states.

3.8 Integration of DRR Measures Into Master Plan, Regional Plan, Zonal And CDPS

Urban Planning System has four inter-related levels, i.e.:

i. Urban projects/schemes at local level
ii. Annual action plan at town level but within one financial year
iii. Development plan or master plan at town level. It is medium term, generally five years to 100 years perspective.
iv. Perspective plan at town level with regional outlook. It is a long-term plan with 20 years perspective (with provision of revision and regulation assessment).

Urban planning strategies and practices in India are limited to preparation of City Development Plans or Master Plans or Regional Plans of 20-30 years perspective. These plans indicate location of major land uses, mobility network, building bylaws and regulations. Most of these plans are prepared without background studies, with limited technical manpower and within a very short period. Most of these plans are outdated and do not respond to aspiration and vision of residents. Even after master plans, there are unauthorised developments, especially on marginal lands that are vulnerable and hazardous for human habitation.

Insufficient database and weak institutional setup, both in technical manpower and financial resources require more attention. Multiple authorities with limited power, jurisdiction and lack of coordination also create problem of implementation.

Besides, zoning regulations and building bylaws are not comprehensive and not implemented in its true spirit. The low level of their compliance results in unauthorised and illegal development which due to various pressures gets regularised in due course. This requires awareness of benefits of such regulations and their effective enforcement through accountable institutions.

Lack of up-to-date base map with micro-zonation of vulnerability will lead to planning with assumption of safe and secured area. Hence, proposals are also

mundane in nature based on projected population and type of projected economic growth in particular field of economy. So far, disaster mitigation concerns are not integrated into urban planning. Provision of infrastructural facilities and other major urban development schemes do not consider the cost of disaster mitigation. Whereas infrastructure is also affected by the disaster event. Now urban experts are voting for resilient cities capable to meet any disastrous event without causality of life and property. To make town and cities resilient, certain rules have to be followed and precautions have to be taken. Hence, the necessity to formulate this toolkit has emerged with top priority.

Table-3.1: Checklist For Assessment Of Regional, Master And Zonal Plan

Sl .no.	Components
1	Disaster mitigation proposal
	1.1 Hazard assessment
	1.2 Protective measures
2	Disaster preparedness
	2.1 Disaster plan
	2.2 Repair and recovery procedure
	2.3 Disaster forecasting, warning and predictions
3	Disaster relief/response
	3.1 Secure and rescue operation
	3.2 Evacuation and shelter
	3.3 Food and medical supply
4	Reconstruction planning
5	Economic and social rehabilitation
6	Remote sensing and GIS in urban development
	6.1 Hazard analysis and mapping
	6.2 Risk and vulnerability assessment
7	Schedule for awareness and preparedness activities
	7.1 Infrastructure in emergencies: water, medical sanitation, transportation, and communication and shelter
8	Financial and insurance issues in disaster management in urban areas

	8.1 Role of macro insurance
	8.2 Assessment of damage for insurance: quantity of risk
	8.3 Risk management products
	8.4 Disaster finance and risk reduction- private sector participation
	8.5 Financing disaster risk
9	Disaster management mechanism in urban areas
	9.1 Institutional framework of disaster management
	9.2 Stakeholders in disaster management
	9.3 National/Central-level management: nodal agency
	9.4 State level/district level/local level
	9.5 Community participation
	9.6 NGOs, private organisations
	9.7 Police, Army
	9.8 Educational institutions
10	Legal aspects (Acts, laws, bylaws, guidelines, etc.)
	10.1 Disaster Management Act 2005: role of human rights
	10.2 State Disaster Management Act
	10.3 Building bylaws
	10.4 Schedule for regulation and enforcement
11	Others

3.8.1 Inter-Relationship Among Various Plans

There is an inter-relationship between the different development plans, directly or indirectly related to urban development at various levels ranging from national to a transitional urban area under the jurisdiction of a Nagar Panchayat. There are linkages for aggregation of plans proposals for consolidation and integration of physical and fiscal planning efforts at district, metropolitan area, State and National levels. It further indicates the pattern of disaggregation of policies,

programmes and resources. It also helps in interaction of guidelines of disaster risk reduction related to various natural hazards from national level to project level.

It needs to be emphasised that urban plans should not be conceived in isolation from its region as each urban center is part of a regional system of settlements which in turn play their respective roles in the process of development of the region as a whole. As contained in the provisions of the 74th Constitutional Amendment Act (CAA), the metropolitan area development plan or the district development plan serves as a guide for identifying the basic functions and other development initiatives in case of an urban center located in the district or the metropolitan area. This must be considered and incorporated in the urban development plans.

3.9 Proposed Amendments of The Technical Committee

Following are the steps which need to be taken at the State level for safe and secured urban planning and development and help to create resilient towns.

- State Government should ensure to include an expert from SDMA or Disaster Management Authority (DDMA) as a disaster advisory member of District Planning team/town planning team to advice on disaster related issues.
- Disaster-prone areas of different nature are to be marked on the State map. The State shall be divided into micro-zoning of disaster-prone areas of different categories. Further multi-hazard areas are superimposed to identify their critical nature. Based on this the whole State be divided into different zones based on their critical hazard-prone nature, available infrastructure facilities, administrative convenience, organisational setup, density of population, awareness, public participation and preparedness. State Government shall ensure planning structure for each zone and their coordination especially during disaster response.
- Detailed micro-zonation map should be prepared to identify the utility of each parcel of land keeping in mind the risk of disaster. State Government

should get risk-sensitive land use zoning for the whole State. This will help in selection of compatible and non-conforming land use as per broad land use zones. Compatible land uses may attract certain precautions or conditions before and after implementation. This exercise will help to keep the whole State safe and secured, prepared for hazards with no or minimum casualties.

- State should advise the municipalities and the city development authorities to make necessary changes in their respective building bylaws and regulations in accordance with the amended model laws prepared by the committee of experts (MHA) with reference to different types of disasters in the State.
- State plan should ensure strategic locations of DRR related equipment depot and manpower in such a network so that at the time of disaster the affected towns/districts should get the required help of equipment and manpower for disaster mitigation with the help of nearest approachable nodal point. State Government may instal hotline among ULBs offices, district head and State headquarters.
- State Government shall ensure especially in disaster-prone districts/towns a prompt and efficient emergency medical response network by QRMTs, mobile field hospitals, ARMVs and heli-ambulances trained for this kind of disaster. It should be mandatory to keep them active in urban areas for immediate response to the disaster depending on the magnitude of the disaster. These should be part of zonal plans prepared as part of master plan.
- It should be made mandatory by the State that the financial and the economic cost of disaster mitigation should be incorporated in every construction activity in the urban areas and also part of their budgetary allocations. Project clearance and completion fee could be charged and deposited for DRR works.
- State Government should declare high-risk areas as protected areas and they may be developed as urban forest, herb culture or medicinal plants, open spaces, recreational areas with minimum construction, open parking,

helipads, wildlife sanctuaries, etc. These areas and their designated land use be indicated on base map of the town.

- It has been observed that slums grow on mostly unattended areas. It is a complex problem. Poverty, lack of development and Government apathy towards such areas makes the problem more complex. State Government should take action to declare such areas out of bound for residential use. ULBs and police department should be held accountable for slums' growth in these areas. Besides,State Government should ask ULBs to keep priorities to accommodate poor migrants in their areas on a temporary basis till they manage their accommodation in proper residential zones. Municipal Government may consider providing platform with minimum sanitary facilities on nominal charges to such migrants. This way the growth of slum pockets can be channelised and hazard risk zone could be avoided. These platforms need to be earmarked in their master plans and each entry point of the town should display them in their key map.
- State Government shall direct local planning authorities to earmark sites and develop them properly with the basic infrastructure to accommodate neighbourhood population on temporary basis during disaster event. There sites can be developed on PPP model in lieu of advertisement rights, parking rights, floriculture right, pisciculture right, minor forest produce right, etc. Among various stakeholders, chief town planner at the State level will coordinate and guide urban planning practices in its respective State. CTP will ensure publicity of planning norms and standards for disaster-prone areas. These norms shall be on the website and freely available to public and other stakeholders for further action. Short refresher courses and training for non-planning stakeholders be designed and imparted at regular interval. During training among others, rescue and evacuation plans should also be explained in details followed by mock drill exercise.
- Contents of urban planning should have provision of rehabilitation aspect for vulnerable and affected population on the basis of the intensity of their vulnerability, affordability, awareness and type of structure at the site.

Rehabilitation may be on permanent or temporary basis. Both need to be part of planning exercise at State level as ULB may not afford the cost of rehabilitation.

- In order to enhance capability of disaster risk reduction related staff and officers, State Government should support development of technology, process, practices, procedures and new measures to identify vulnerable areas, their causes, mitigation methods, quick response setup and financing mechanism. Institutes having such capabilities should be identified or new institutes should be set up to closely monitor disaster events and suggest solutions with zero-cost effective technologies, impart training to stakeholders and spread awareness campaign among the masses for dos and don'ts before, during and after the disaster event.
- Institutional setup for State Disaster Response Force (SDRF) preferably is constituted from officers of State Armed Police, civil police, fire service, home guards and civil defence departments. Other departments and NGOs should also be part of such team.
- Sites for relief camps need to be marked on state maps, district maps and town maps. These sites should have provision of basic amenities and logistics support to mobilise relief supplies, tents, water, medical, transport and communication, sanitation and security, etc. These sites will be part of emergency rescue and evacuation plan prepared at State level for all vulnerable areas. Provisions of these facilities and services will be need based, especially of vulnerable and disadvantaged strata of population in relief camps and on identified sites will be prioritised. The first batch will be from nearer to the disaster originating point. Mobile hospitals and ARMTs need to be stationed at those sites to manage patients with injuries and SOS treatment.
- State plan should identify and mark vulnerable transport routes on the State map with temporary shelters and basic amenities for stranded travellers, vehicles and animals. Public should be made aware of all these aspects.

- State housing and urban development department should allocate 5% of their total budget for safe and secured planning practices.

3.10 Strategy For Planning Hill Towns

3.10.1 Planning considerations for earthquake-prone settlements

Critical areas of concern in the planning process related to earthquake

- Insufficient attention to structural mitigation measures in the engineering education syllabus
- Absence of systems of licensing of engineers and masons
- Absence of earthquake-resistant features in non-engineered construction in suburban and rural areas
- Lack of formal training among professionals in earthquake-resistant construction practices and
- Inadequate monitoring and enforcement of earthquake-resistant building codes and town planning bylaws

There is a certain cycle of chain reaction in case disaster strikes urban settlement. All infrastructure services and facilities will get adversely affected which further result in losses in planned development which in turn result in less planning for natural assets and increase of disaster's impact. Hence it will be advisable to prevent disaster impact through hazard assessment and its planning strategies. There are a number of actions that Local Government ,State Government, Central Government and private sector can undertake to make a city more resilient. Natural hazards may occur but they will not turn into devastation.

Photo-5.1: Earthquake Disaster (Source: Google Images).

At community level, there should be an advance planning in setting up emergency shelters for distributing relief among the affected people, identifying missing people and addressing the needs of healthcare, water supply, sanitation, food and education, etc., of the affected community in the city/town. The master plan should identify schools, hospitals or fire brigade campus or police line for such event.

National level expert group constituted by MHA has recommend modifications of existing regulations to ensure structural safety. This group recommended modifications to the Town and Country Planning Acts, land use and zoning regulations, DCRs and building bylaws. The MHA has circulated these model bylaws to the State Governments for review of the bylaws currently in force and for ensuring their adoption after revision. The State Governments should review and adopt the model town planning bylaws.

In cities, especially those which are prone to earthquake, the management of cinema theatres, malls, auditoria, community facilities, etc., should develop plans for public safety at the time of an earthquake. Mock drills need to be conducted in these buildings at least once in six months.

The DM plans should outline the strategies for addressing the various roles and responsibilities relating to earthquake preparedness and awareness, capacity development, monitoring and enforcement of earthquake-resistant codes and building bylaws. They should also include emergency response, earthquake-resistant infrastructure design and construction of new structures and seismic strengthening and retrofitting of priority and lifeline structures in earthquake-prone areas. The master plan of the town should also consider all these aspects in physical planning to make the town resilient.

3.11 Strategy For Planning Coastal Areas

3.11.1 Planning considerations for tsunami-prone settlements

- The change of land use in coastal zones should not be permitted without approval of the authority implementing Coastal Zone Management Plan. It is desirable to take up development at a safe distance from the coast line.

- New location of settlements may be sited above 10 m contour levels or 3 m above the high tide line, whichever is higher.
- Location of new settlements should be planned on the basis of thorough analysis of distance from the sea, elevation above MSL, height of high-tide line, maximum run-up of tsunami, expected depth and speed of tsunami waves, etc.

- The process of urban renewal and urban extension should be used to plan new land uses in order to limit or prevent potential disasters.
- Open spaces such as agricultural lands, parks, other forms of open space, etc., can be used as places assemble and take shelter during to tsunami. Provision of basic infrastructural facilities are to be planned accordingly.
- For preparing the proposals for development in disaster-prone area, town planning departments/development authorities concerned should take specialised advice from Geological Survey of India, Metrological department and other nearby academic institutions concerned having expertise in earthquake engineering, structural engineering, etc. Coastal buildings need to be designed to withstand tsunami wave pressures.
- There is an urgent need to frame tsunami resistant design code and include it in local building bylaws. The code may fulfill various safety measures under multi-hazard environment.
- Effective implementation of building bylaws is to be ensured by the State Governments and ULBs in construction of buildings and local infrastructure should be strengthened to make them resistant to tsunami and cyclonic sea surge.
- The coastal geomorphic features such as beaches, sand dunes, etc., should be protected as they act as buffers against the coastal hazards.

3.12 Strategy For Planning Coastal Areas, Plain And Hilly Areas

3.12.1 Planning considerations for flood and cyclone-prone settlements

Local communities need to be encouraged to follow prescribed cyclone resistant structural design standards for construction of private houses.

i. Maintenance aspects of cyclone shelters and other safe places at the ULB/PRI level need to be institutionalised by making adequate provision for maintenance of shelters and ensuring its multi-purpose utilisation. A periodical assessment system by the line departments. Adequate maintenance arrangements for schools, hospitals and places of worship by the local committees.

ii. Making adequate provisions of amenities shelters such as drinking water, bathing and toilet facilities for large number of people during the disaster phase taking into consideration requirements of women, children, aged and physically challenged people.

Photo-5.2: Vulnerable People after Cyclone (Source: Google Image)

iii. Cyclone resistant design standards will be incorporated in the housing schemes Like Integrated Housing and Slum Development Programme(IHSDP), Basic Services for Urban Poor (BSUP) and Jawaharlal Nehru National Urban Renewal Mission (JnNURM) projects planned for coastal urban areas.

Coastal areas are vulnerable to coastal hazards such as cyclone and tsunami. Coastal land use should be so designed so as to incur minimal losses to life and property due to these events. Natural mangroves and bio shields should be protected and grown so as to provide a natural defence against tsunami waves.

By developing bio shields in coastlines, tsunami-prone land use can be re-designated as tsunami resistant.

i. Design considerations for roads[16]

- The link roads have to be laid in M30 grade concrete.
- Drainage away from the road needs to be ensured. Further, culvert clearance before the monsoon is necessary.

ii. Considerations for transmission/communication town and water tanks[17]

Transmission line and communication towers and elevated water tanks located in the cyclone-prone areas will be designed with wind speed 1.3 times that pecified by IS: 875/ (part 3)/1987. The open area in the zone and its topography will be given due consideration in selecting the correction factors. The towers will be designed using their dynamic analysis with suitable wind gust loading.

3.13 Strategy for planning hill and plateau areas

3.13.1 Planning considerations for landslide-prone settlements

The planning and design of human settlements in landslide-prone areas is a task usually left to town planners, architects and engineers. Simple geological considerations are increasingly being appreciated to locate human settlements. Urban planners should be aware of the special consideration that goes into the design of human settlements in the hills vis-à-vis those in the plains. They, however, need to be educated on the importance. and highly specialised nature of landslide investigation, mapping and analysis, which has an impact on both safety and economy.

There is a need to look closely at human settlements, especially those being built on problematic slopes by the community.

photo-5.4Glimpse of Destruction made by Landslide (Source: Google Images)

[16] National Disaster Management Authority, Government of India (20 Guidelines, Management of Cyclones

[17] National Disaster Management Authority, Government of India (20 Guidelines, Management of Cyclones

Mitigation measures, particularly in ecologically fragile hilly areas, will become much more expensive if new settlements continue to be built without recourse to proper slope investigation and timely protective action, ignoring well known professional practices in landslide risk management.

Photo-5.4: Glimpse of Destruction made by Landslide (Source: Google Images)

Human settlements must be viewed not only from the perspective of their landslide vulnerability but also from the perspective of the hazards that they create or exacerbate.

Urban local authorities have highest stake in disaster mitigation programme but have least power in administrative hierarchy. District authorities, State Government and Central Government have superseding power in respect of legal and financial matters. Even their development plans or master plans are amended due to change in policy at State or National levels.

Chapter – 4: Strengthening of Urban Governance

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4.1 Strengthening of Urban Governance For Effective Disaster Risk Reduction Planning

Urban planning and development system is mostly limited to State Government or UT Governments for their urban settlements as land is a state subject. Further 74th constitution amendment Act (74th CAA) empowered municipalities and local authorities (wide article 243(w) for plan preparation, adaption and implementation.

At the State level urban planning is similar to that of National level. Efforts at top level are to evolve urbanization policy at National level or at State level.

4.1.1 The National Commission on Urbanization (NCU)

It was entrusted with the task of suggesting appropriate framework and guidelines for urban policies and programmes. The NCU emphasised integration of urbanization and economic development.

The NCU having looked into various aspects of urbanization has made detailed recommendation on dimensions of urbanization, land as resources, water and sanitation, energy, transport, urban poverty, housing, planning the city, urban form, conservation, spatial planning, finance, urban management, public participation, information system, etc. However, it has not addressed fully natural and manmade disasters in urban settlements.

In 1996, Government of India (M/O Urban Affairs and Development) had issued Urban Development Plans Formulation and Implementation Guidelines (UDPFI) for the preparation of perspective plan, development plans and annual plans of all categories of towns. Though it was a comprehensive guideline to deal all aspects of Urban Planning but has only a passing reference of disaster-prone areas (under special areas) in the context of development plan of a town.

In December 2005, the Prime Minister launched the Jawaharlal Nehru National Urban renewal Mission (JNNURM). The JNNURM is basically a reform-linked incentive scheme for providing assistance to State Governments and urban local bodies (ULBs) in selected 63 cities, comprising all cities with over one million

population, State Capitals and a few other cities of religious and tourist importance for the purpose of integrated development. It is thus by far the single largest initiative of the Central Government in the urban sector."

A key point is to assess the health impacts of environmental conditions within the city. It is equally essential to include in the analysis the city's susceptibility to floods, earthquakes or other disasters. Disaster mitigation schemes were not considered eligible as development project for funding.

Government of India already recognised dignified life to everybody and hence in this direction constituted NDMA to ensure the protection from disaster with no risk in recovery process. The Government feels morally accountable to the risk community and sensitivity to gender, equity and justice. Due to this, the approach to disaster has been changed from emergency response to risk reduction and from centralised to local govt. and public participation.

4.1.2 NDMA Guidelines

NDMA has already released guidelines for 17 types of disasters in various situations. These guidelines will also be part of guidelines for urban planning and development wherever required, compatible and justified. These guidelines were studied under review of literature on DRR.

a. Already released

1. Earthquake
2. Floods (urban flood)
3. Cyclones
4. Landslides and avalanches
5. Medical preparedness and mass casualty management
6. Training regime for disaster response
7. Incident response system
8. Role of NGOs in disaster management
9. Pandemic preparedness beyond health
10. Preparation of State disaster management plan
11. Chemical (Industrial) disaster
12. Drought
13. Tsunami

14. Chemical (Terrorism) disaster
15. Nuclear and radiological emergencies (Part-I)
16. Biological disaster
17. Psycho-social support and mental health service in disaster

b. On the anvil
    1. Post-disaster reconstruction
    2. Protection of heritage monuments
    3. Microfinance and risk transfer
    4. National disaster communication and information network
    5. Fire services
    6. Minimum standards of relief for food, water, medical cover and sanitation during disaster
    7. Nuclear emergencies (Part-II)
    8. Community-based disaster management
    9. Urban planning and development

In the preparation of toolkit for urban planning and appropriate strategies from the above guidelines have been considered and reproduced.

4.1.3 Coastal Regulation Zone (CRZ)

The first focused initiative towards the protection of coastal zones in India was taken up in 1981 by the then Prime Minister Smt. Indira Gandhi. She wrote to the Chief Ministers of all the coastal States, directing them to avoid all activities up to 500 meters from the maximum high tide line along the coast. The guidelines also suggested that construction along the coast, irrespective of their location, i.e., even beyond 500 m of the high tide mark, will be subjected to Environmental Impact Assessment (EIA) studies.

The guidelines were circulated to all coastal States and UTs in March 1984. However, none of the States/UTs prepared the required Environmental Management Plans as per the guidelines.

The Ministry of Environment and Forests (MoEF) has the responsibility of framing legislation and implementing measures for protecting and conserving the environment of the country, including the marine environment up to the Exclusive Economic Zone (EEZ) (12 nautical miles). For the purpose of protecting and conserving the environment, the Environment (Protection) Act, 1986 (EPA) has been enacted as an 'umbrella legislation'. Under the EPA, MoEF has issued various notifications for the control of pollution and conservation of environmentally sensitive areas. In order to regulate multifarious activities going on in coastal zones which have resulted in over exploitation of marine and coastal resources and marked the degradation of the quality of coastal habitats and environments, the first CRZ notification was issued in February 1991 and various amendments are made as per ground realities till date[18].

4.2 Planning Practices: Legal Status

As per item 20 of the Concurrent List in the Seventh Schedule of the Constitution of India, social and economic planning is a joint responsibility of the Central and State Governments. However, land being a State subject the role of State Governments becomes more pronounced in the implementation process.

At the State level, the system of economic planning is similar to the one at the national level. Spatial or physical planning is generally limited urban settlements. The urban planning system includes the master plan, detailed further through zonal plans. State Government may direct the Local Planning Authority to prepare development plans keeping in view the natural hazard-proneness of the area by the local planning authority.

[18] Published in the Gazette of India, Extraordinary, Part Part-II, Section 3, Sub-section (ii) of dated, 15 September, 2010), Ministry of Environment and Forests, Government of India, 2010.

Chapter – 5: Conclusion

Thus, it can be concluded that in urban planning following mainstreams of integration of DRR into urban planning are required to be followed following –

I. Integration of DRR into urban planning starts at national, state, town and project levels by strengthening the urban governance.

As per guidelines and Acts from the National Disaster Management Authority (NDMA) chaired by the Chief Minister, the State Government should prepare State disaster management plan keeping in view all natural and potential manmade disaster-prone areas. Most of the sates have already prepared their SDMP while for some states SDMP is under preparation.

The urban planning and development process at State level is almost same as at national level. Since the land is under the State Government, the implementation process is faster than that of the National level.

It has suggested formulation of development interaction committees to advise on aims and objectives, priorities and major requirements of all section of society for secured and safe development of the community. Sometimes these natural hazards spread to more than one State like cyclone or tsunami or even earthquake. In this event, Central Government is required to organise hazard response and maintain peace and security. The help of Central Government is also required in channelizing international help and expertise to tackle the hazard and its after effects.

Stakeholders -- Keeping in view the disaster proneness, various stakeholders should follow and implement the development of toolkit for strengthening disaster management. Representatives from Government departments and agencies, academics, professionals, multilateral and humanitarian agencies and corporate sector should participate in stakeholder meetings to discuss pros and cons of big

project. Communities and other stakeholders will ensure compliance to the town planning zoning regulations bylaws, disaster-resistant building codes and other safety regulations, as well as their effective enforcement. The district level Government/DDMAs and ULBs will be responsible for reviewing and monitoring the implementation of the DM plans at project level.

Community-based disaster preparedness -- Without people's involvement in the urban planning DRR process, community will not be self-confident. Therefore, people's participation is essential and must be introduced at relevant stages of the urban planning process. People's involvement at all levels includes preparedness, response and rehabilitation for disaster management. At all stages, i.e., from planning to implementation and maintenance public participation, is a must for the success of urban planning exercise, especially in vulnerable areas. Taking into account the interest, attitude and behaviours of the people, a system of direct and indirect participation has to be ensured.

II. Integration of DRR measures into master plan, regional plan, zonal and CDPS

Urban planning strategies and practices in India are limited to preparation of City Development Plans or Master Plans or Regional Plans of 20-30 years perspective. These plans indicate location of major land uses, mobility network, building bylaws and regulations. Most of these plans are outdated and do not respond to aspiration and vision of residents. Insufficient database and weak institutional setup, both in technical manpower and financial resources require more attention. Multiple authorities with limited power, jurisdiction and lack of coordination also create problem of implementation.

Urban planning also relates to planning interventions in housing, especially urban poor, Comprehensive planning for water supply, sanitation, power, drainage and solid waste, environment management plan, urban mobility plan, livelihood and poverty alleviation plan, comprehensive urban information plan, heritage conservation tourism development plan, local economic development plan for service, commercial and industrial sectors, capacity buildings plan, financial

operating plan, social infrastructure like education, medical, fire service, security (police), recreation, parks, community halls, etc., are also to be planned for getting maximum benefit and minimum disaster risk guidelines, tools, etc., for DRR have to take into consideration by all above planning exercise individually and collectively.

III. Integration of DRR measures on settlement patterns

1 Earthquake-prone settlements

2 Cyclone-prone settlements

3 Coastal Regulation Zone (CRZ), 1991

4 Tsunami-prone settlements

5 Landslide-prone settlements

6 Manmade disaster like misuse of atomic, chemical, gas, fire, etc., items

IV. Integration of DRR measures on urban infrastructure

Finally, toolkit for urban planning is needed to serve as a guideline to promote urban development and it should be dynamic, expeditious, where time taken in plan preparation and approval is drastically reduced, participatory in nature where people, their representatives, policymakers, administrators and experts get opportunity to participate at both the stages of planning and implementation, strive for sustainable urban development, action oriented with adequate fiscal support and resource mobilisation strategy, provide effective mandatory monitoring and review mechanisms and above all provide safe and secured habitat.

References

Following references are used in the report and also recommended for further study:

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DDFCL owned responsibility for the completion and preparation of this report. Views expressed within report are a joint work of technical team worked at DDFCL. For every quote and misquote DDFCL is responsible and it absolves all references from any misquote

ANNEXURE

Annexure-1

Earthquake

1.1 List of Cities with the First Level of Priority

S. No.	Name of the City	Seismic Zone
1	Agartala	
2	Aizawal	
3	Gangtok	
4	Guwahati	
5	Imphal	
6	Itanagar	
7	Kohima	
8	Port Blair	
9	Shilling	
10	Srinagar	V
11	Ambala	
12	Amritsar	
13	Chandigarh	
14	Dehradun	
15	Delhi	
16	Gurgaon	
17	Jalandhar	
18	Jammu	
19	Jamnagar	
20	Meerut	
21	Patna	
22	Shimla	IV
23	Chennai	
24	Kolkata	
25	Lucknow	
26	Mumbai	III
Note: This list may undergo some changes or completion of micro-zonation		

Source: National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Earthquakes.

Annexure-2

Landslide

2.1 Major landslides in India

Date/Year	District/State	Remarks
1867 and 1880	Nainital, Uttarakhand	Two major landslides on the Sher-ka-Sher Danda slope in Nainital.The 1880 landslide took place due to rainfall and an earth tremor, destroying buildings. This landslide permanently filled a portion of the Naini lake.
1893	Alaknanda, Uttarakhand	Floods in the Birehi Ganga river near its confluence with the Alaknanda river triggered landslides, causing major blockage of the river with a 10-1310 m afflux. A girder bridge was bypassed and another one was destroyed.
October 1893	Gohana, Uttarakhand	The Gohana landslide which hurtled down from a height of a few thousand meters into the Birehi Ganga, a tributary of the Alaknanda river, filled the river bed up to a height of 350 m.The lake formed was 25 km by 2 km. The landslide dam was breached in 1970, raising the water level by 50 m at Srinagar. Two days later, the river water level rose by 4 m at Haridwar.
1913 to 1993	At km 138 along NH 1A (from Jammu to Srinagar), J&K	Nashri landslide is an old and notorious landslide causing disruption and road blockage at regular intervals. Often, many vehicles and equipment are buried in the huge debris generated.
September 1968	Maling landslide, H.P.	A bridge was washed out. The landslide is still active.
1968	Rishi-Ganga, Uttarakhand	The Rishi Ganga river in Garhwal was blocked up to a height of 40 m due to a landslide at Reni village. The dam was breached in 1970, causing extensive damage.

3-5 October 1968	Darjeeling and Jalpaiguri, W.B.	Widespread landslides and other mass movement causing death and devastation.
Oct-68	Ambootia Landslide, Kurseong subdivision, Darjeelinging District, W.B.	High landslide vulnerability with recurring threat of landsliding. Heavy landslide activity in 2003 and 2008, affecting Mamring village.
Jul-70	Patal Ganga, Uttarakhand	Narrow constriction of the Patal Ganga, a tributary of the Alaknanda river. The Patal Ganga got choked and a reservoir more than 60 m deep was created. The bursting of this choked reservoir resulted n flash floods in the Alaknanda river, triggering many landslides.
Feb-71	Jammu & Kashmir	Widespread landslides caused disruption of traffic and communications systems along NH-1A.
1971	Kanauldiagad, Uttarakhand	A major landslide on the bank of the Kanauldiagad, a tributary of the Bhagirathi river upstream from Uttarkashi, formed a debris cone which impounded water to a height of 30 m. Its breaching caused flash floods downstream.
Jul-73	Shimla, H.P.	A landslide cut Shimla town off from the rest of the country.
Jul-75	North of West Bengal	Widespread landslides and floods rendered 45,000 people homeless in the areas of Teesta, Jaldhaka, and Diana.
September 1975	Jammu & Kashmir	Landslides killed two labourers and disrupted the transportation system for three days.

Jun-76	Darjeeling, WW.B.	Floods in Teesta triggered many landslides. Three people were buried alive due to the caving-in of a hillock.
Jul-77	Jammu & Kashmir	The Srinagar-Leh road was blocked due to landslides.
Aug-78	Uttarkashi, Uttarakhand	The Kanauldia Gad, a tributary joining the Bhagirati river upstream from Uttarkashi in the Uttaranchal formed a debris cone across the main river, impounding the river to a height of 30 m. Its breaching caused flash floods, creating havoc. A 1.5 km long, 20 m deep lake was left behind as a result of the partial failure of the landslide dam.
1920, 1952, 1963, 1964, 1965, 1968, 1969, 1970, 1971, 1972 and 1985	Kaliasaur, Uttarakhand	This was one of the most persistent and regularly occurring landslides along the Rishikesh-Badrinath road.
December 1982	SoldingNallah, H.P.	At SoldingNallah, three bridges have collapsed in the last decade due to landslides. About 1.5 km of NH-22NH vanished.
Mar-89	Nathpa, H.P.	At Nathpa, about 500 m of road was damaged. The landslide is still active, frequently blocking the road.
Oct-90	The Nilgiris, T.N.	36 people were killed and several injured. Several buildings and roads were damaged, and communications disrupted.

Jul-91	Assam	300 people were killed, roads and buildings worth lakhs of rupees damaged.
November 1992	The Nilgiris, T.N.	The road network and buildings were damaged. Damage estimated at Rs. 50 lakh.
1993	Jhakri, H.P.	About half a km of road was completely damaged and landslide debris blocked the river Sutlej. Traffic was restored after two months.
Jun-93	Aizwal, Mizoram	Four people were buried by debris.
Jul-93	Itanagar, Arunachal Pradesh	25 people were buried alive, 2 km of road damaged.
Aug-93	Kalimpong, W.B.	40 people were killed, heavy loss of property.
Aug-93	Kohima, Nagaland	200 houses were destroyed, 500 people killed, a 5 km stretch of road was damaged.
Oct-93	Marapplam, the Nilgiris, T.N.	40 people were killed, property worth several lakhs of rupees damaged.
Jan-94	Jammu & Kashmir	NH-1A1A severely damaged by landslides.
Jun-94	VarundhGhat, Konkan Coast	20 people were killed, the road damaged to a length of 1 km.
May-95	Aizwal, Mizoram	25 people were killed and the road severely damaged.
Jun-95	Malori, Jammu & Kashmir	Six people were killed, NH-1B damaged.
September 1995	Kullu, H.P.	22 people were killed and several injured and about 1 km of road destroyed.
14-Aug 1998	Okhimath, Uttarakhand	69 people were killed due to several landslides.

18-Aug 1998	Malpa,Kali river, Uttarakhand	210 people were killed. The heap of debris created was about 15 m high. The village was wiped out in the event.
24-Sep 2003	VarunavatParvat, Uttarkashi, Uttarakhand	A massive landslide started on 24 September 2003, following incessant rains in the area, causing the burial of numerous buildings, hotels and government offices located at the foot of the hill slopes. This landslide affected 3,000 people and the loss of property was to the tune of Rs. 50 crore.
5-Jul-04	Badrinath, Chamoli district, Uttarakhand	16 persons killed, 200 odd pilgrims stranded, 800 shopkeepers and 2,300 villagers trapped as cloudburst triggered massive landslides washed away nearly 200 metre of road on the Joshimath-Jos Badrinath road cutting off Badrinath area.
16-20 February 2005	Anantnag, Doda, Poonch, Pulwama, and Udhampur Districts, Jammu & Kashmir	Avalanches at several places. Over 300 people lost their lives.
10-May-05	Itanagar, Arunachal Pradesh	Nine people were killed and loss of property resulted.
26-May-05	Mokokchung, Nagaland	12 persons were killed, two injured and six houses damaged. The places affected were Tongdentsuyong, Alongmenward,

		Aongza.
Jun-05	Nogli and Rampur, H.P.	Severe damage was caused to 70 to 80 m of the road due to heavy rain and flash floods.
Jun-05	Rampur, H.P.	The junction of the HPSEB Rest House road and NH-22 near Chuhabagh area of Rampur Town was affected due to a landslide resulting from rainfall.
29-30 June 2005	Govindghat, Chamoli, Uttarakhand	A cloudburst/landslide occurred in which a huge quantity of debris and rock boulders was brought down along a seasonal nala. 11 people were killed and property lost.
Jul-05	Mumbai, Maharashtra	Caused death and loss of property in Mumbai. Four deaths on the Belapur-Kharagpur road,14 deaths at Nerul and100 deaths at Sakinaka and Tardeo.
Jul-05	Satara District Maharashtra	Within Satara, places affected were Bhilar, Gadalwadi, Met Gutad and Tapola.
Jul-05	Raigad, Maharashtra	Within Raigad, places affected by landslides were at Dasgaon (36 deaths), Rohan (15 deaths), Jui (96 deaths) and Kondivate (34 deaths). Also, damage was caused to roads and other structures.
Aug-05	Ratnagiri District, Maharashtra	Places affected were Mandangad, Chiplun, Sangameshwartalukas. Destabilisation of slopes affecting manmade features.

13-Nov 2006	The Nilgiris - Coimbatore, T.N.	Between Burliar and Mettupalayam on NH-67,67, the road was washed off due to landslide.
September 2006	Doda, Jammu & Kashmir	Between Ramsu and Batote, there were many minor slope failures and landslides due to heavy rains.
7-Aug-06	Betul, M.P.	At km 837/22 of the Betu-Itarsisection of the Central Railway, a rock slide occurred 5 km north of Maramjhiri Railway station, bringing down 100 m of rock material. This resulted in blockage of rail traffic.
19-Jul-06	Darjeeling, W.B.	A landslide occurred due to incessant rainfall, 21 houses and property worth Rs. 25 lakhs was damaged.
20-Jul-06	Darjeeling, W.B.	Debris slide within the GingLadenla Hatta village caused the destruction of three dwelling units.
30-Aug 2006	Darjeeling, W.B.	Due to incessant rain, a landslide occurred causing loss of two lives, damage to eight houses and loss of property to the tune of Rs. 36 lakh.
3-Jul-06	Gajpati, Orissa	In Minjri and Jingirtala village, Gumma block of Gajpati district in Orissa, a landslide occurred due to prolonged heavy rainfall and unplanned civil structures on hill slopes blocking the nala flow led to debris/mud flow. Seven people died and seven to eight houses were buried under debris.
Aug-06	Araku valley, Paderu, Andhra Pradesh	Massive landslides occurred in Vishakhapattanam district, Andhra Pradesh, at several places. 18 lives were lost and damage was caused to 10-1510 dwelling units.

14-Aug 2007	Dharla Village, H.P.	A landslide led to the burial of the entire village. 14 houses and one primary health centre was buried under the debris. 60 lives were lost.
6-Sep 2007	Village Baram/Sialdhar, Dharchula, Pithoragarh district, Uttarakhand	A landslide due to excessive rainfall resulted in 15 fatalities and loss of livestock.
14-Jun-08	Parampure District, Arunachal Pradesh	17 people were killed in a series of landslides preceded by heavy rainfall.

Source: National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Landslides and Snow Avalanches

Annexure-3

Cyclones

3.1 Indian Classification Of Cyclonic Disturbances In The North Indian Ocean (Bay Of Bengal And Arabian Sea)

Type	Wind Speed in km / h	Wind Speed in Knots
Low Pressure Area	Less than 31	Less than 17
Depression	31 – 49	17 – 27
Deep Depression	50 – 61	28 – 33
Cyclonic Storm	62 – 88	34 – 47
Severe Cyclonic Storm	89 – 118	48 – 63
Very Severe Cyclonic Storm	119 – 221	64 – 119
Super Cyclone	222 or more	120 or more

Source: India Meteorological Department

In the US, cyclones are classified into five different categories on the basis of their wind speed as measured on the Saffir-Simpson scale.

3.2 Saffir-Simpson Hurricane Scale

Scale Number (Category)	Sustained Winds in m/h	Damage	Storm Surge
1	74 – 95 (64 – 82 kt)	Minimal: Unanchored mobile homes, vegetation and signs	4 – 5 feet
2	96 – 110 (83 – 95 kt)	Moderate: All mobile homes, roofs, small craft: flooding	6 – 8 feet
3	111 – 130 (96 – 113 kt)	Extensive: Small buildings, low-lying roads cut off	9 – 12 feet
4	131 – 155 (114 – 35 kt)	Extreme: Roofs destroyed, trees down, roads cut off, mobile homes destroyed, beach homes flooded	13 – 18 feet
5	156 or more (135 kt or more)	Catastrophic: Most buildings destroyed, vegetation destroyed, major roads cut off, homes flooded	Greater than 18 feet

Source: National Weather Services (NWS), National Oceanic and Atmospheric Administration (NOAA) Note: Tropical Storms: winds 39–73 mph (34–63 kt)

Annexure-4

Tsunamis

4.1 An Illustrative Priority List Of Buildings For Protection Against Tsunami

Buildings of national importance like Raj Bhavans, Legislatures, High Courts, State Secretariats, Historical Monuments, Museums, Heritage Buildings, Strategic Assets and Vital installations such as power plants, and water works located in coastal districts.
Lifeline buildings, structures and critical facilities like Schools, Colleges and Academic Institutions; Hospitals and Health facilities, Tertiary Care Centre and all hospitals designated as major hospitals in coastal districts.
Public utility structures like reservoirs and dams; bridges and flyovers; ports and harbours; airports, railway stations and bus station complexes in coastal districts.
Important buildings that ensure governance and business continuity like offices of the District Collector and Superintendent of Police and buildings of financial institutions in coastal districts
Multi-storey'd buildings with five or more floors in residential apartments, office and commercial complexes in coastal districts.

Notes; 1.The responsibility to identify and prioritize these structures will rest with respective state governments.

2. Additional lists of buildings and structures to be retrofitted can be prepared, after completion of the first phase of retrofitting of prioritized buildings and structures, based on the experience gained, by respective State Governments in selected coastal districts.

Table-4. 2: General Design Values/Factors For Coastal States/Uts

	Housing	Important Buildings	Cyclone shelter or very important Installation
Wind speed	IS: 875(3)	IS: 875(3)	65 m/s
Factor k1 for k2 Pressure k3	1.0 1.05 1.00	1.08 1.05 1.00	1.08 1.05 1.00
Seismic coefficient IS:1893 (1)	I=1.0, R as per code	I=1.5, R as per code	I=1.5, R as per code
Storm Surge	As per Vulnerability Atlas of India, 1997, riding over maximum astronomical tide level		
Fire safety	1.5 hr rating	2 hr rating	≥ 2 hr rating
Flood safety	Plinth height at recorded high flood level or for		
	10 yr flood	50 yr flood	100 yr flood
	Or Use plinth height of 60 - 120 cm above ground level & needed stilts		

Source: National Disaster Management Authority, Government of India (2007) National Disaster Management Guidelines, Management of Tsunamis.