PRELIMINARY REPORT
ON
RISK-INFORMED MASTER PLAN
TURA

Department of Urban Affairs

Government of Meghalaya

I. BACKGROUND

Disasters cannot be avoided entirely, but the vulnerability of people and assets to various hazards can be substantially and sustainably reduced through planned prevention, mitigation and preparedness measures. The impact of hazards in different regions varies based on numerous factors; in urban areas with a concentration of people, establishments and infrastructure, the damages caused by hazards would be manifold compared to less developed areas. Unplanned developments and lack of investment in resilient infrastructure and services increase the likely disaster impact on a community. Risk reduction measures are more effective and less costly than medical measures. Integrating risk information with land use planning can reduce the impact of hazards on life, property and the environment.

Master Plans are statutory documents for guiding future development sustainably with a focus on spatial and land use planning. Disaster Risk Reduction strategies shall strive to lower Risk in existing developments and also in preventing exposure of new developments to Hazards.

An informed master plan is one of the components under the Revised Supplementary Guidelines on the Scheme for Special Assistance to States for Capital Investment 2023 -24, Part - III (only for NE/predominantly hilly states). Undertaking Risk Informed master planning by way of mapping/earmarking of vulnerable areas prone to disasters that should not be inhabited or should not be densified further. For example, construction activities in highly vulnerable areas like steep slopes areas near water bodies prone to flooding should not be allowed. States shall specify slope gradient (depending upon the local conditions), beyond which an explicit ban on undertaking any construction shall be imposed by the notified building bye-laws of the state governments. The risk-informed master plan should include the following:

- Contour–based Drainage plan,
- Mapping of Low Risk/High-Risk Areas,
- Preparation of mitigation plan

To achieve the risk informed Master plan following modules need to addressed which are

M-1 Draft GIS-based Master Plan for the Tura Planning Area has been prepared as per URDPFI guidelines**.**

M-2 Hazard Vulnerability & Risk Assessment (HVRA)

M-3 Preparation of Contour-Based Drainage, Mapping of Vulnerable Areas & Mitigation Plan.

II. M 1 – TURA MASTER PLAN 2041

1. PLANNING AREA

The GIS Based Master Plan of Tura -2041, will have a planning area covers a total area of 54.65 Sq. Km., including the municipal area which is 18.32 Sq. Km. in area. The Masterplan also includes villages towards its northern and western side, within its boundary. The physiographical landmark as wells as physical infrastructure landmark boundary areas under the Tura Master Plan Area - 2041 are as follows:-

Table 1 Tura Master Plan, - Coverage Area

Sl. No.	Boundary	Area (Sq. Km.)
1	Municipal Area	18.32
2	Villages outside municipal boundary but within masterplan boundary:- ➢ Duragre ➢ Chasingre ➢ Rongkhongre ➢ Atlatgiri ➢ Ballonggre ➢ Danakgre ➢ Doldegre	36.33
3	**Total Masterplan Area**	**54.65**

The physiographical landmark as wells as physical infrastructure landmark boundary areas under the Tura Master Plan Area - 2041 are as follows:-

i. South west boundary – Mellim Higher Sec school, DanakDopgre Baptist Church
ii. West boundary –Governor's House - Danakgre, Ballongre L.P. School
iii. North western boundary – Ringrey stream, Tura Baptist church cemetery, Auxillum School – Wadanang, tributary of Ganol river and Rongkhon stream
iv. North boundary – Ganol River, Ganol Eco Park
v. East Boundary – Foothills of Tura Peak, Municipal boundary of ward No. 1, 2 9 and 10
vi. South Boundary – Rongkhon Stream

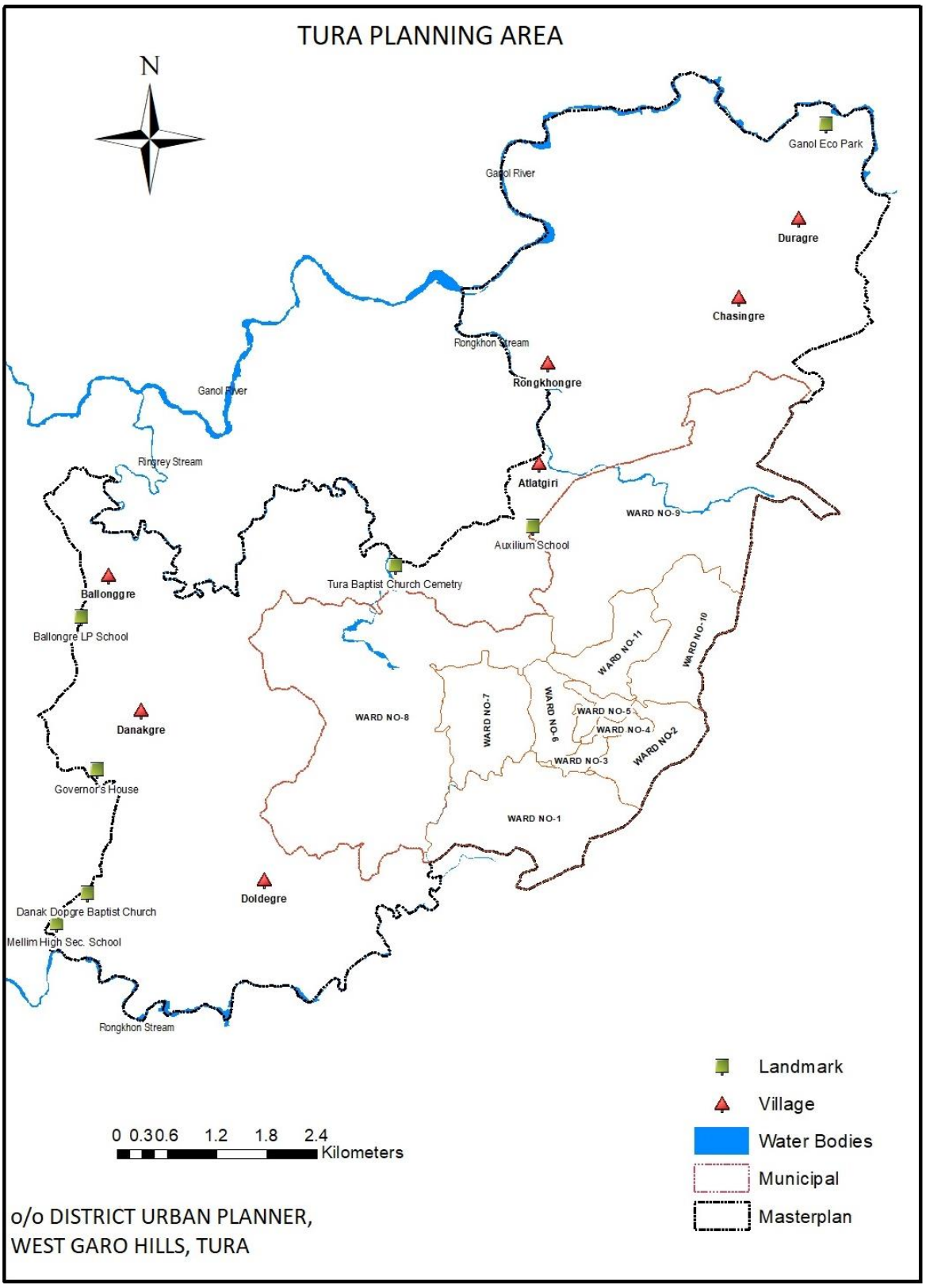

Figure 1: Base map of Tura Masterplan Area

2. DEMOGRAPHIC STUDIES

For the past 5 decades, the population growth rate of Tura has increased drastically from 8,888 to 74,858. The growth rate between these 5 decades have never been uniform. The estimated population of Tura is based on Arithmetic Progression and Geometric Progression.

As per the Fig 2.1, projection by Geometric Method indicates that the population is increasing drastically with every decadal growth. While Arithmetic Method shows a more linear increment and follows the growth trend of the existing population. Hence it is more considerable to consider the population projection by Arithmetic Progression. By 2021, the population is expected to reach 88,052 and by 2031, the population is said to increase to 1,01,246. By 2041, the population is said to be 1,14,440.

Table 1: Comparison of different methods of populated projection for 2041

Arithmetic Method		**Geometric method**	
Pn = P + nC		**Pn = P (1 + Ig/100)^n**	
Year	**Population**	**Year**	**Population**
2021	88,052	2021	1,09,728
2031	1,01,246	2031	1,60,840
2041	1,14,440	2041	2,35,761

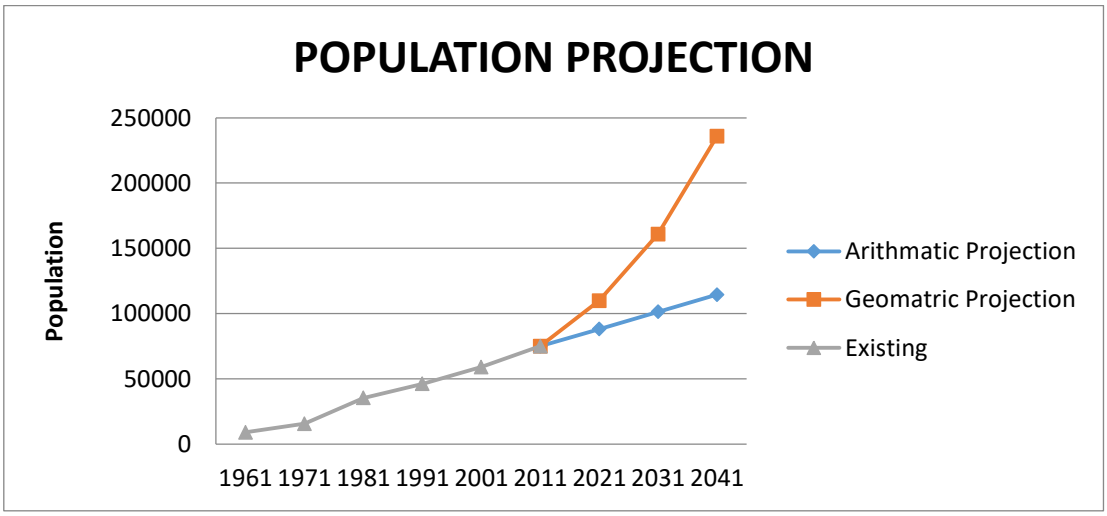

Figure 2: Population Projection for Tura Masterplan Area

3. URBAN LAND USE

i. EXISTING LANDUSE

The Tura Master Plan covers an area of 54.65 Sq. Km, out of which 9.16 Sq. Km. (901.27 falls on existing built up area, which comprises of 16.76% of the existing landuse pattern.
Transportation sector contributes only 1.50% of the existing landuse, which is 0.82 Sq. Km. urban agriculture is 6.56 Sq. Km. which constitutes about 11.77 %. The vacant area, which is the unutilized area has an area of 1.40 Sq. Km. which is about 2.56 The forest area is the most domination sector in terms of landuse allocation within the master plan. It has 35.94 Sq. Km. and comprises of almost 65.76% of the entire master plan area. The water bodies consist of 1.65% of the existing landuse, which is 0.90 Sq. Km.

Table 2: Existing Landuse of Tura Masterplan Area

Landuse	Area (Sq. KM.)	Area (%)
Builtup (Rural & Urban)	9.16	16.76%
Transportation	0.82	1.50%
Urban Agriculture	6.43	11.77%
Vacant	1.40	2.56%
Forest	35.94	65.76%
Water Bodies (Rivers & Streams)	0.90	1.65%
	54.65	**100.00%**

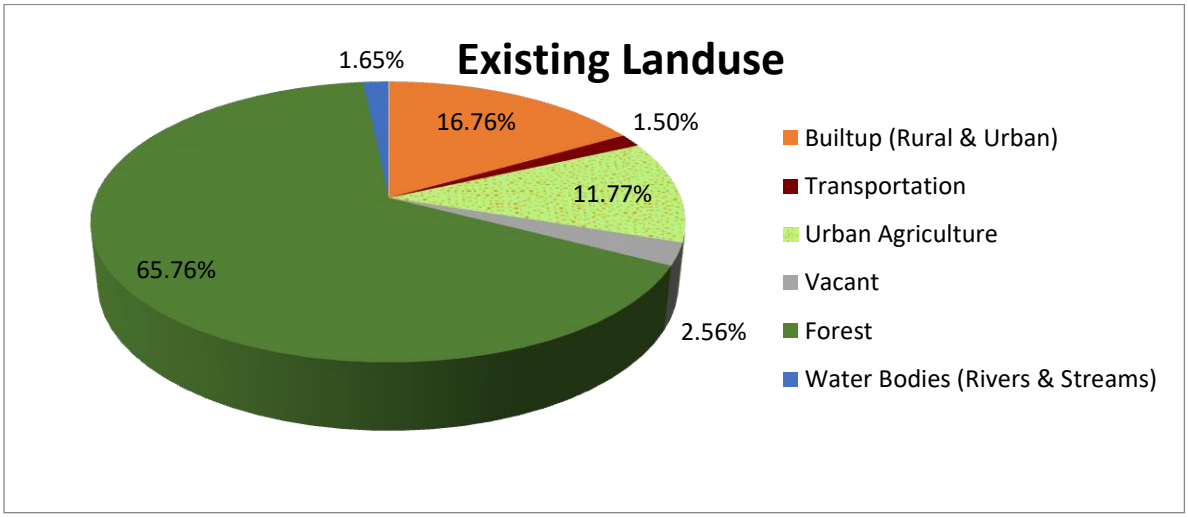

Fig 3: Existing Land Use of Tura Planning Area

ii. EXISTING LANDUSE (BUILTUP)

The residential units within the master plan area covers a total of 4.97 Sq. Km. It has the highest occupied area, covering nearly half, of existing landuse infrastructure, being about 55.28%. The commercial unit covers a total area of 0.22 Sq. Km. which is 2.45% of the builtup area. The Public and Semi Public covers a total area of 0.85 Sq. Km. which is 9.45% of the infrastructure landuse. Mixed Landuse has an area of 0.69 Sq. Km. which is 7.67% of the existing landuse

infrastructure. Industrial area has an area of only 0.001 Sq. Km. (0.05 Hectares) which is negigible of the existing landuse infrastructure, being the least. Recreational area include the social activities in M.P. Stadium and Parade Ground. They have a total area of 0.21 Sq. Km. which is 2.34% of the existing landuse infrastructure. The rural settlements cover a total area of about 2.01 Sq. Km. which is 22.36% of the existing landuse infrastructure.

Table 3: Existing Land Use (Built –Up) of Tura Planning Area

Landuse	Area (Sq. KM.)	Percentage	% (Masterplan Area)
Residential	4.97	55.28%	9.09%
Commercial	0.22	2.45%	0.40%
Mixed Landuse	0.69	7.67%	1.26%
Public/Semi Public	0.85	9.45%	1.56%
Public Utilities	0.04	0.44%	0.07%
Industrial	0.001	0.01%	0.00%
Recreational	0.21	2.34%	0.38%
Urban Builtup	**6.98**	**77.64%**	**12.77%**
Rural Settlement	2.01	22.36%	3.68%
Total (Builtup Area)	**8.99**	**100.00%**	**16.45%**
Non Builtup Area	**45.66**		**83.55%**
Master Plan Area	**54.65**		**100.00%**

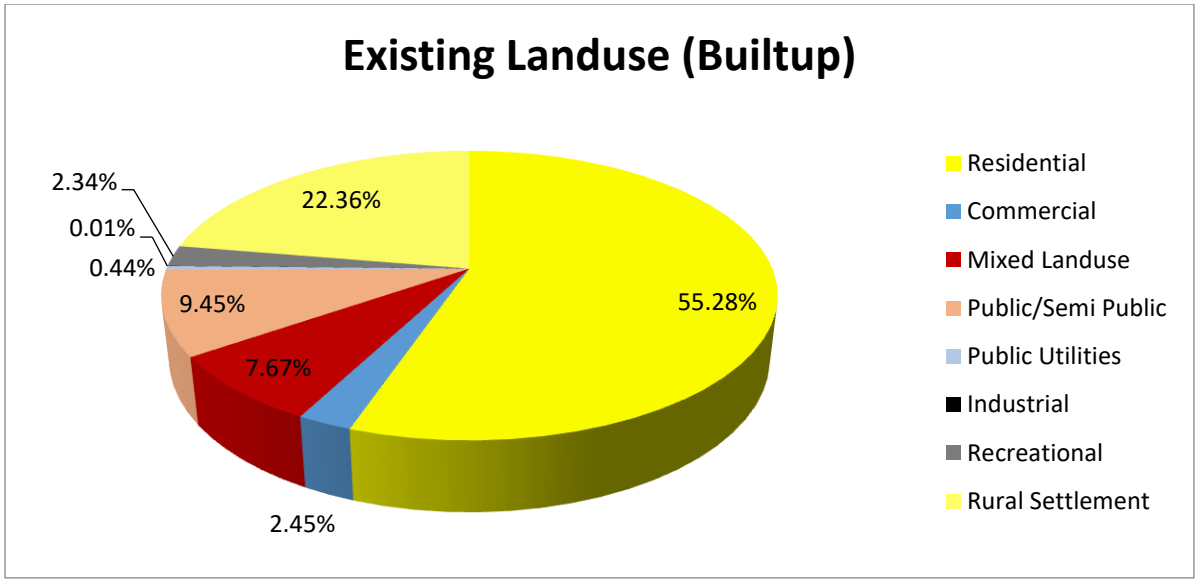

Fig 4: Existing Land Use (Built –Up) of Tura Planning Area

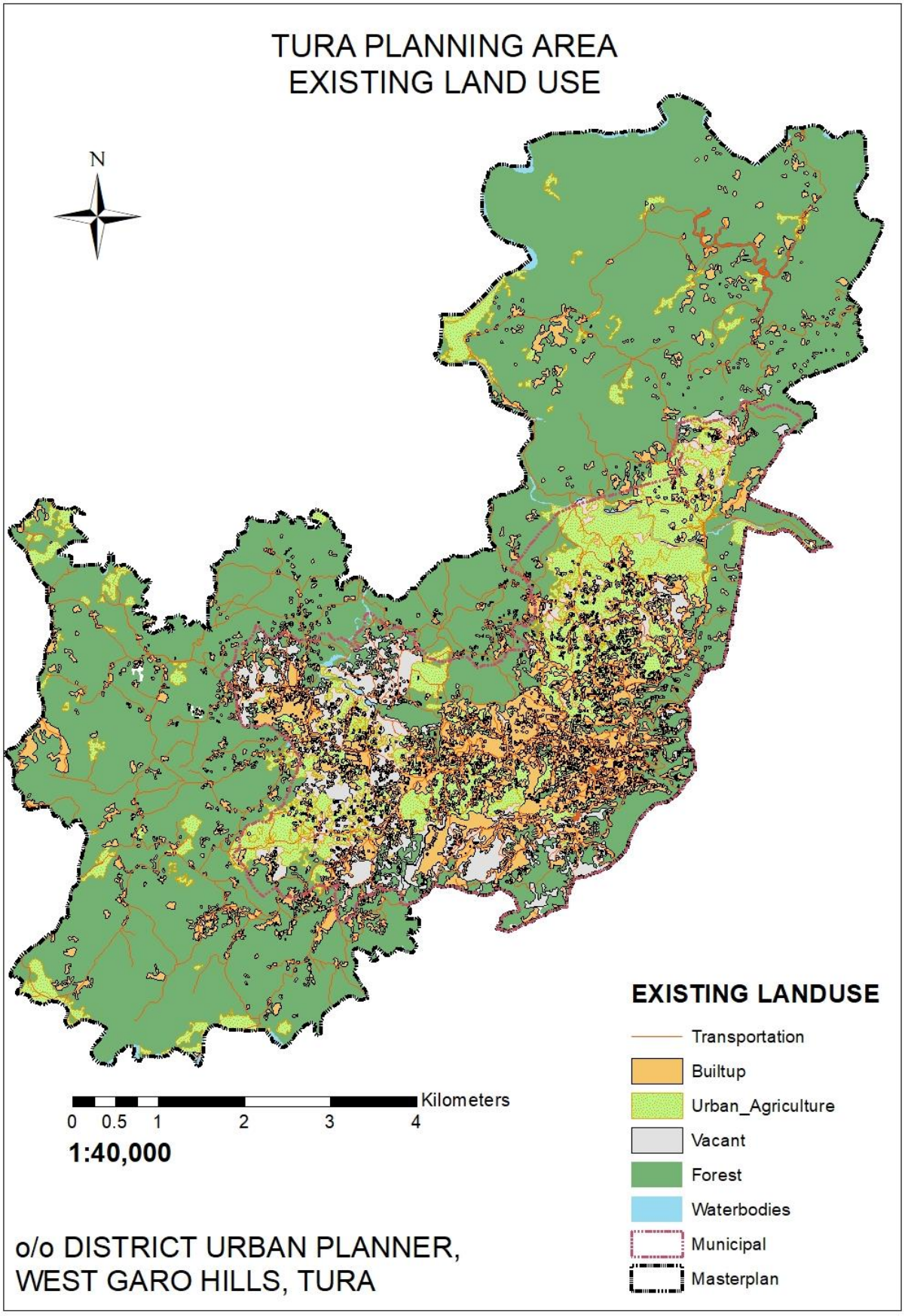

Figure 5: Existing Land Use

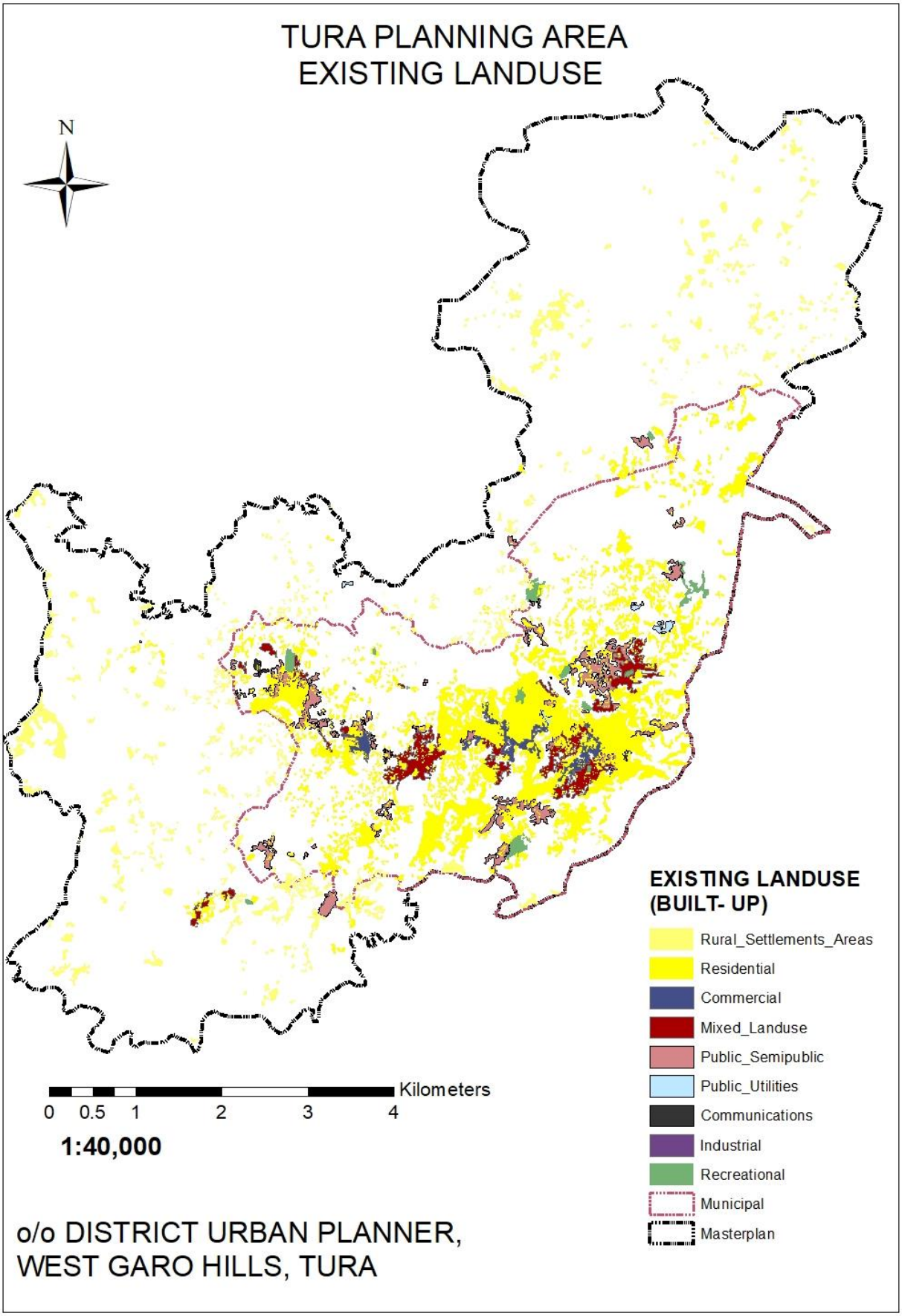

Figure 6: Existing Land Use (Built-Up)

4. PROPOSED LAND USE

The propose landuse plan for Tura Masterplan can be propose in accordance with Section 4.7 of the URDPFI Guidelines. The propose landuse map of the Tura Master Plan consist of various classification of zones, which is as per the URDPFI Guidelines, which includes Urbanisable Zone (Existing Zone, New Area Zone & Potential for Urban Development Zone), Transportaion Zone and Primary Activity Zone. The includes the Existing Zone will have a total area of 12.43 Sq,Km. which is 22.74% of the total landuse area. The New Area Zone will have an area of 20.15 Sq.Km. which contributes about 36.87%, while the Potential for Urban Development Zone will have an area of 15.64 Sq.Km. which is 28.62% of the total landuse. Primary Activity Zone will have 5.85 Sq.Km which is 10.70% of propose landuse distribution. Water bodies will have an area of 0.58 Sq.Km. which is 1.06% of the propose landuse area.

Table 2: Proposed Land Use (2041) of Tura Planning Area

Landuse	Area (Sq. Km.)	MasterPlan Area (%)
Existing Zone	12.43	22.74%
New Area Zone	20.15	36.87%
Potential Urban Dev. Zone	15.64	28.62%
Primary Activity Zone	5.85	10.70%
Water Bodies	0.58	1.06%
Masterplan Area	**54.65**	**100.00%**

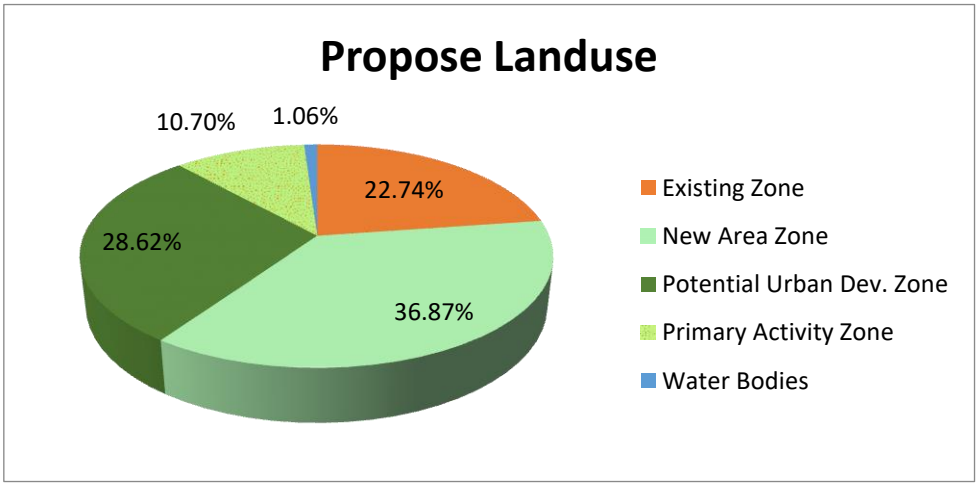

Figure 7: Proposed Land Use (2041) of Tura Planning Area

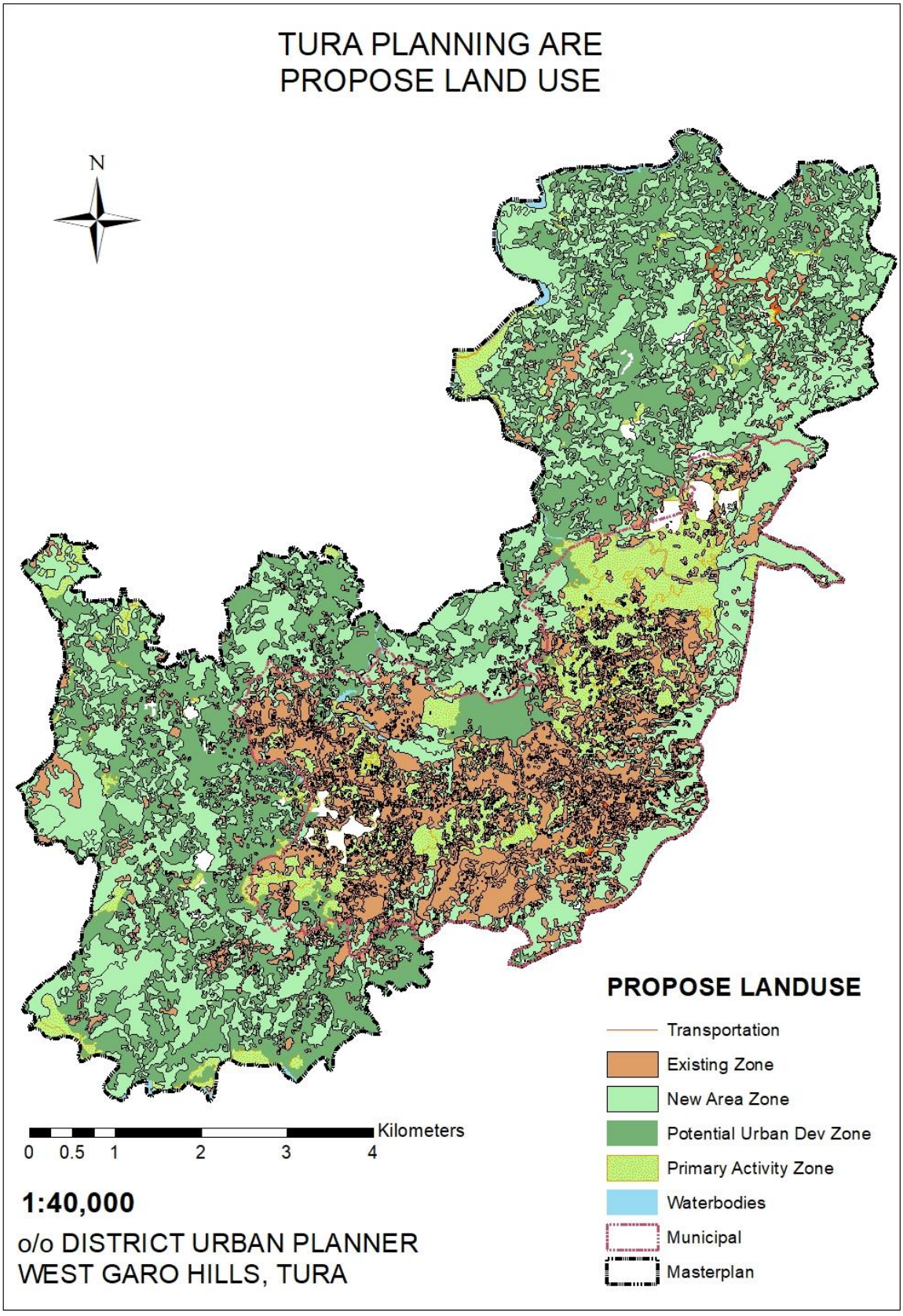

Figure 8: Proposed Land Use (2041) of Tura Planning Area

5. ZONING REGULATIONS

The Tura Master Plan has been categorized to distribute the different type of land uses in terms of different categories of land resources. The zoning regulations of Tura Masterplan is done in accordance with the URDPFI Guidelines 2014, given in table below. Zoning regulation of Tura masterplan is done by classifying the different zones as residential (R), commercial (C), Public & Semi-public (PS), Transportation (T), Primary Activity (A), Protective Area.

Table 5: Zoning Regulation of Tura Planning Area

Sl.	Zoning Regulations	Propose Landuse			
		Existing Zone	**New Area Zone**	**Potential Urban Dev. Zone**	**Primary Activity Zone**
1.	Residential (R)	• Primary Residential Zone (R1) • Mixed Residential Zone (R2)			
2.	Commercial (C)	• Retail Shopping Zone (C1) • Gen. Business & Commercial Centres (C2) • Wholesome, Warehouse, etc. (C3) • Service Sector. (C4) • Informal Market. (C5)			
3.	Public & Semi-public (PS)	• Govt./Semi Govt./Public Office (PS1) • Govt. Land (PS2) • Security & Safety Service – Police & Fire Station (PS3) • Academic Service (PS4) • Medical Service (PS5) • Socio-cultural & Religious (PS6) • Other Utility Service (PS7)			
4.	Transportation (T)	• Road (T1) • Truck Terminus/Bus Station (T2) • Transmission & Communication (T3)			
5.	Primary Activity (A)	• Tree Clad Area (A1)		• Tree Clad Area (A1) • Agriculture (A2) • Farming (A3)	
6.	Protective Area (E)	• Water Bodies (E1) • Reserve Forest, Tribal Forest & Dense Forest (E2) • Slope Areas above 45°(E3)			
7.	Special Area (S)	• Heritage & Conservation Area (S1) • Govt. restricted Area, Defence (S2) • Other Uses(S3)			
8.	Recreational (P)	• Playgrounds, Stadiums (P1) • Public Open Spaces (P2)			
9.	Industrial (I)	• Service & Light Industry (I1)		• Service & Light Industry (I1) • Heavy Industry (I2)	• Service & Light Industry (I1)

III. M2 – HAZARD VULNERABILITY RISK ASSESSMENT (HVRA)

For the Tura Town, the Hazard Vulnerability and Risk Assessment (HVRA) project has been proposed to address various hazards, including landslides, floods, and lightning, and to assess both social and physical vulnerability and associated risks at local scale 1:4000 by using appropriate techniques based on the concerned hazard type.

In order to create a vulnerability map, account population vulnerability was considered by using demographic information of the Tura Town as well as building vulnerability considering socio-economic survey data with respect to the specific hazard. The risk was finally computed by incorporating the findings of each hazard and vulnerability evaluation.

Scope and Objectives: Undertaking a vulnerability and risk assessment in Tura town to evaluate the susceptibility of critical infrastructure, socio-economic, demographics, and vulnerable populations to identified hazards. The project has the following objectives**:**

1. Preparation/generation of Hazard/Susceptibility zonation to various hazards, namely, flood, landslide and thunderstorm/Lightning.

2. Assessment of building and population vulnerability using socio- economic and census data.

3. Assessment of associated risk with hazard/ susceptibility and preparation of technical report.

1. **Landslide Susceptibility:** From the *Figure 9* on the landslide susceptibility map, the study area was divided into four susceptible zones: "Very Low," "Low," "Moderate," and "High." The percentages of the total area found in each of these zones are as follows:

   Very Low Susceptibility Zone: This zone encompasses an area of 0.32 km² and holds the least likelihood of experiencing landslides. The "Very Low" susceptibility zone constitutes 0.84% of the total area. *Low Susceptibility Zone:* The zone labeled as "Low" susceptibility, spanning 10.38 km², signifies an area with a comparatively low risk of landslides. This zone comprises 27.17% of the total area under consideration. *Moderate Susceptibility Zone:* The "Moderate" susceptibility zone includes an area (23.20 km^2) with a moderate probability of landslides. The percentage of the total area in this zone is 60.70%. *High Susceptibility Zone:* The zone classified as "High" susceptibility, covering an area of 4.31 km², exhibits the greatest likelihood of experiencing landslides. This zone constitutes 11.29% of the total area under consideration.

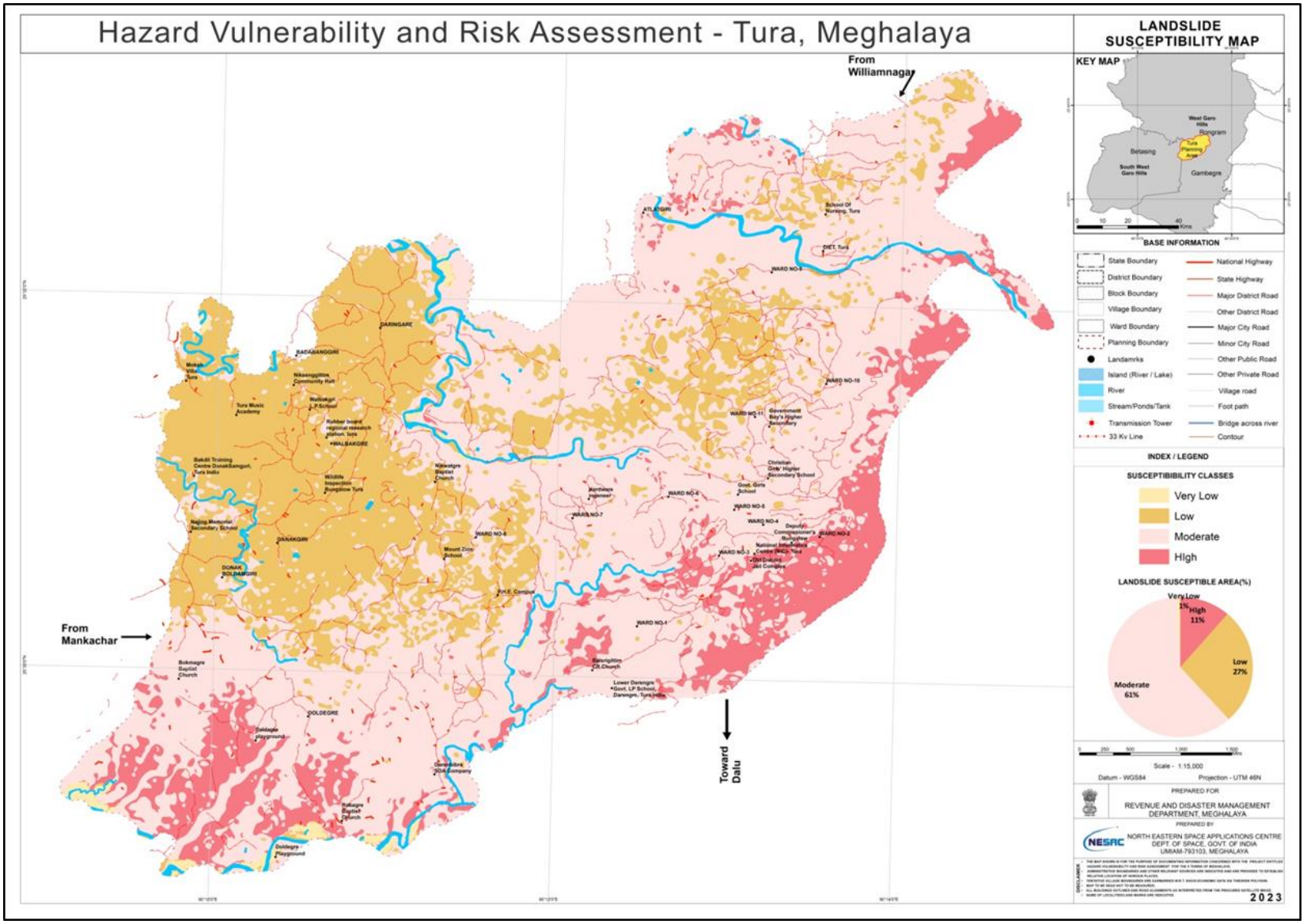

Figure 9-Lanslide Suitability Map

2. **Flood Hazard Zonation:** The flood inundation areas generated were classified according to Flood Hazard classes according to *Mihu-Pintilie et al. 2019 (Table 6).* The hazard map as shown in *Figure10.*

Table 6: Classification according to Mihu-Pintilie et al. 2019

Flood Hazard	Flood Depth (m)	Hazard Classes
H1	<1	Low
H2	1-2	Moderate
H3	2-5	High
H4	>5	Very High

3. **Lightning Hazard Zonation:** Meghalaya is one of the most lightning vulnerable areas in the NER regions. Meghalaya, being a region with diverse topography and climatic conditions, may experience varying degrees of lightning hazards. Tura, located in the West Garo Hills district, may be susceptible to lightning hazards due to its geographical and climatic conditions. Chandragiri, Danakgiri and Ringiri areas are most hazardous *(Figure11)*. The months of April, May and June are most vulnerable month for lightning hazard. Implementing lightning safety measures and raising awareness about lightning risks could be crucial for mitigating potential hazards in the area.
4. **Vulnerability Assessment:** Vulnerability is the risk caused by any natural and man-made hazard toward the community or substances. A community's vulnerability is determined by physical, social, economic, and environmental factors and location and hazard categories (UNISDR, 2017). These impacts are partly due to characteristics inherent in a community's social interactions, institutions, cultural values, and economic structure. The vulnerability zones are categorized into high, moderate, low and very low categories based on the degree of vulnerability. Hence, three hazards, e.g. landslides, floods and lightning, have been considered for the building vulnerability of the Tura town area.

   The study shows that 251.32 hectares (20%), 524.05 hectares (41%), 300.44 hectares (24%) and 188.48 (15%) of built-up areas are very low, low, moderately and highly vulnerable to landslides, respectively. It also found that 475.83 hectares (38%), 258.01 hectares (20%), 335.33 hectares (27%) and 195.12 (15%) of built-up areas are low, moderate, high and very highly vulnerable areas to flooding, respectively. Moreover, the study area is highly vulnerable to lightning, like other parts of Meghalaya. In this context, 193.25 hectares (15%) built-up is low, 81.18 (7%) moderate, 496.44 hectares (39%) is high, and 493.42 hectares (39%) are very highly vulnerable to lightning hazards. This socio-economic building vulnerability study will help the local authorities and other stakeholders identify the most vulnerable area in the planning. Figure 12 shows Landslide Building Vulnerability Map, Figure 13 shows Building Vulnerability for Flood Map, Figure 14 shows Building Vulnerability for Lightning Map and Figure 15 shows Population Vulnerability Map.

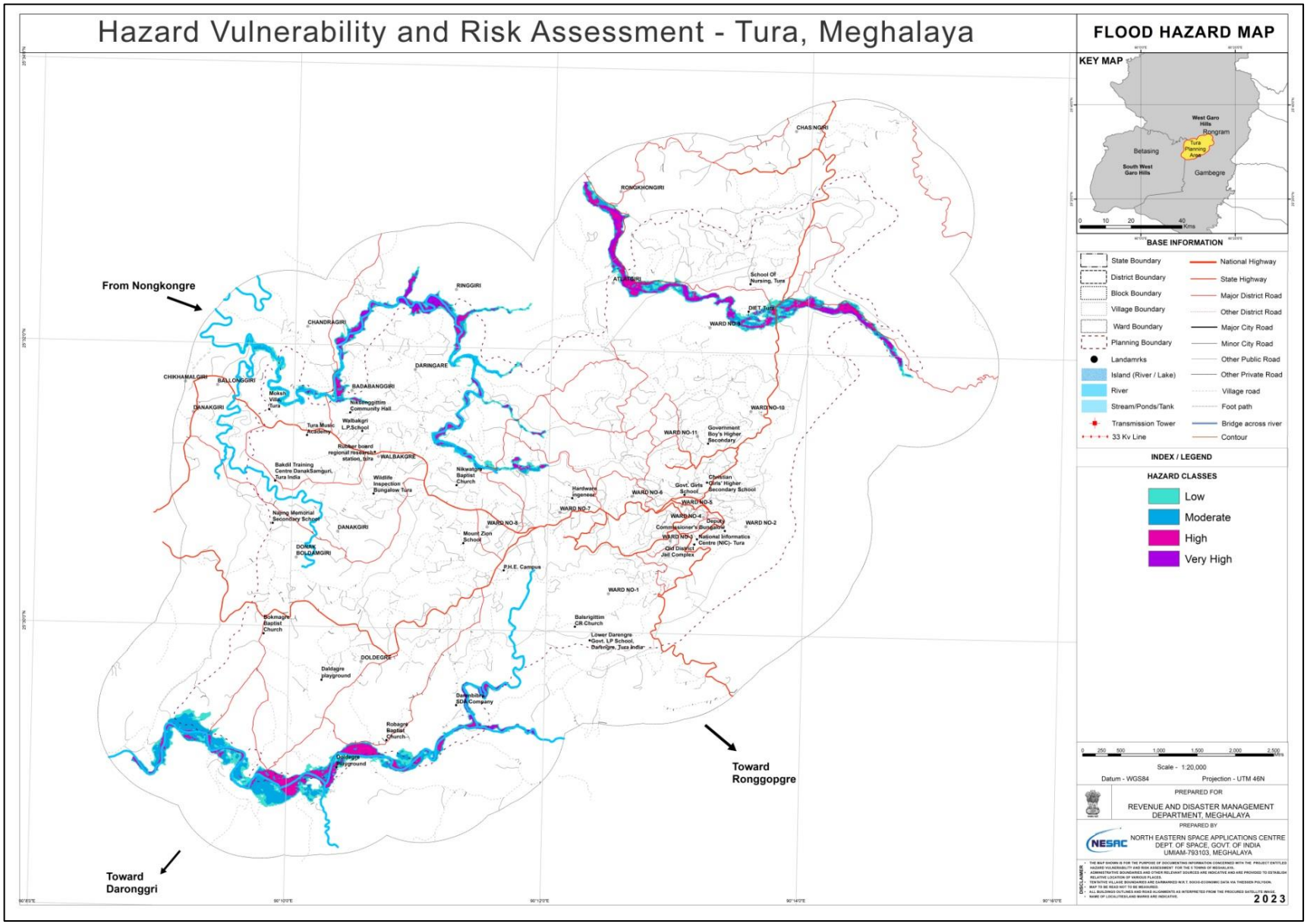

Figure 10-Flood Hazard Map

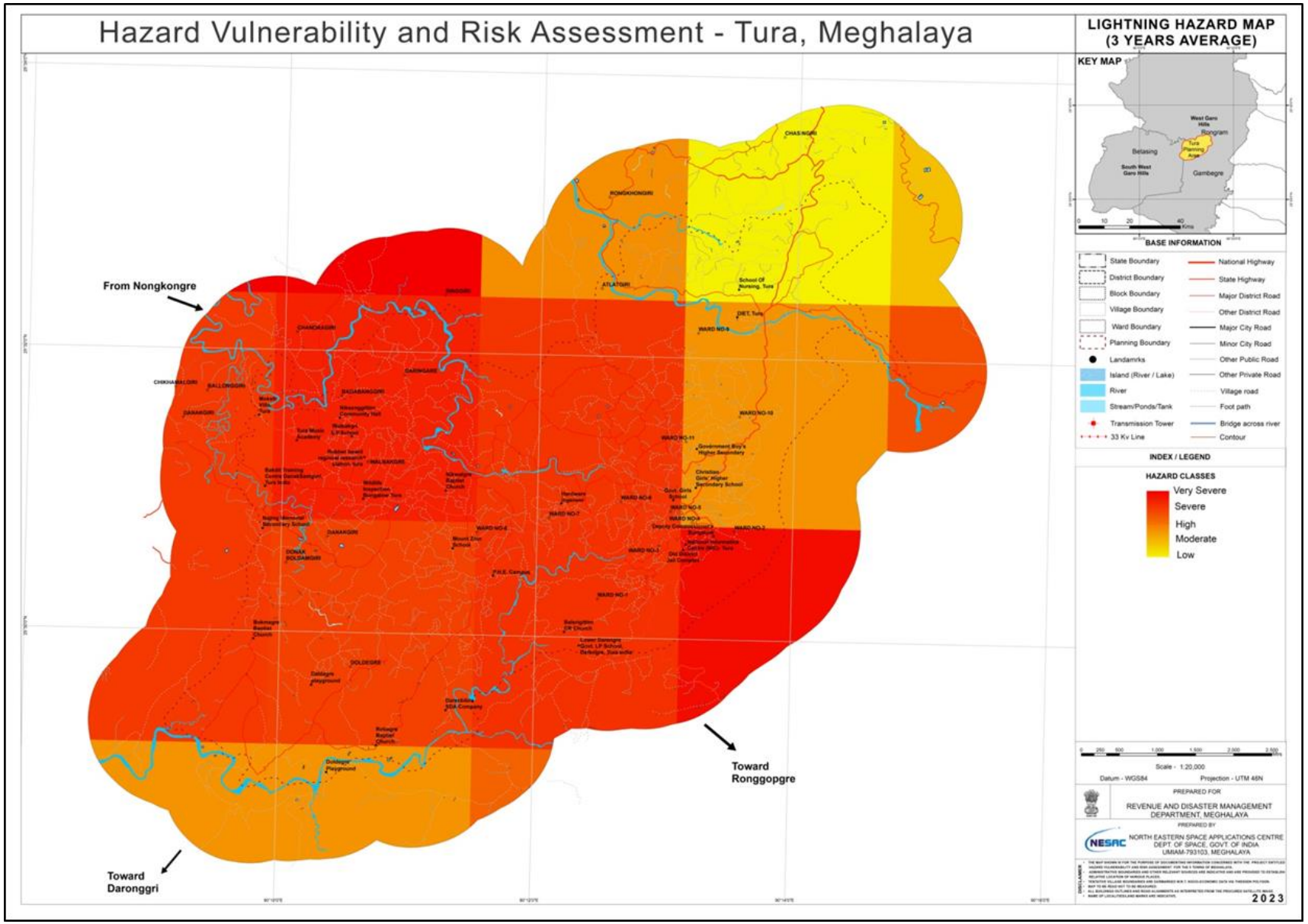

Figure 11-Lightning Hazard Zonation Map

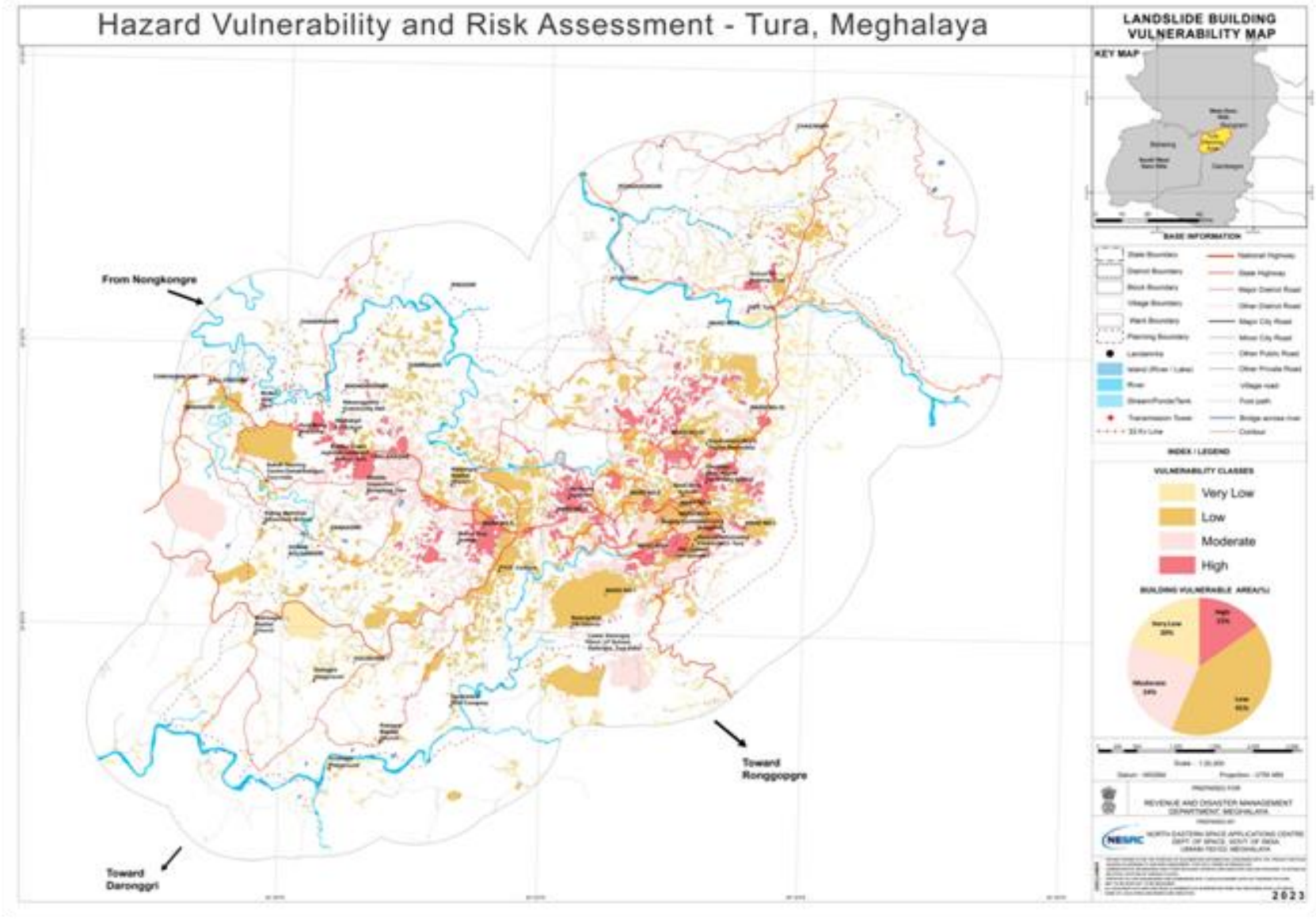

Figure 12-Landslide Building Vulnerability Map

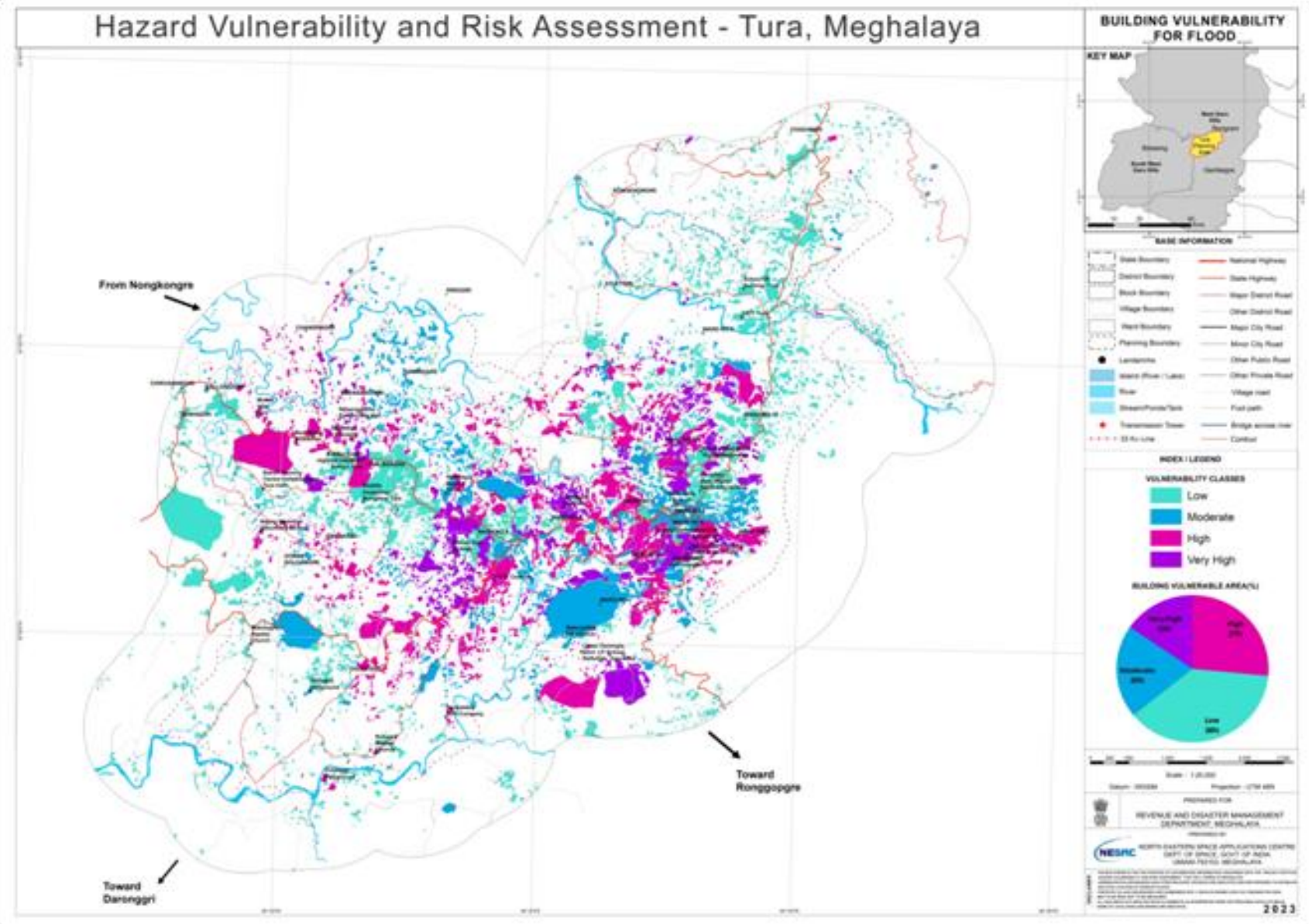

Figure 13-Building Vulnerability for Flood Map

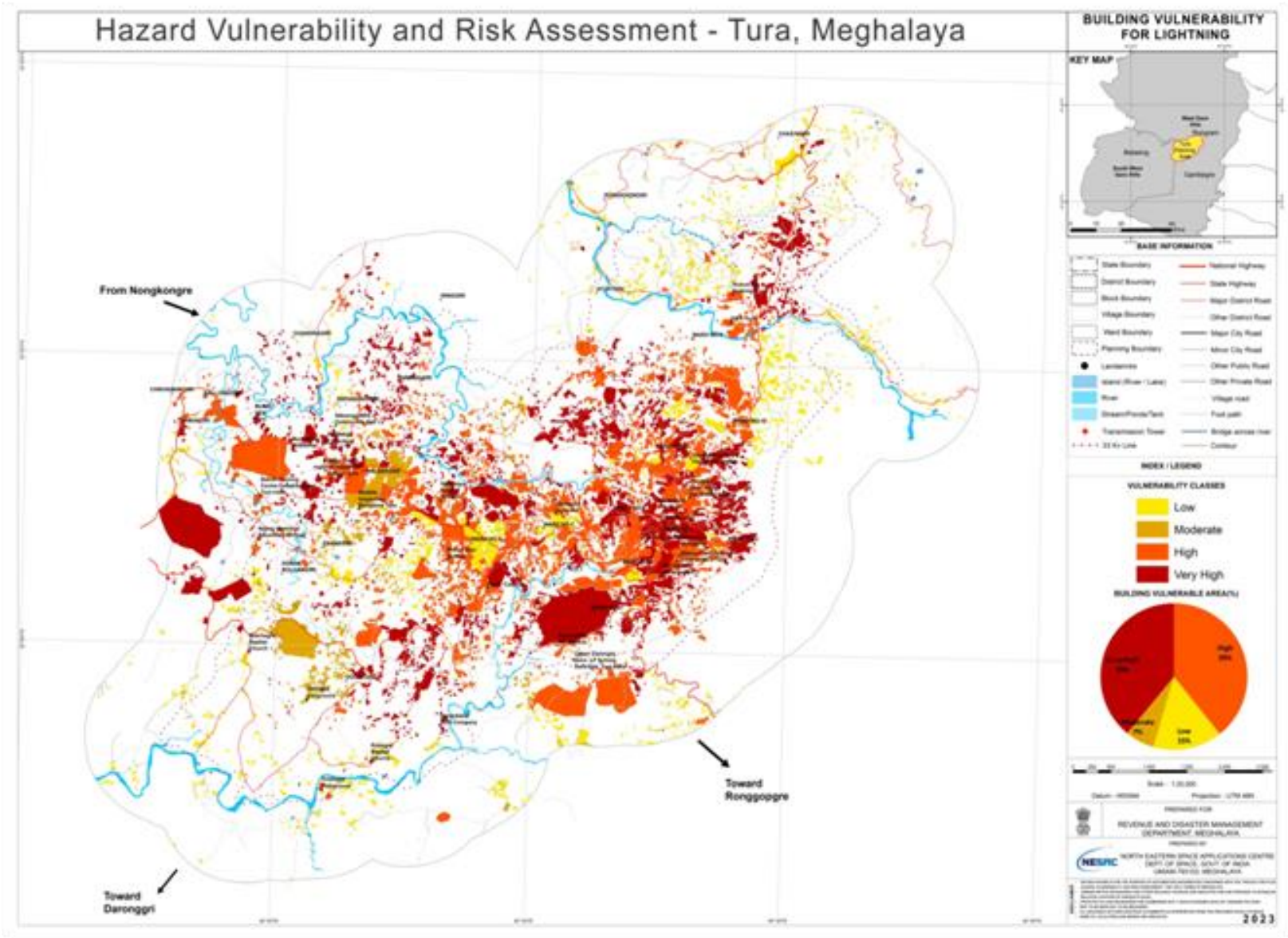

Figure 14-Building Vulnerability for Lightning Map

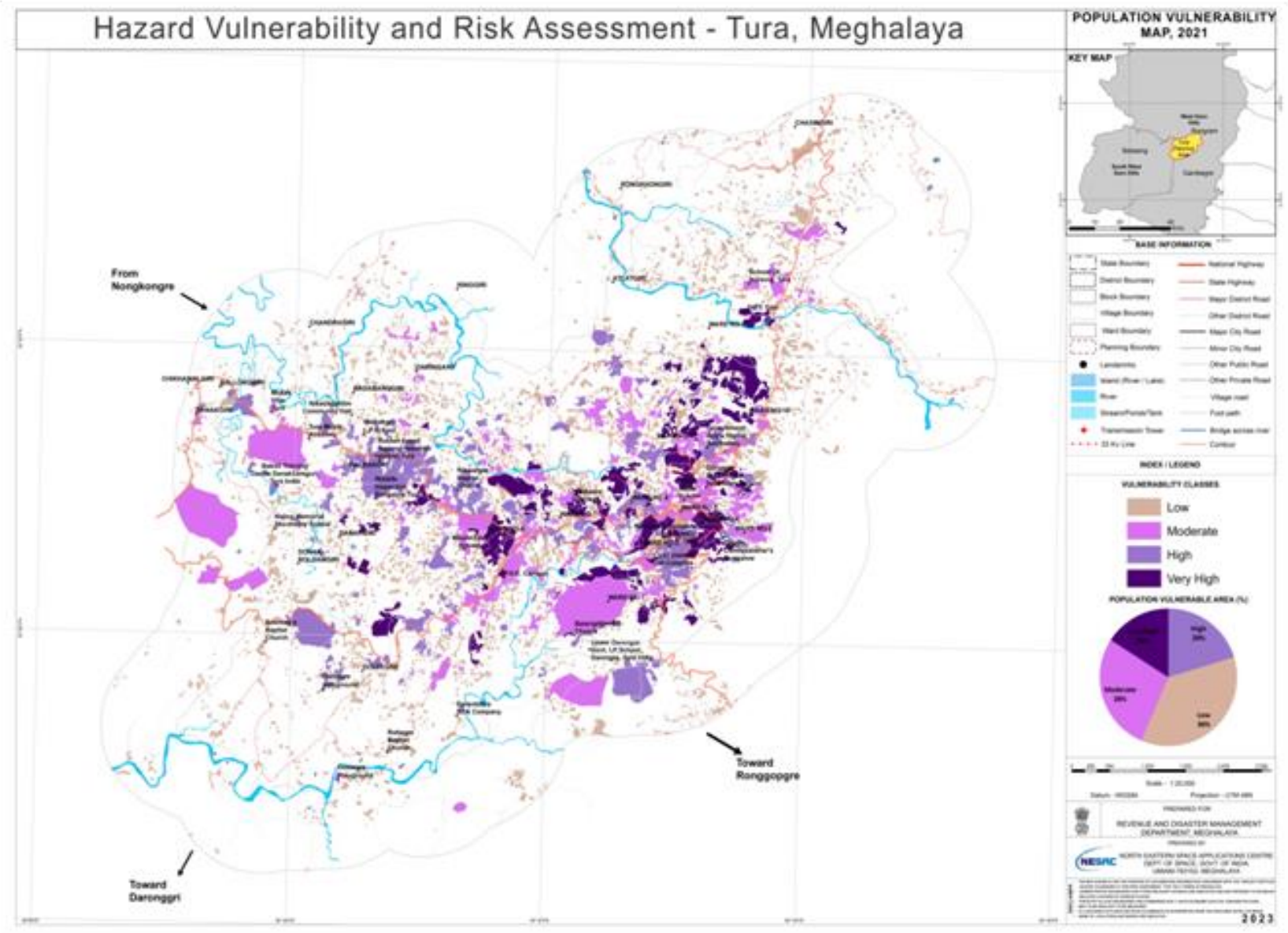

Figure 15-Population Vulnerability Map

5. **Risk Assessment:** ***Risk = Hazard x Element at Risk x Vulnerability*****;** the geographical representations of vulnerability and hazard zones are the foundation for risk estimation. Detail on the factors at risk, such as buildings, the economy, and the population, is needed to assess an area's risk in connection to a certain hazard. Hazard risk assessment requires specific building information based on location, building type, number of floors, construction, roof, etc. Based on the kind and density of the building structure/footprint determined from high-resolution satellite images with ground truth and census data, this data was obtained from field data collected in various areas.

   MCDA technique has been used for multi hazard risk assessment of Tura planning area after integrating hazard with vulnerability layers. Tura is very low to highly vulnerable to landslide risk *(Figure16)*. It is inferred that about 54.95 hectares (4%), 134.32 hectares (11%), 346.87 hectares (27%) and 727.58 hectares (58%) of the area came under the study area's high, moderate, low and very low-risk zone. In case of flood risk, the planning area lies in a very low-risk zone due to its topographical structure. Flood risk assessment *(Figure 17)* of Tura planning area depicts that only 22.63 hectares (2%) area comes under high risk zone and 1218.81 hectares (96%) is coming under low risk zone. However, from the local information, it is observed that flash floods inundated the urban area, and the flood lasted less than 30 minutes. Lightning risk *(Figure 18)* evaluation reveals that 349.87 hectares (28%), 683.36 hectares (54%), 210.60 hectares (17%)

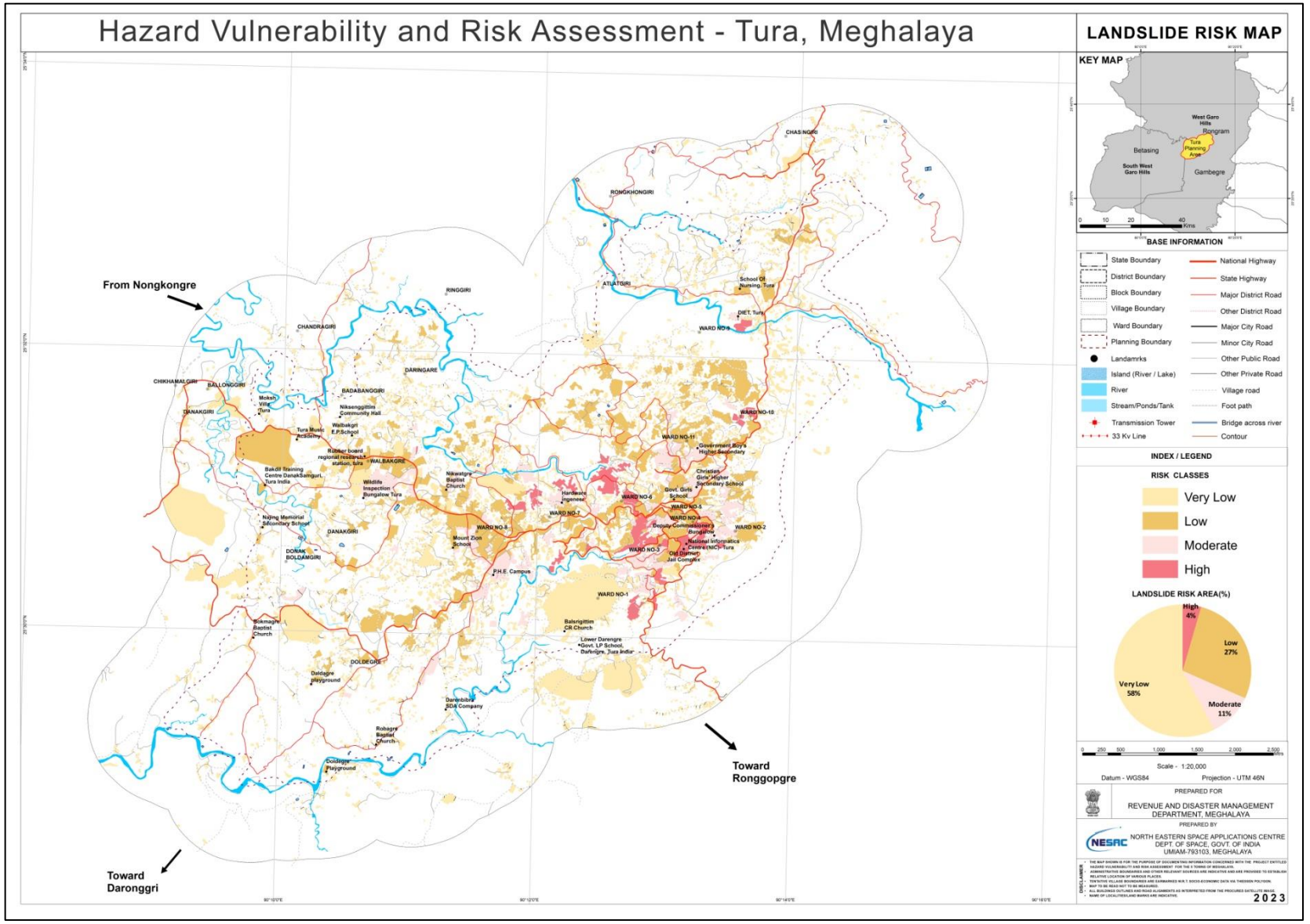

Figure 16-Landslide Risk Map

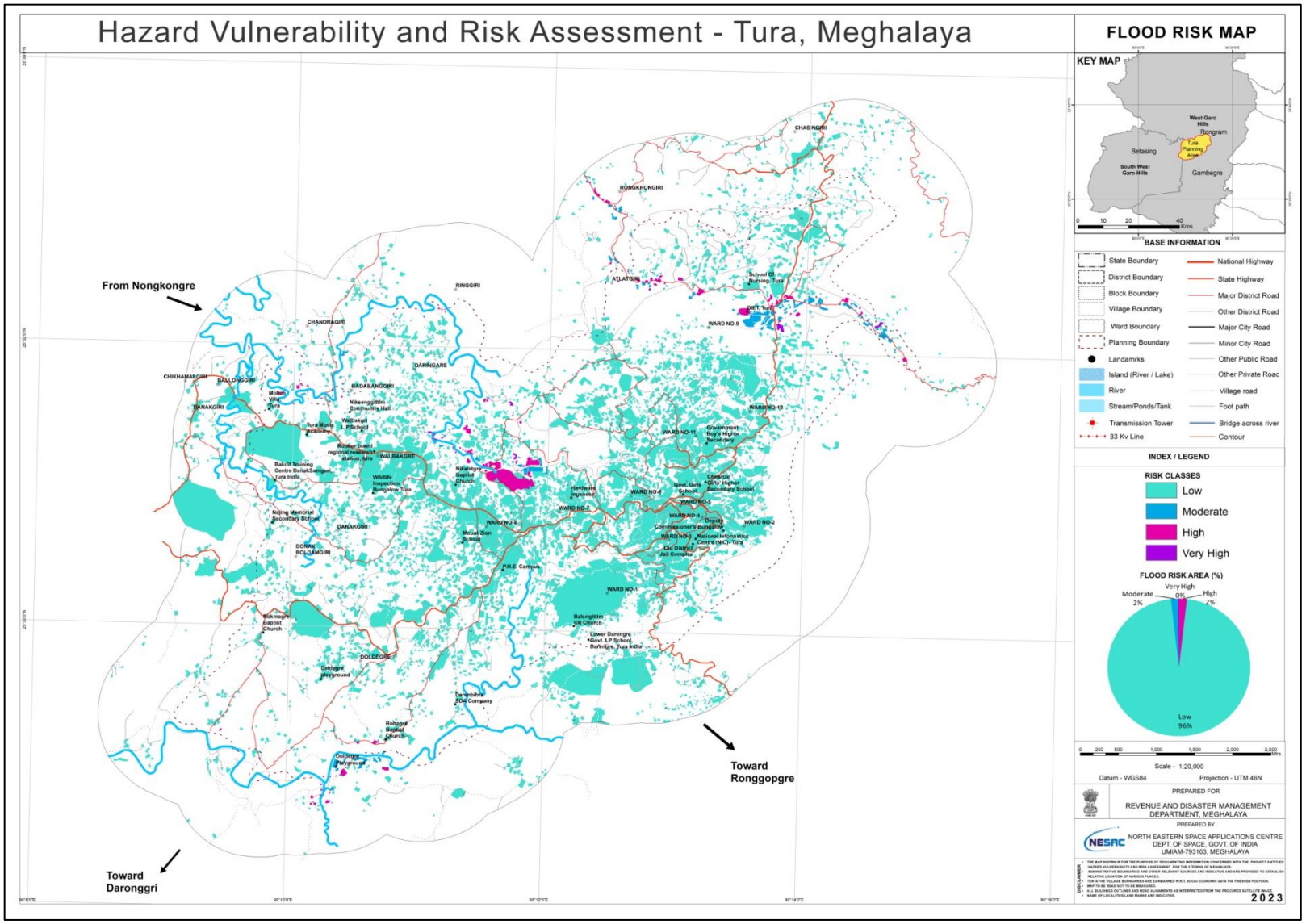

Figure 17-Flood Risk Assessment Map

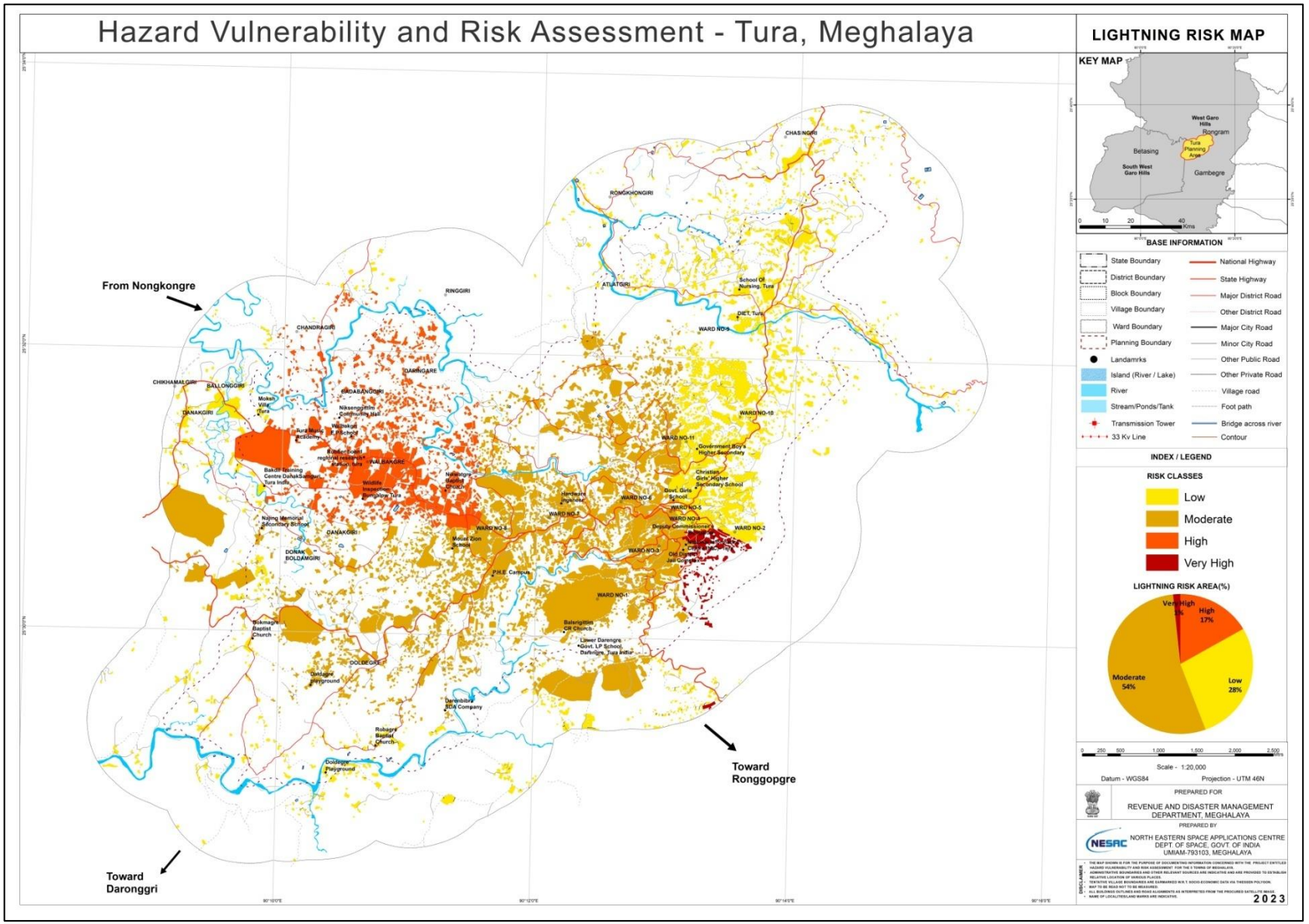

Figure 18-Lightning Risk Map

IV. SLOPE ANALYSIS

The Tura Planning Area, covering 54.65 sq. km, exhibits diverse slopes ranging from gentle to rugged, with a dataset (Table 1 and Figure 1) detailing slope categories and corresponding spatial extents. This topographical complexity poses challenges and opportunities for land use planning. The dataset, crucial for suitability assessments, factors in slope and elevation (Figure 2) as natural limited factors, with varying weightages for different land use classes in the Master Plan. In hilly and valley regions (Figure 4), aspect (Figure 5), or the compass direction a slope faces, plays a significant role. Different aspects influence sunlight exposure, temperature variations, and water drainage patterns. South-facing slopes receive more direct sunlight, affecting vegetation types, while north-facing slopes may experience cooler conditions. Valleys, with varying orientations, impact microclimates and water flow. Understanding slope aspect is vital in land use planning, guiding decisions related to agriculture, forestry, urban development, and conservation efforts in these diverse landscapes. In hilly and valley regions (Figure 4), aspect (Figure 5), or the compass direction a slope faces, plays a significant role. Different aspects influence sunlight exposure, temperature variations, and water drainage patterns. South-facing slopes receive more direct sunlight, affecting vegetation types, while north-facing slopes may experience cooler conditions. Valleys, with varying orientations, impact microclimates and water flow. Understanding slope aspect is vital in land use planning, guiding decisions related to agriculture, forestry, urban development, and conservation efforts in these diverse landscapes.

Table 1: Categories of Slope

Slope (Deg)	Area (Sq. Km.)
<5	7.02
5 -15	21.12
15 – 30	9.8
30 – 45	0.6
>45	0.004
Total Planning Area	**38.58**

In this hilly area, the topography unfolds across various slopes, challenges and opportunities for land use and planning. The region comprises gentle slopes of less than 5 degrees, expansive spaces of 5-15 degree slopes, and areas with more pronounced elevation changes ranging from 15 to 30 degrees. The terrain becomes even more complex with slopes of 30-45 degrees, while the most rugged slopes exceeding 45 degrees occupy a smaller yet distinct portion.

RISK INFORMED MASTERPLAN FOR TURA PLANNING AREA
SLOPE MAP

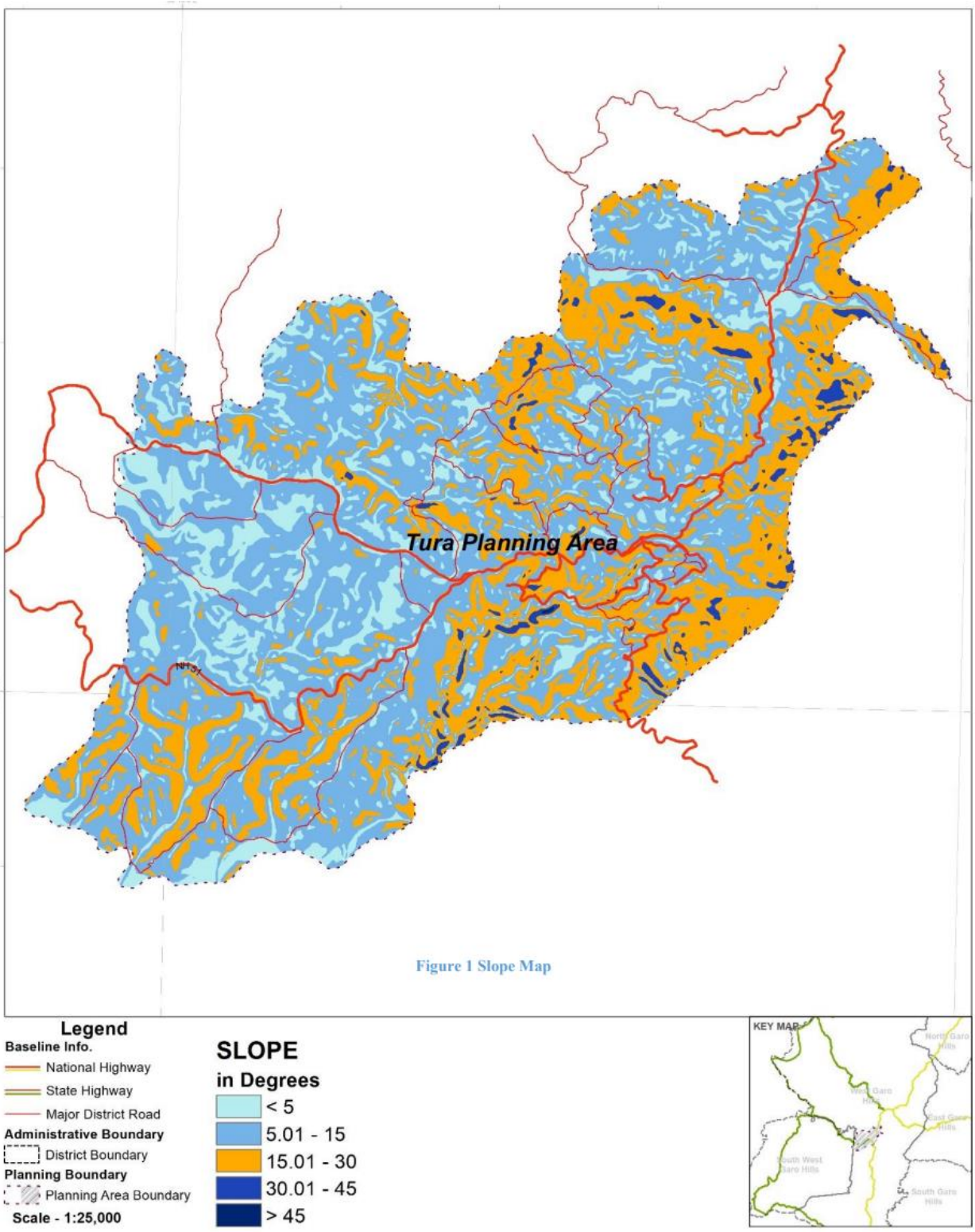

Figure 1 Slope Map

RISK INFORMED MASTERPLAN FOR TURA PLANNING AREA
ELEVATION

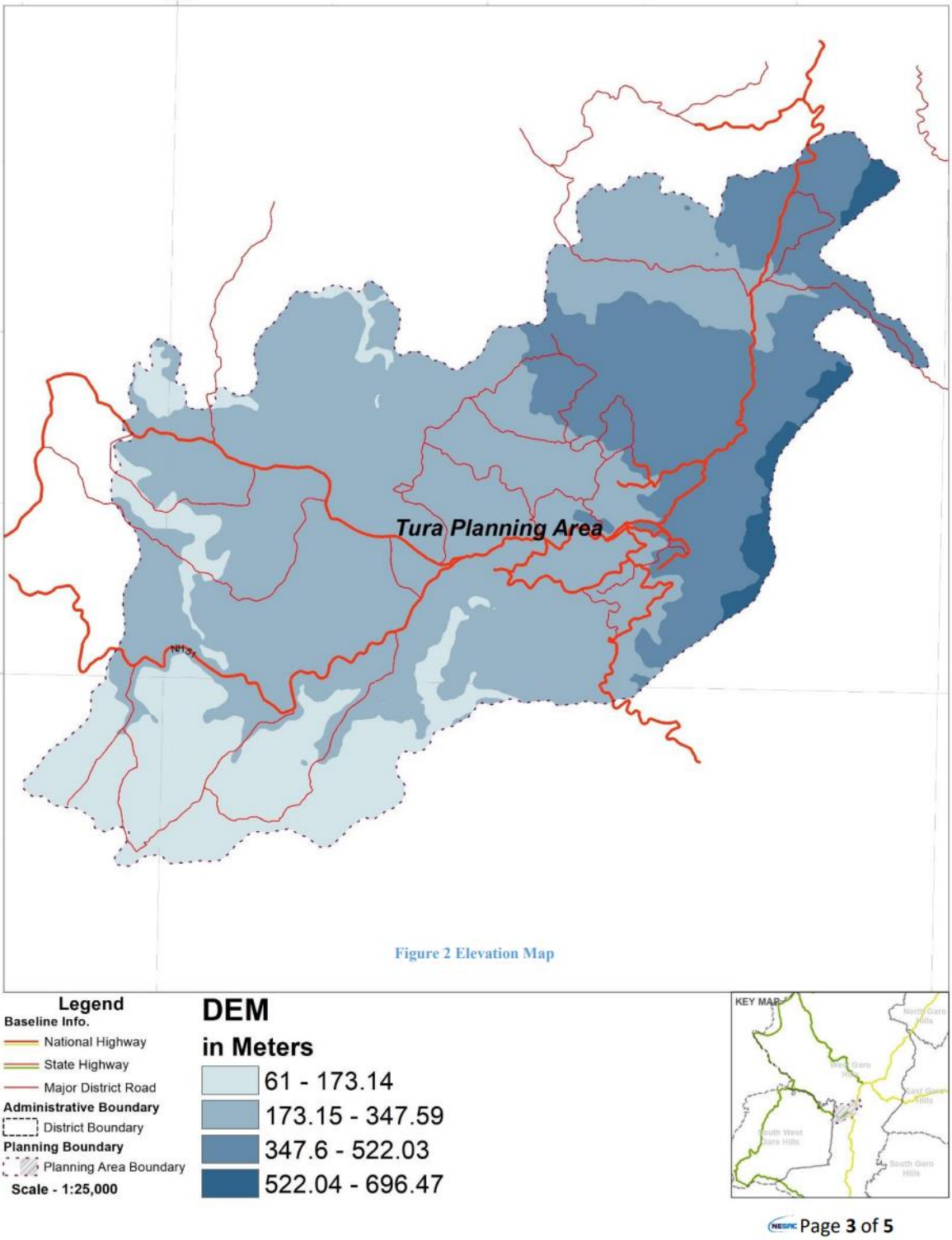

Figure 2 Elevation Map

RISK INFORMED MASTERPLAN FOR TURA PLANNING AREA
ASPECT

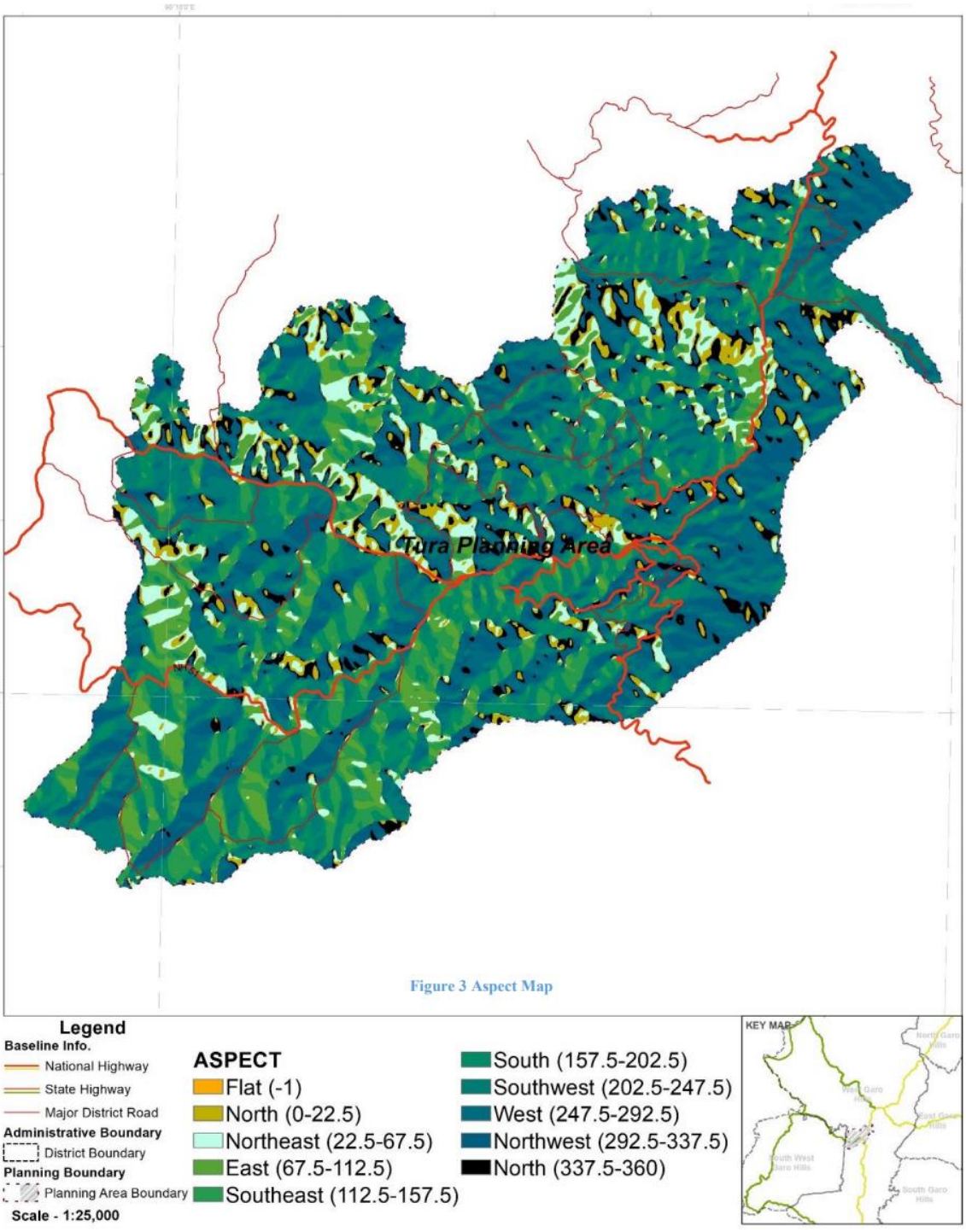

Figure 3 Aspect Map

RISK INFORMED MASTERPLAN FOR TURA PLANNING AREA
HILLY AND VALLEY REGIONS

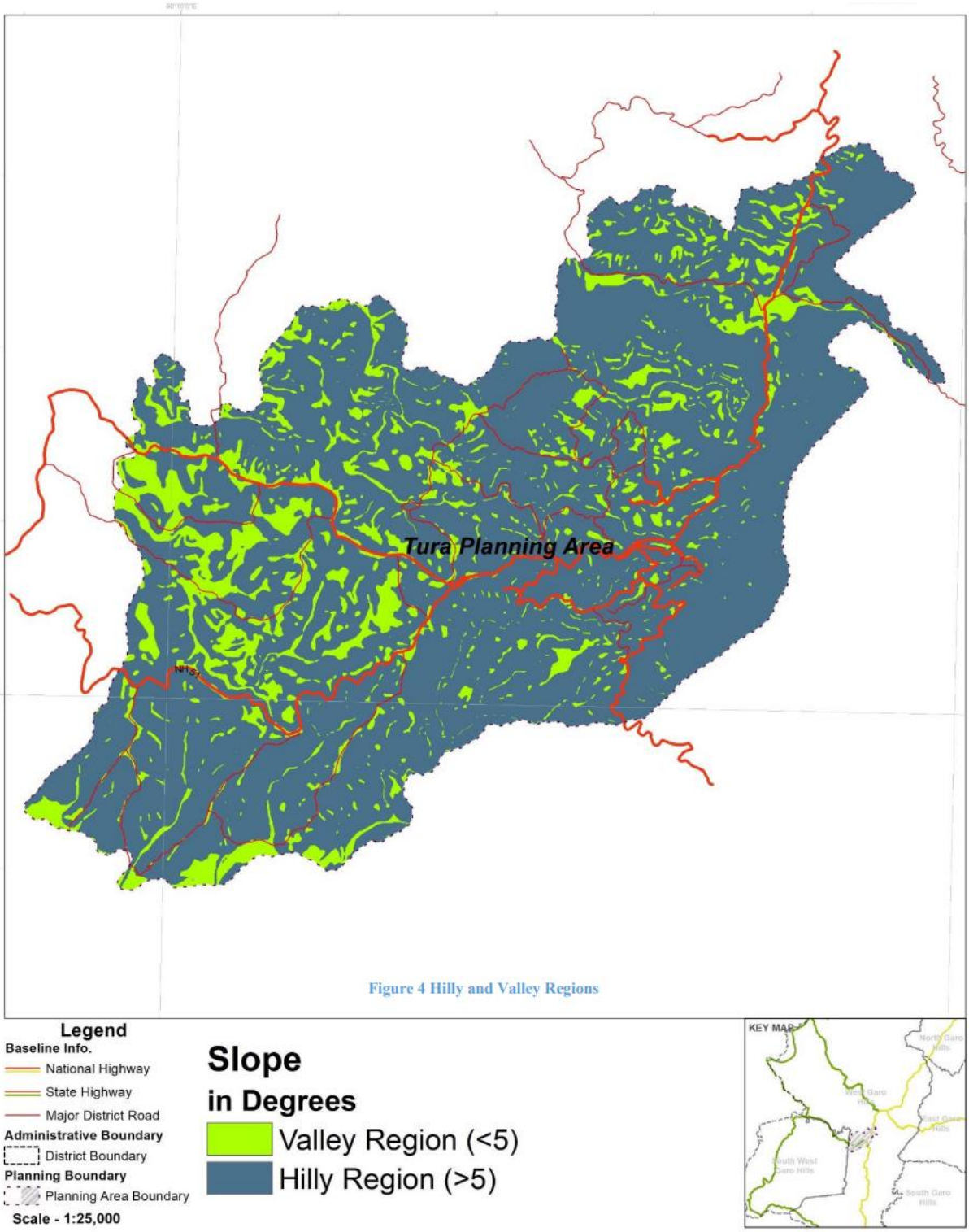

Figure 4 Hilly and Valley Regions

V. M3 – PREPARATION OF CONTOUR BASED MAP, MAPPING OF VULNERABLE AREAS AND MITIGATION PLAN

This particular section is under process for being initiated on finalization of Risk Assessment Aspect. It will include as follows:

1) Mapping of Low/Risk Areas on the analysis carried out and Preparation of Contour Based Drainage Plan

2) Include Disaster Risk Reduction element in Master Plan

a) Hazard mitigation measures should not only be infrastructure-related. They can include community level communication, preparedness planning, and other non-structural measures.

b) Whenever possible, mitigation measures should work to mimic natural processes rather than engineered solution.

c) The safety of vulnerable communities related to natural hazard risks and other factors should receive particular attention in the comprehensive plan.

d) Hazard mitigation is to be integrated throughout the plan elements.

e) Land Use: Establish land-use policies that discourage development or redevelopment within natural hazard prone areas. Provide adequate space for expected future growth in areas located outside natural hazard areas. The goals and objectives of land use plans should reflect risk analysis and translate them into the planned specific

f) Transportation: Provide adequate connections within and between different zones. Ensure road layouts and connections support response requirements for emergency services.

g) Conservation/Resource Protection: Identify areas that are community and natural assets and also that, when protected or restricted to development, would reduce risk to natural hazards. For example, avoiding development in wetlands provides a tangible resource to the community while also reducing exposure of people and structures to flood.

h) Economic Development: Communicate the short- and long-term economic benefits of planning for hazards and developing resilient communities (e.g., lower long-term infrastructure repair costs). Evaluate whether economic development policies promote commercial or industrial expansion in areas vulnerable to hazards.

i) Public Facilities: Identify appropriate locations for all public facilities, but especially critical facilities whose continued operation is essential during or following a major hazard event. For example, police and fire stations, disaster management offices, hospitals, water treatment plants, and community centers are important facilities that should not be located in hazardous areas.

j) Housing: Ensuring that the location and design of new or improved housing complies not only

with existing building codes, but with potential hazards in mind. Identify opportunities to strengthen or replace structures identified as vulnerable to hazards. Consider whether a disproportionate amount of affordable housing is located within known hazard areas. Address the challenges communities face in locating dense residential areas away from hazards.

3) Land Use Zoning and Development Control Regulations

To include the following:

a) Effective measures and building regulations are to be proposed for flood plain areas to regulate unplanned growth and preventing encroachment in the waterways.

b) Regulation of Landuse and building regulations in landslide susceptible areas, earthquake susceptible areas, Cyclone prone areas etc,

c) Sponge City approach to come up with strategies to guide the urban water management coordinating the relationship between the multi-water cycle, land use and the rainwater system to enhance urban sustainability. To involves the integration of different scales of green water infrastructures, expanding the strategy of low Impact Development.

d) Incentives: To come up with effective strategies for enhancing relationships with the development community, guiding growth and development to desirable areas, and encouraging compliance with community objectives without additional regulation. Incentives can come in the shape of financial savings, increased density, relaxation of regulations, expedited review processes, or waivers of either fees or regulations altogether.

4) Implementation Stage-

To include the following:

a) Role of different Stakeholders of Govt. Authorities in line with State Disaster Management Act.

b) Resource Mobilisation.

c) Monitoring & Review.