Prioritize and Strengthen Disaster Resilience Action

For

Shillong city, Meghalaya

20 YEARS Integrated Research and Action for Development

NESAC

G.B. Pant 'National Institute of Himalayan Environment'(NIHE)
(*An Autonomous Institute of* Ministry of Environment, Forest & Climate Change, Govt. of India)

सत्यमेव जयते
Ministry of Environment, Forest & Climate Change

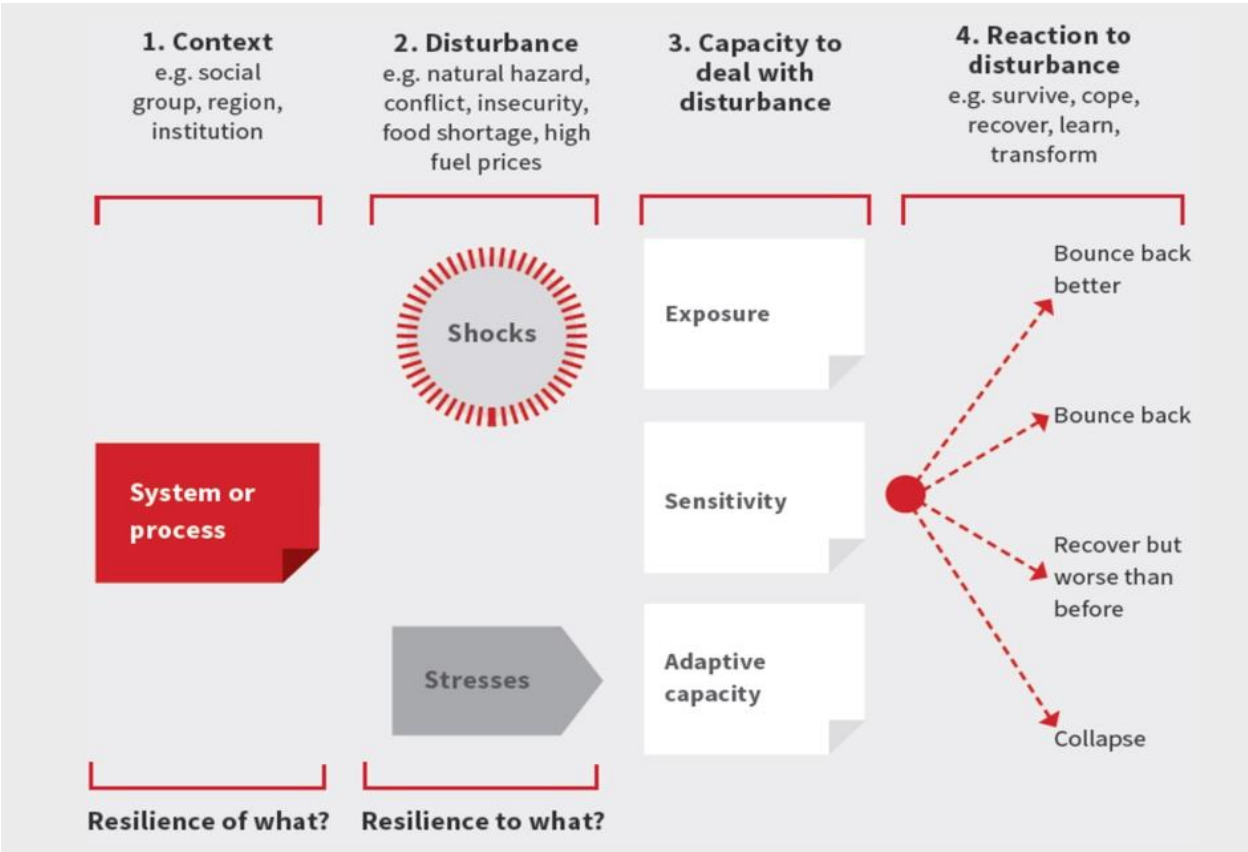
NMHS
National Mission on Himalayan Studies

Disaster Resilience Action Plan

Need

Himalayan cities are particularly vulnerable to disasters and extreme events like earthquakes, landslides, flash floods, thunderstorms and cold waves. The magnitude of hazards and extreme events in the region may vary depending on the risk exposure of the city. Physical risks and vulnerabilities in the Himalayan cities are often accompanied by difficult terrain, lack of necessary resources – financial, human and institutional – as well as lack of access to relevant scientific information on the coping mechanism.

This necessitates a thrust on improving the knowledge base and adaptive capacity of the cities by integrating disaster risk reduction measures in urban planning. In addition, rapid urbanization and climate change could exacerbate environmental stress in the region. Thus, there is a need to collect and review evidence to assess the vulnerability and likely impact of disasters in the region. IRADe with support from Ministry of Environment, Forests & Climate Change (MoEFCC) under National Mission on Himalayan Studies (NMHS), aims to develop Disaster Resilience Action Plans for Shillong and Gangtok cities.

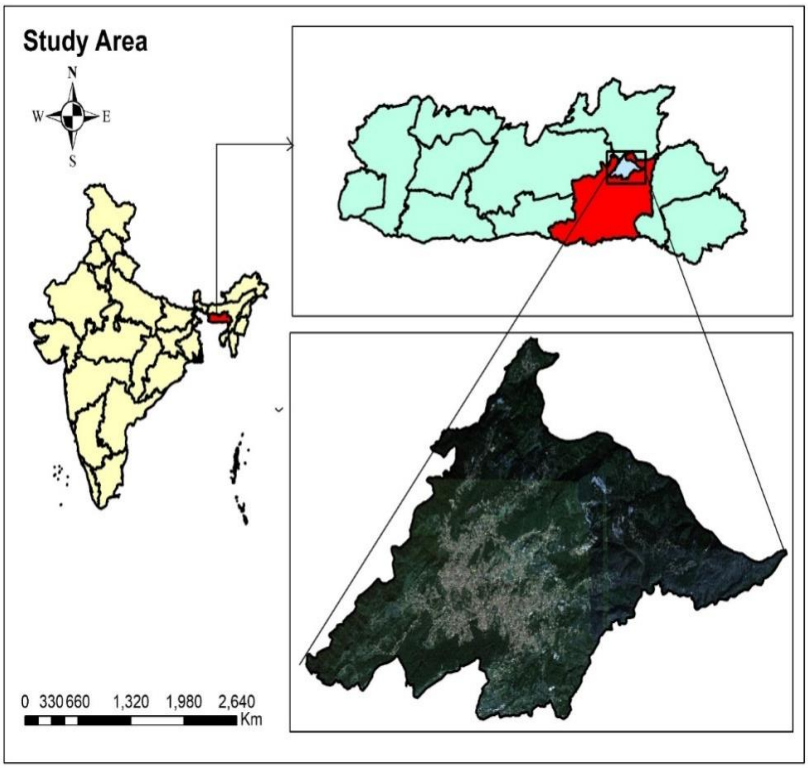


Model of Resilience

Source: DFID, Defining Resilience: A DFID Approach Paper (London: DFID, 2011), reproduced in J. Twigg, Disaster Risk Reduction, Good Practice Review 9, Revised Edition (London: ODI, 2015)

A Composite Hazard and vulnerability map on the **scale 1:4000** is developed for both the cities indicating **High, Medium and Low** risk hazards for the city. This helps in analyzing the city vulnerability and provide decision-making tools to assist the city for better disaster management. Based on the vulnerable zone mapping of the two cities, actions are prioritized for disaster risk reduction. **The action plans suggest hazard/disaster wise (floods, landslides, earthquake) measures for mainstreaming disaster risk resilience for the identified cities which can be integrated with the master plans and proposed smart city plans of the identified cities.** .

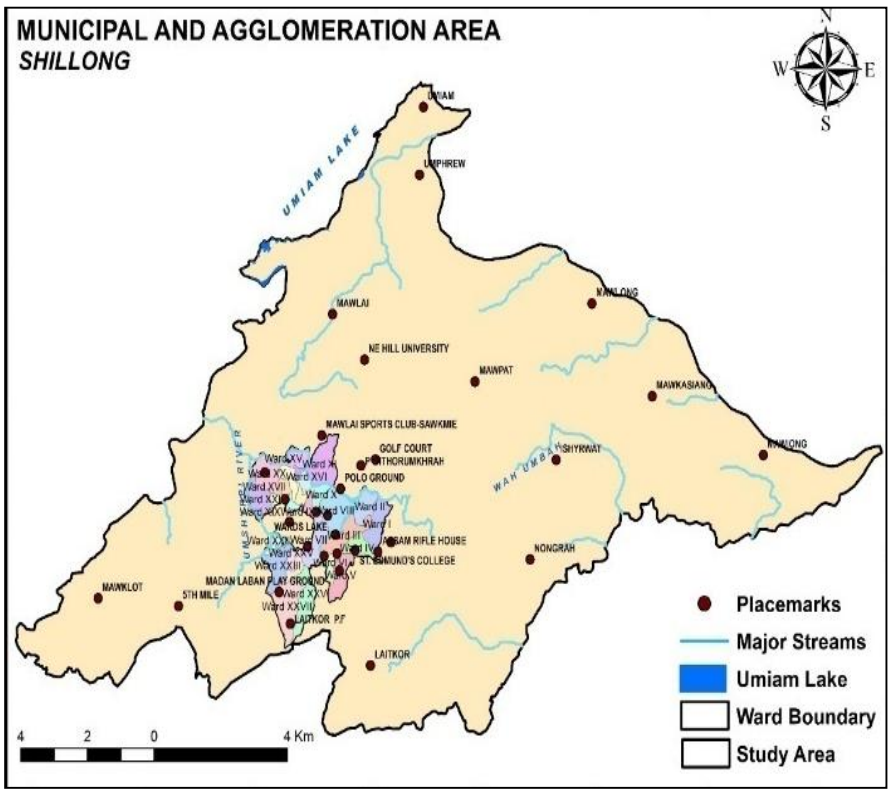
Shillong city, Meghalaya



Shillong, 2nd largest city in North-East Himalayan Region of India, is the capital city of Meghalaya and located on central upland zone of the Meghalaya Plateau. Shillong Urban Agglomeration, covers an area of 70.4 sq.km. and has Shillong Municipality (10.36 Sq. KM), the Cantonment (1.84 Sq. KM), and the townships of Mawlai, Nongthymmai Madanrting Pynthorumkhrah, Nongmynsong. The city is divided into 27 wards.

Shillong is prone to the consequences of climate change because of its geo-ecological fragility, eastern Himalayan landscape, trans-boundary river basins and inherent socio-economic instabilities.

The city is vulnerable to both natural hazards and man -made disasters



Hazard Exposure

Hazards Affecting the city every year			
No	**Hazard Type**	**Exposure**	**Key Disasters**
1	Flash Flood	Y	✓
2	Drought	Y	-
3	Earthquakes	Y	✓
4	Landslides/Avalanches	Y	✓
5	Forest Fires	Y	-
6	Heavy rainfall	Y	-
7	Hailstorm/thunderstorms	Y	-

Hazard Timeline												
Hazards	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Flash Floods												
Extreme winds												
Landslide												
Thunderstorm/Lightning/ Hailstorms												

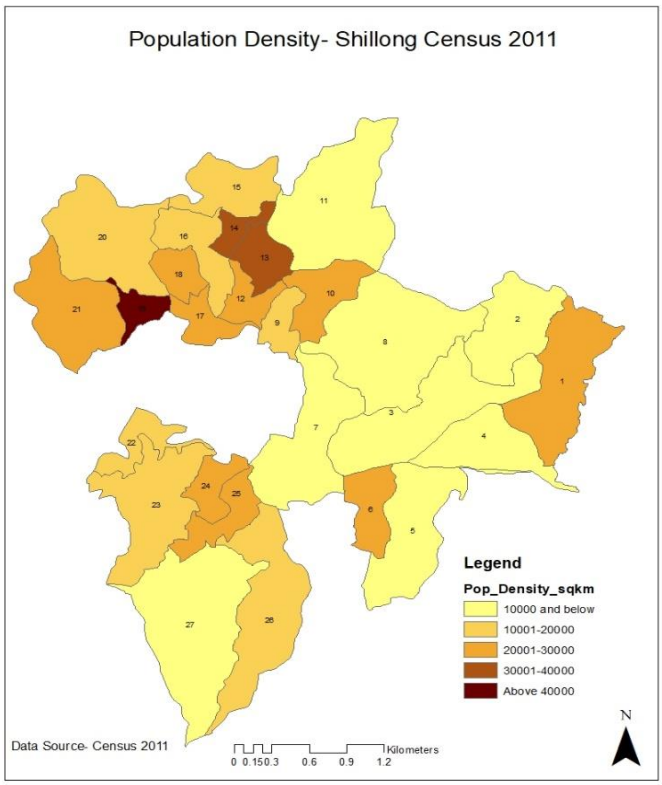
HAZARD AND EXTREME EVENTS	
Temperature Projections	• Temperature increase is expected to be 1.6-1.7°C by 2050 (Meghalaya State Action Plan on Climate Change, 2015)
Rainfall Projections	• East Khasi hills district is expected to experience an increase of 10-15% in precipitation by 2050 (Meghalaya State Action Plan on Climate Change, 2015)
Landslide	• In 2015, 12 people were killed in the landslides in Meghalaya
Earthquake	• Shillong city lies on the Shillong Plateau (SP), one of the most seismically active regions in the world.
Urban Floods	• Incidences of water logging in the city is 25%, with the numbers increasing during monsoons .

Disaster Vulnerability

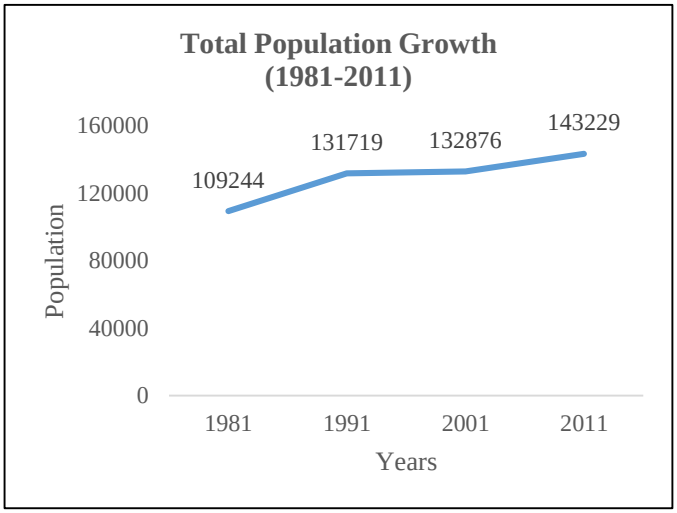
Physical Vulnerability

Population growth, especially an increase in population density and urbanization, increases vulnerability to disasters.

- The Shillong Municipal Board has a population of 143,229 of which 70,135 are males while 73,094 are females (Census, 2011)
- Shillong is also the most urbanized and largest city in the hill state of Meghalaya. The population growth rate over the last decade has been 7.79% (2001 Population – 132,867).



SOCIO-ECONOMIC CHARACTERISTICS	
Population	• 143,229 (Census, 2011). • Growth Rate – 7.79%
Density	• 13,825 per sq km in 2011
Slum Population	• 12 slum pockets, covering 10% of the city population

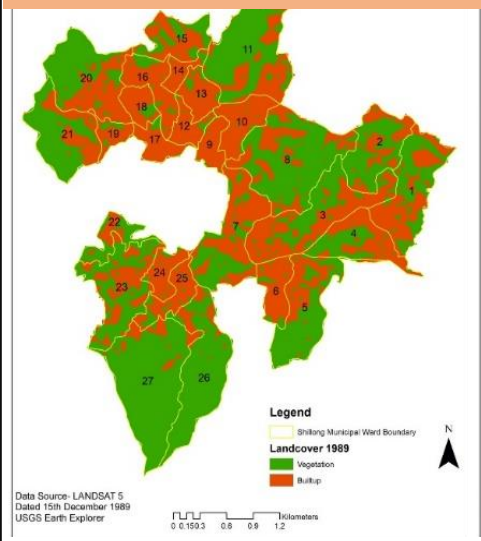


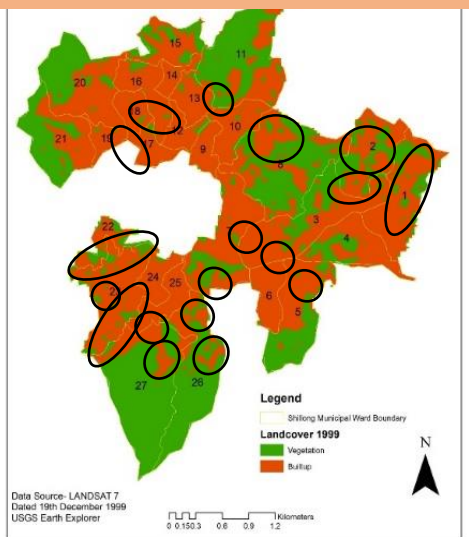
Social Vulnerability

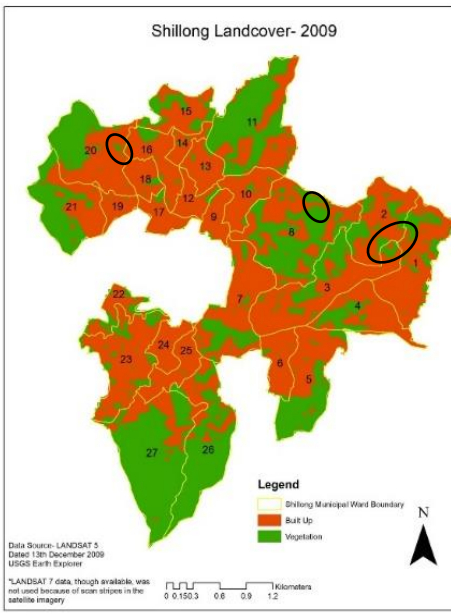
Shillong city has over 2992 slums (spread over 12 pockets) and scattered settlements in which population of 14,458 resides across private and public land. This is around 10.09% of the total population. However the Rajiv Aawas Yojna survey in 2015 addresses 13,120 number of Slum households, with 42%notified slums.

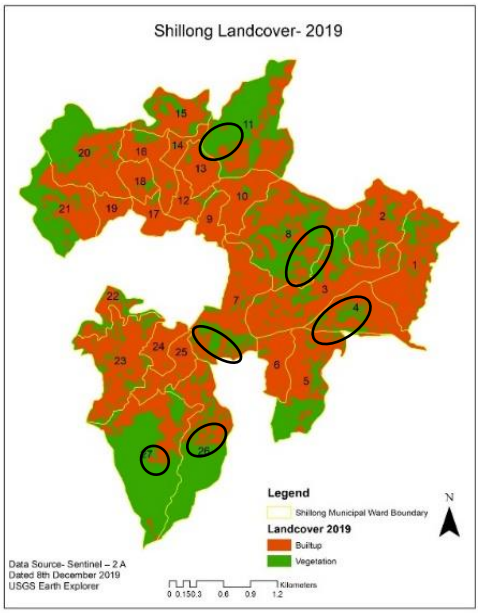
Most of the slum pockets are located in low-lying and water-logged areas amid poor sanitary conditions and unhygienic surroundings (Meghalaya State Development Report, 2008)

Land use & Land Cover



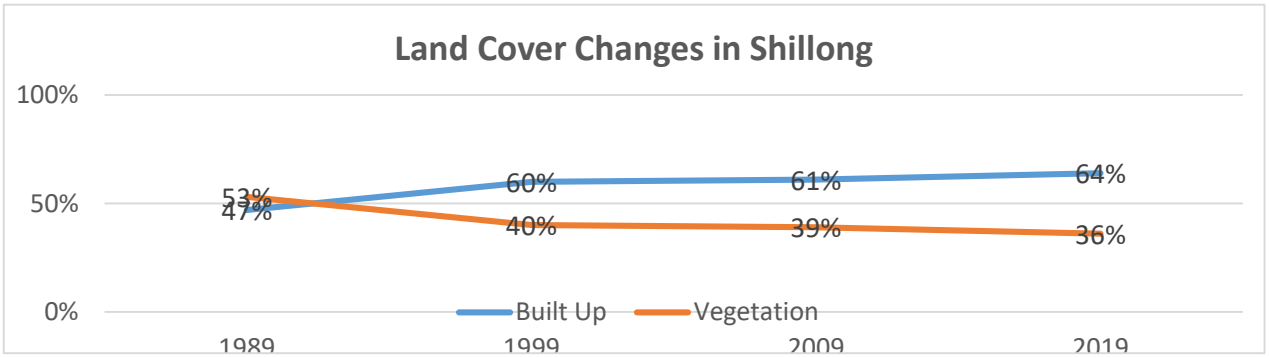






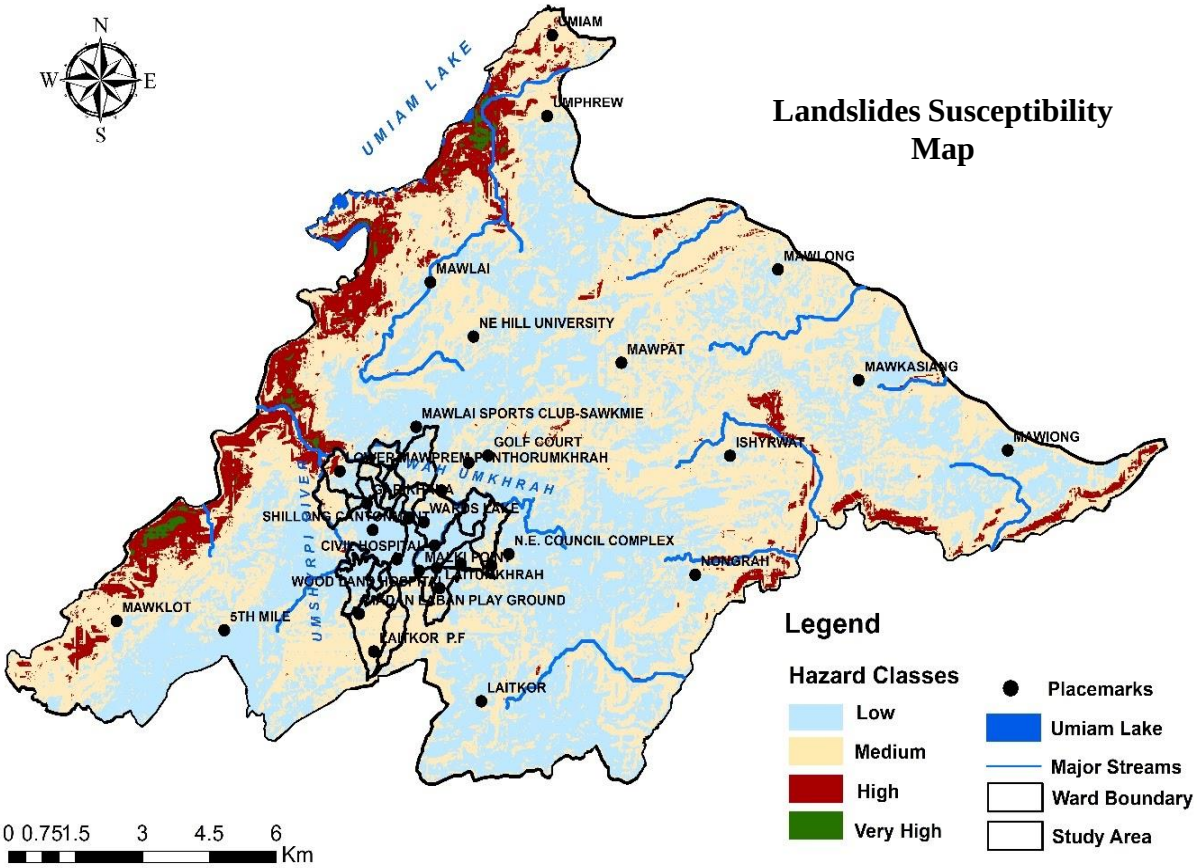
Taking **1989** as the **Base Year**,

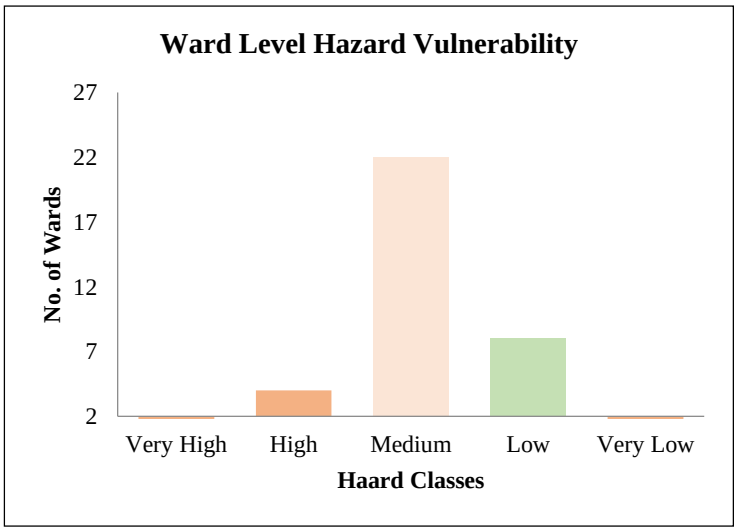
- The **built-up area in 1999** increased by a drastic **13%** followed by **1%** and **3%** in **2009** and **2019** respectively.
- The analysis shows that during the last **forty years**, the **Built-up Area** increased by a significant **17%,** taking up the area under the **Vegetation Cover** which **decreased** by the same percentage.



Years	Built Up %	Vegetation %
2019	64%	36%
2009	61%	39%
1999	60%	40%
1989	47%	53%

Landslides Susceptibility



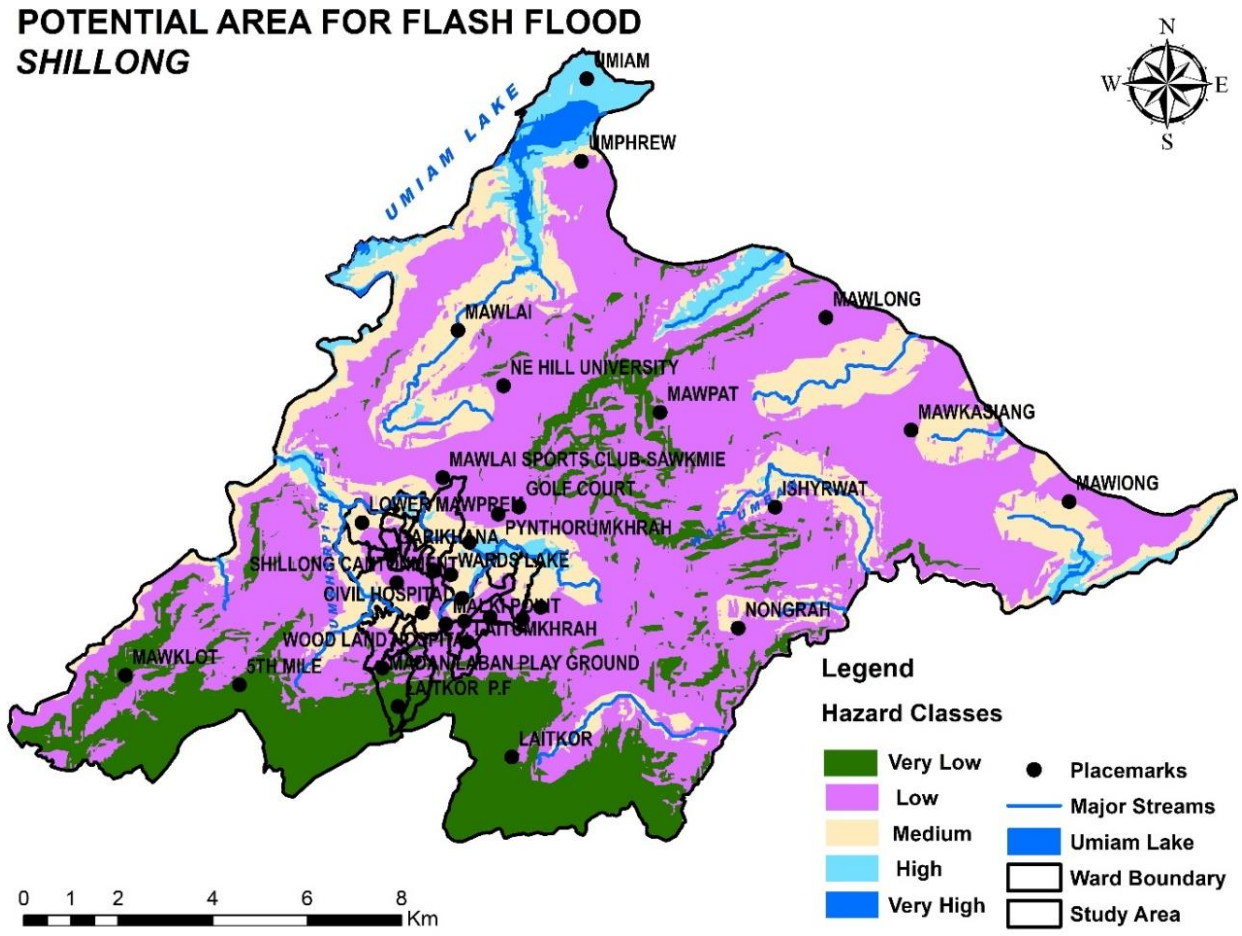


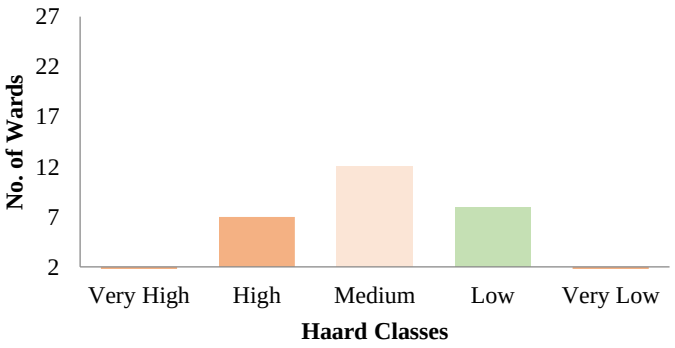
Landslides:

- ***Highly Vulnerable Wards*** - **Laitumkhrah I & II and Mawprem I & II,** inhibiting 21% of the city's population

Hazard Classes	Ward
Very High	Nil
High	1,4,20,21
Medium	2, 3,5 ,6, 7,8, 9,10,11,12,13,14, 15, 16, 17,18,19,22,23,25,26,27
Low	24
Very Low	Nil

Flash Floods Susceptibility



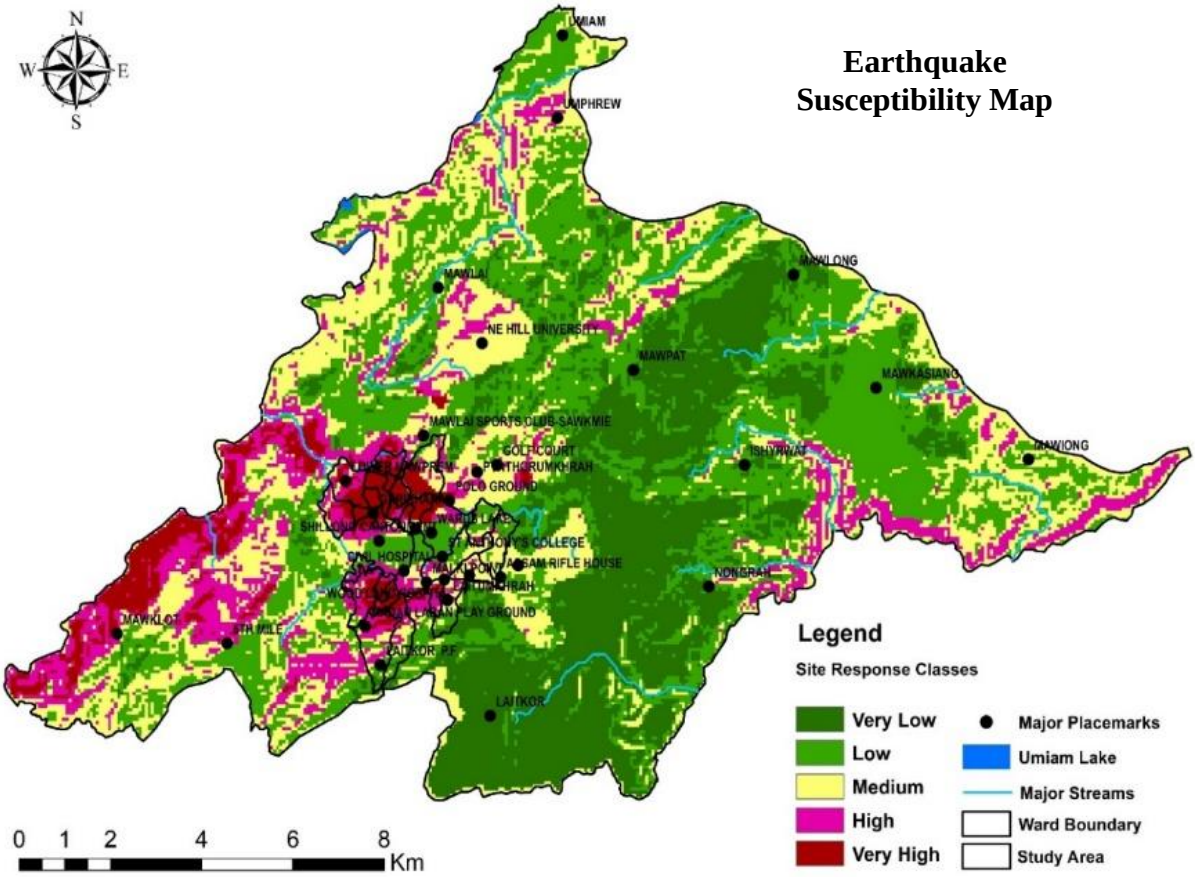


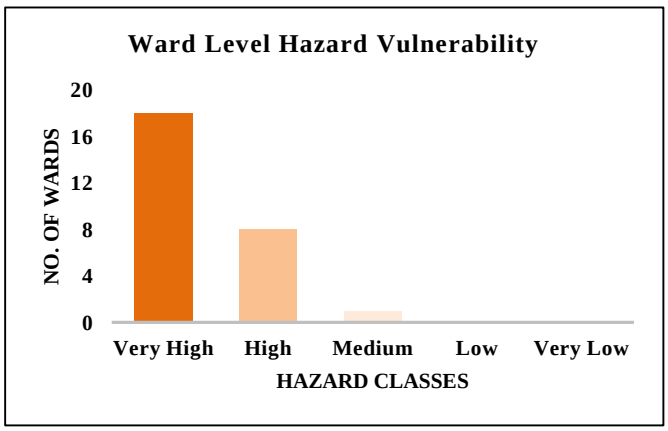
Flash Floods:

- ***Highly Vulnerable Wards-*** **Laitumkhrah I & II, European Ward, Jail Road, Jaiaw I & II and Mawprem, i**nhibiting 47% to total city population

Hazard Classes	Ward
Very High	Nil
High	1,2,8,11,14, 15,20
Medium	3,6,9,10,12,13,16,21,22,23,24,25
Low	4,5,7,17,18,19,26,27
Very Low	Nil

Earthquakes Susceptibility





Earthquake

- ***Very highly vulnerable wards*** **- 18 wards (out of 27)** inhibiting 76% of the city population
- **Highly vulnerable- 8 wards -,** inhibiting 22% of the total population

Hazard Classes	Ward
Very High	6 ,9,10,11 ,12,13,14,15,16,17, 18,19, 20,21,23,25, 26,27
High	1,2,3,4,5,7,8 ,22
Medium	24
Low	Nil
Very Low	Nil

Hazard Vulnerability

Landslides					
Hazard Classes	**Ward No**	**Ward Name**	**Total Population**	**%**	**Total**
Very High	**Nil**				
High	**1**	Laitumkhrah	11537	6.17	**20.81**
	4	Laitumkhrah	2753	1.47	
	20	Mawprem	10613	5.68	
	21	Mawprem	14009	7.49	

Urban Floods					
Hazard Classes	**Ward No**	**Ward Name**	**Total Population**	**%**	**Total**
Very High	**Nil**				
High	**1**	Laitumkhrah	11537	6.17	**46.49**
	2	Laitumkhrah	3266	1.75	
	8	European Ward	6009	3.21	
	11	Jail Road	48643	26.01	
	14	Jaiaw	3032	1.62	
	15	Jaiaw	3838	2.05	
	20	Mawprem	10613	5.68	

Earthquake					
Hazard Classes	**Ward No**	**Ward Name**	**Total Population**	**%**	**Total**
Very High	6	Malki	4888	2.61	**75.75**
	9	Police Bazar	2145	1.15	
	10	Jail Road	5766	3.08	
	11	Jail Road	48643	26.01	
	12	Mawkhar	2797	1.50	
	13	Mawkhar	5337	2.85	
	14	Jaiaw	3032	1.62	
	15	Jaiaw	3838	2.05	
	16	Jaiaw	4067	2.17	
	17	S.E.Mawkhar	3270	1.75	
	18	S.E.Mawkhar	3875	2.07	
	19	Mawprem	4556	2.44	
	20	Mawprem	10613	5.68	
	21	Mawprem	14009	7.49	
	23	Kench’s Trace	8161	4.36	
	25	Laban	5218	2.79	
	26	Lumparing	6319	3.38	
	27	Lumparing	5133	2.74	
High	1	Laitumkhrah	11537	6.17	**22.34**
	2	Laitumkhrah	3266	1.75	
	3	Laitumkhrah	5437	2.91	
	4	Laitumkhrah	2753	1.47	
	5	Malki	4908	2.62	
	7	European Ward	4891	2.62	
	8	European Ward	6009	3.21	
	22	Kench’s Trace	2973	1.59	

Multi-Hazard Susceptible Wards

Hazard Type	Ward No	Ward Name	Total Population	%	Total % of city's population
L, F & E	**1**	Laitumkhrah	11537	6.17	**55.45**
F & E	**2**	Laitumkhrah	3266	1.75	
L, F & E	**4**	Laitumkhrah	2753	1.47	
F & E	**8**	European Ward	6009	3.21	
F & E	**11**	Jail Road	48643	26.01	
F & E	**14**	Jaiaw	3032	1.62	
F & E	**15**	Jaiaw	3838	2.05	
L, F & E	**20**	Mawprem	10613	5.68	
L, F & E	**21**	Mawprem	14009	7.49	
L- Landslides, F- Urban Floods & E- Earthquakes					

- **Total 9 wards are among the most vulnerable wards, susceptible to disasters - landslides, urban floods and earthquakes**
- **Located on the east and the North & North western part of the SMB area**
- **Total vulnerable population– 103700 persons (55.45 % of the total city's population)**

Service Level Benchmarks – Shillong City

	INDICATOR	BENCHMARK	SHILLONG STATUS
	WATER SUPPLY		
1	Coverage of Water Supply Connections	100%	76.89%
2	Per capita availability of water at consumer end	135 lpcd	78 LPCD
3	Extent of metering of water connections	100%	No info
4	Extent of non-revenue water	20%	58%
5	Continuity of Water Supply	24*7	No info
6	Adequacy of Treatment and Disinfection and Quality of water supplied	100%	100%
7	Efficiency in redressal of customer complaints	80%	No info
8	Cost recovery in water supply services	100%	12%
9	Efficiency in collection of water supply related charges	90%	71.3%
	SEWAGE MANAGEMENT		
1	Coverage of Toilets	100%	93.86%
2	Coverage of Waste sewerage Network Services	100%	0 (No STP)
3	Collection Efficiency of Waste Water Network	100%	0
4	Adequacy of waste water treatment Capacity	100%	0
5	Quality of sewage Treatment	100%	0
6	Extent pf reuse and recycling of sewage	20%	0
7	Efficiency in redressal of customer complaints	80%	No info
8	Extent of cost recovery in sewage management	100%	No info
9	Efficiency in collection of sewerage charges	90%	No info
	SOLID WASTE MANAGEMENT		
1	Household level coverage of Solid Waste management services	100%	46%
2	Efficiency of collection of municipal solid waste	100%	80%
3	Extent of segregation of municipal solid waste	100%	0
4	Extent of Municipal solid waste recovered/recycled	80%	0
5	Extent of scientific disposal of municipal solid waste	100%	0
6	Efficiency in redressal of customer complaints	80%	No info
7	Extent of cost recovery in solid waste management services	100%	No info
8	Efficiency in collection of SWM charges	90%	No info
	STORM WATER DRAINAGE		
1	Coverage of Storm Water Drainage Network	100%	85%
2	Incidence of water logging/flooding	0%	25%

Source:
Shillong Municipal Board
Smart Cities Challenge (Stage 2) Smart City proposal
State Annual Action Plan, AMRUT

Traditional Knowledge

Housing Structural Knowledge

Khasi Housing

- Timber framed structures have inherent earthquake resistant characteristics
- Earthquake Resistant & stable Structures - wooden posts and rafters, roof made of thatch (lighter material) and panel wall in leaves, grass, and reed or split bamboo
- Good Flexibility - structural framework of the buildings are separated from walls and well tied together
- Placement on short columns would substantially reduce the effect of lateral loading
- Symmetrically shaped with negligible sharp corners, oval shape reduces stress concentrations at corners.
- No Nails used to reduce pressure on mortised joints

Assam type house or Ikora style

- Individual units rather than one whole continued building, seismically very effective
- C-or L-type plan using localized material, built on ‘earthquake-proof’ lines,
- Earthquake resistant with flexible connections and joinery between various elements
- Gable roof form with 30° slopes, ensuring greater resistance to strong winds which this zone experiences
- Houses are rectangular structure preferably laid out in the SW-NW direction

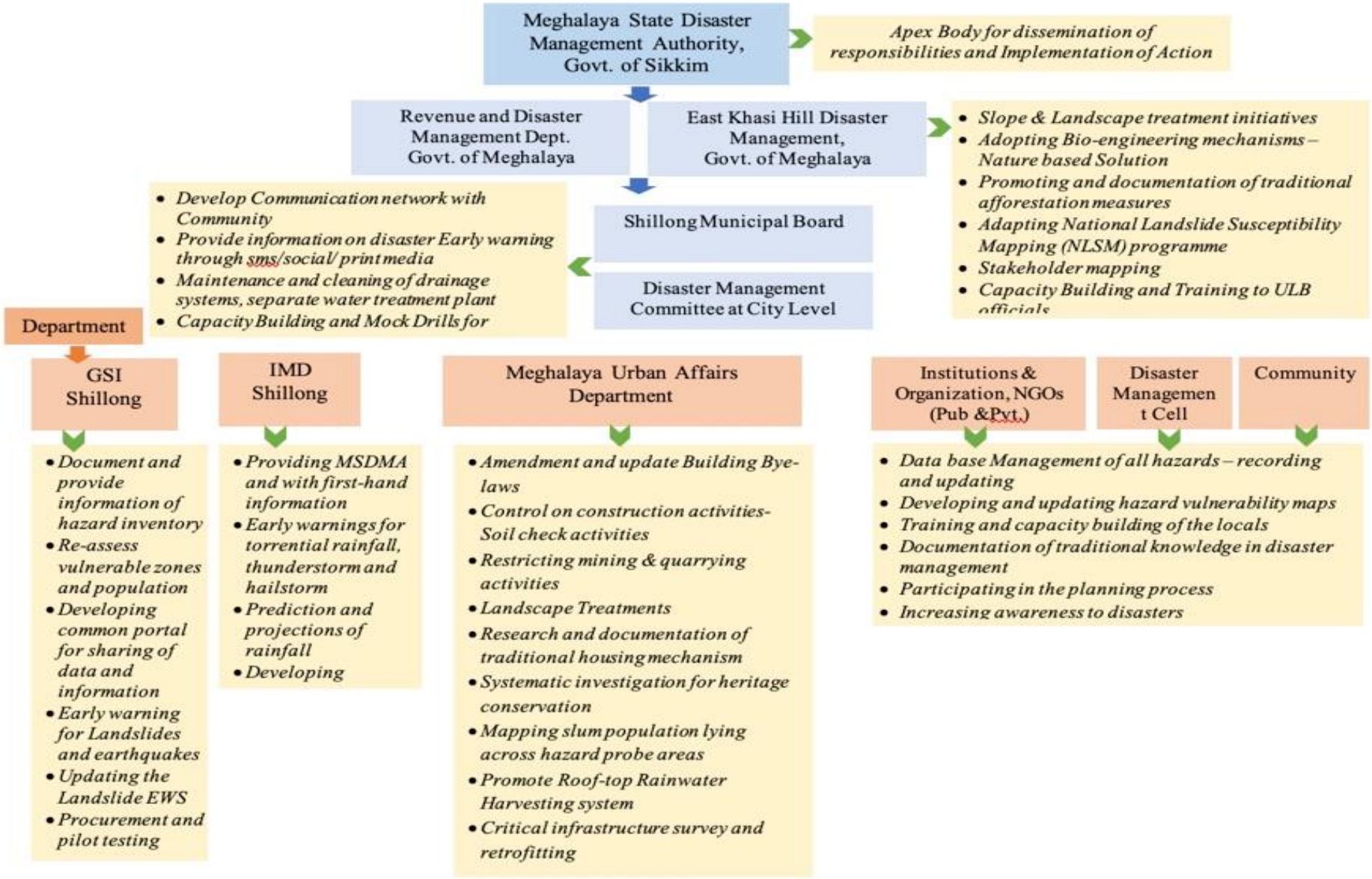
Vegetal Cover & Others

- Control soil erosion and landslides by planting bamboo embankments - Melocannabaccifera, Bambusatulda, Bambusabambos, and other bamboo species
- Traditional practice of home gardening is a vital component in preventing landslides
- Removal of matter (silt and sand) reduces siltation during heavy rains and prevents river channels from overflowing.

Key Interventions Identified For Shillong City

1	**Construction and Building Bylaws – Structural Measures**
	• Restricted construction along 35-60 degree slope. Restricting construction beyond 15 mts. height • Identify and assess Nature Based Solution (NBS) for landslide Risk Management • Change from prescriptive to form based/ performance based/site specific, and formulation of a new enforcement mechanism. • Promoting Soil check measures • Adopting Landscape treatments NIDM Guidelines
2	**Hazard susceptible zonation**
	• Maps using Satellite imageries and GIS tools on the scale of 1:50,000-1:4,000 , mapping landslide/floods/earthquake hazards and create a knowledge /database • Clearing of culverts and Jhoras and stabilization of road side drain along all important roads • Avoid need-based risk computation • Relocation and rehabilitation along the banks of river - Umkhrah and Umshyrpi
3	**Land-use and Land Cover Planning**
	• Developing single point clearances points from MDMA • Selection of dumping sites not located on or at the vicinity of landslide prone areas • Use of the hazard zonation maps in regional planning • Land use-zoning policy, highlight the landslide-susceptible areas and regulating activities. • Quantification of environmental degradation, cost of loss of land and agriculture produce • Preparation of large-scale maps (1:10,000/1:15,000) of area vulnerable to floods with contours at an interval of 0.3 m or 0.5 m. (NDMA)
4	**Basic and Critical Infrastructure**
	• Retrofitting the lifeline facilities like hospital and schools (if required) • Develop integrated - Sewerage Development Plan and Drainage Master Plan • Sewage Treatment Plant • Develop ward level maps for - Basic Infrastructure, Critical Infrastructure, Ecological, Hotspots, Slum Pockets & Population Cover
5	**Community Capacity Building**
	• Establish state /district level Research and Management Cell under “Centre for Landslide Research Studies and Management (CLRSM)” • Provision for research and funding options for community capacity building • Training of - First responders in search, Rescue and Medicare with relevant stakeholders • Defining role and responsibility - Government, local bodies, public sector, NGOs, communities and People before, during and after a disaster
6	**Early Warning System**
	• Monitor and forecast rainfall pattern • Update existing early warning system with NEAC and MDMA • Develop early warning issuing mechanism (information flow framework) among stakeholders and community • Procure landslide early-warning system (LEWS) • Develop Effective Communication, from MDMA to community

Resilience Action Plan Implementation Framework



Implementing Agencies

Sl.N	Action Plan Implementing agencies	Key Roles/Responsibilities
1	**Indian Meteorological Department (IMD)**	• Weather forecasting and disseminating weather information • Warning and early warning system
2	**Geological Survey of India (GSI)**	• Document and update hazard inventory database • Landslide & earthquake prediction and provision of information through common portal
3	**Department of Land Revenue and Disaster Management – Meghalaya State Disaster Management Authority (MSDMA)**	• Mapping multi-hazard risk • Installation of Landslide Early Warning Systems (LEWS) and Flood Information System • Hazard Database management • Coordination of other departments
4	**Urban Affairs Department, Govt. of Meghalaya**	• Amendment of building bye-laws • Assisting and guiding ULBs in terms of its functioning and execution of duties
5	**Public Health Engineering Department, Meghalaya**	• Provision of Adequate safe water and sanitation • Functioning of city sewerage treatment plants
6	**District Disaster Management Authority**	• Guidance and corporation with ULB disaster mitigation
7	**Ward Level Disaster Management Committees**	• Work in coordination with DDMA
8	**Urban Local Bodies: Shillong Municipal Board**	• Relief & Rehabilitation of City slums/ Urban poor

Infrastructure Implementing agencies	Funding Linkages
• **Urban Affairs Dept Govt. of Meghalaya** • **Shillong Municipal Board** • **Water Security and PHE Department** • **PHE Dept** • **PWD** • **PWD NH Division** • **PWD Central Division** • **Meghalaya State Govt. Dept** • **Energy & Power Deportment**	• AMRUT – CBUD • PPP mode funding (Private and Public Partnership) • Smart city • MLDAA (ADB) • Users/Citizens • Swachh Bharat Mission SBM • MLDAA (ABD) • Users/ Beneficiaries • Pradhan Mantri Awas Yojana