

Gaps and Challenges in Addressing the Societal Impact of Climate Variability and Climate Change in the Indian Coastal Metropolitan City due to Interactions with Complex Ocean and Atmospheric Processes: An Example of Bridging Science and Society in Southeast and Beyond

ABSTRACT

Vulnerability of coastal communities through interactions with complex ocean and atmospheric processes at various temporal and spatial scales is a major issue, which has gained attention recently. Changed frequencies and intensities of compound events, combined with marine heatwaves and sea level rise and extremes, are expected to have mostly adverse effects on coastal society. Coastal communities are highly vulnerable to climate change, mainly because of three reasons, high resource dependency, high exposure and limited adaptive capacity. A study on 136 coastal cities showed that cities in east and south east-asia would face increase in exposure of population and assets to coastal flooding. A wide number of often-conflicting human socio-economic activities occur in these areas. These include urbanization, fisheries, tourism, industrial and energy production and delivering, and agriculture. Human activities often struggle with the need to preserve natural ocean systems and their ecological processes. Coastal areas are categorized as one of the areas that are predominantly exposed to current and projected climate risks associated with climate change due to interactions with complex ocean and atmospheric processes. In the perspective of climate change, urbanized and infrastructured coastal areas are of specific concern since they can drastically limit and even impede natural adaptive processes. The proposed methodology is considered as a decision support tool, which helps the decision-makers to detect the vulnerability degree of any areas exposed to climate variability and change based on the parameter to give the priority for climate proofing infrastructure. This study concludes that the rudimentary measures, which are needed just to address societal impact of climate variability and climate change in the coastal community due to interactions with ocean and atmospheric processes, are necessary as a stepping stone to transformative pathways for addressing the gaps and challenges for bridging science and society in southeast Asia and beyond.

Keywords: Coastal metropolitan city, Societal impact, Climate variability and change, Interactions of ocean and atmosphere, Vulnerability assessment, Sea level extremes

INTRODUCTION

- Vulnerability Coastal areas face **numerous threats and stresses** associated to sea level rise and variability.
- India has a 7,517 km elongated shoreline with numerous low-lying and densely inhabited areas with **approximately 260 million people living within 50 km of the coastline**.
- The upsurge in sea level in the north of the Indian Ocean has been witnessed to fall in the range of 1.06 - 1.75 mm per year in the earlier century.
- It discusses on application of ocean-based approaches for climate adaptation strategies and building coastal resilience for the coastal communities in the Visakhapatnam **metropolitan city of India**.
- It calls for policy and institutional reforms, capacity building, and improved knowledge management to ensure effective, equitable, and **safe ocean-based approaches that boost coastal communities' resilience to Human-Induced Climate Change**.
- The city is facing **long-term threats** in terms of sea-level rise.

- The city is located on the eastern coast of India, which is particularly **vulnerable to human-induced climate change events**.
- The city has experienced **high population increase and rapid industrialization** with the growth of major industries like steel, petroleum refining, and fertilizer.
- Visakhapatnam is among the port cities with **high exposure and vulnerability to climate extremes globally**.

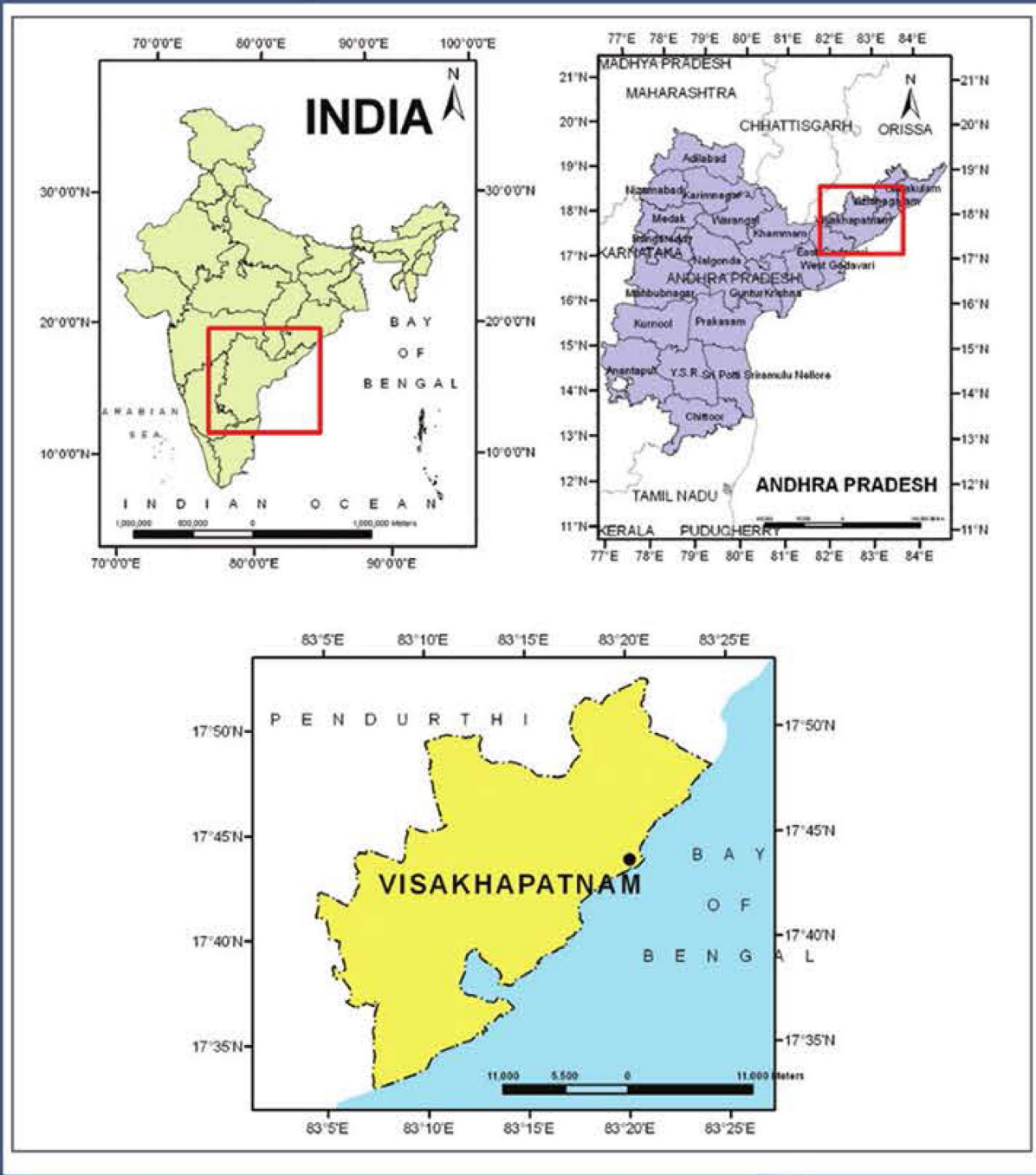


Figure 1: Location map of coastal city of Visakhapatnam

DATA AND METHODS

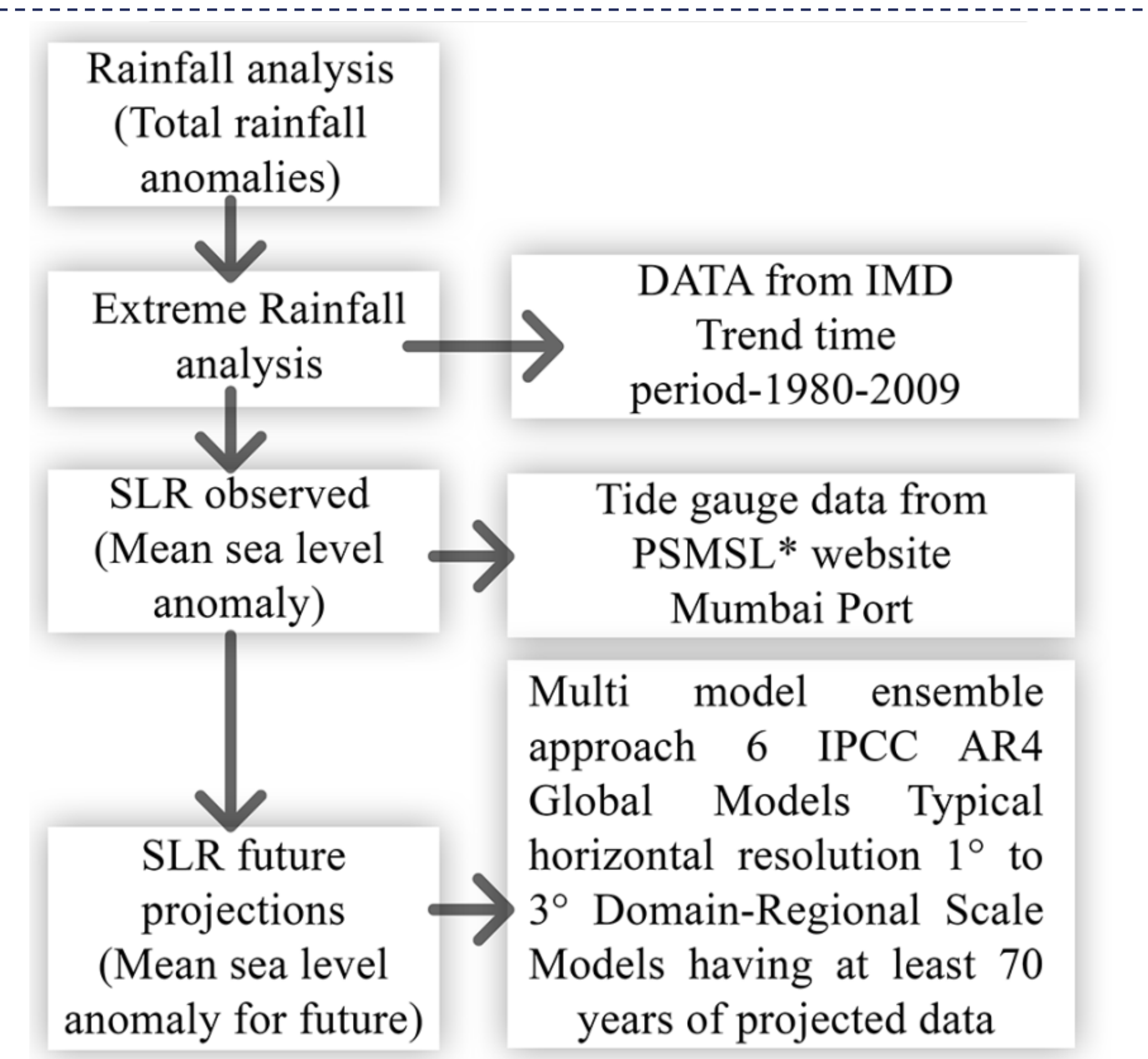


Figure 2: Methodology for climate analysis

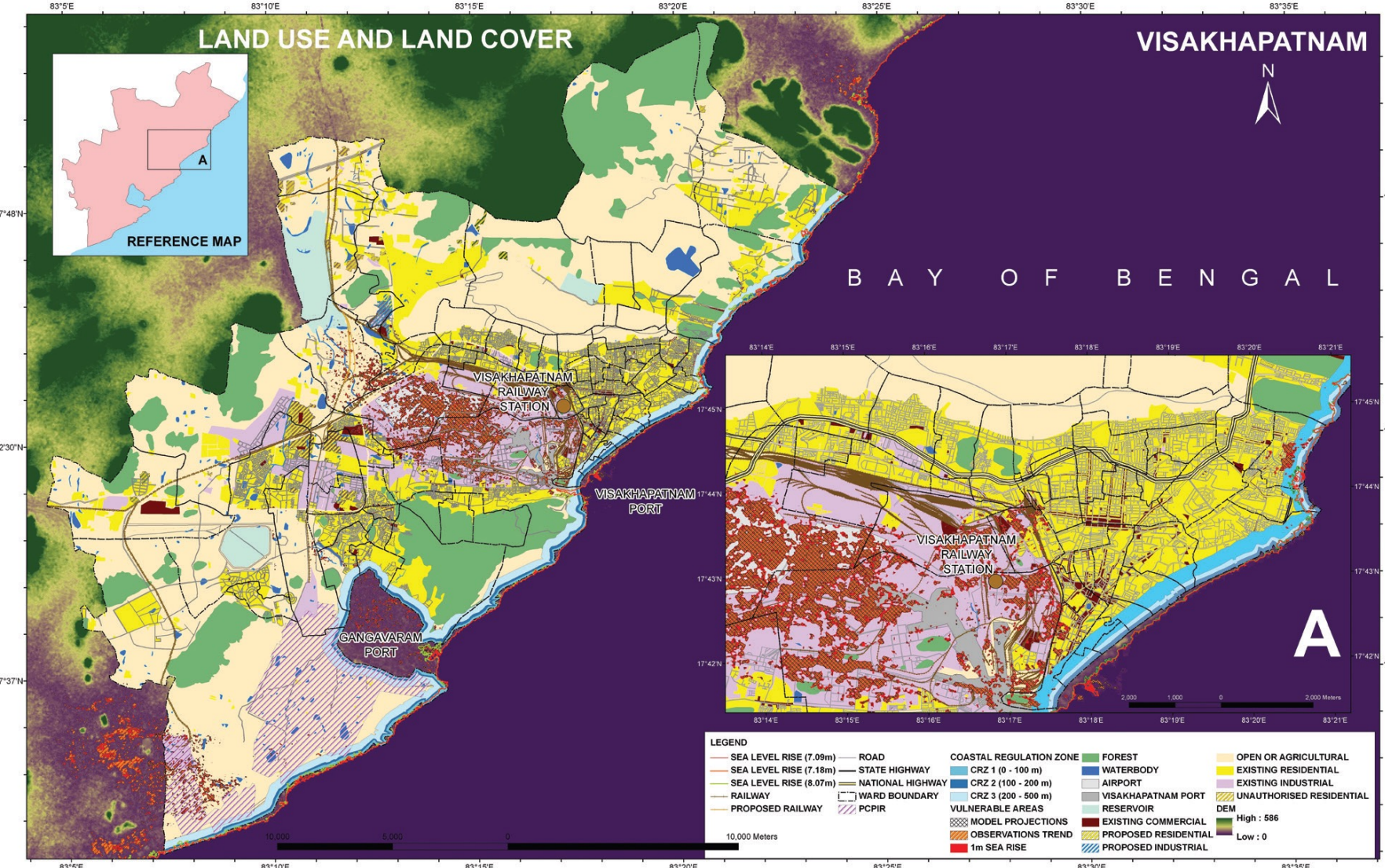


Figure 5: Exposure of Visakhapatnam under SLR scenario

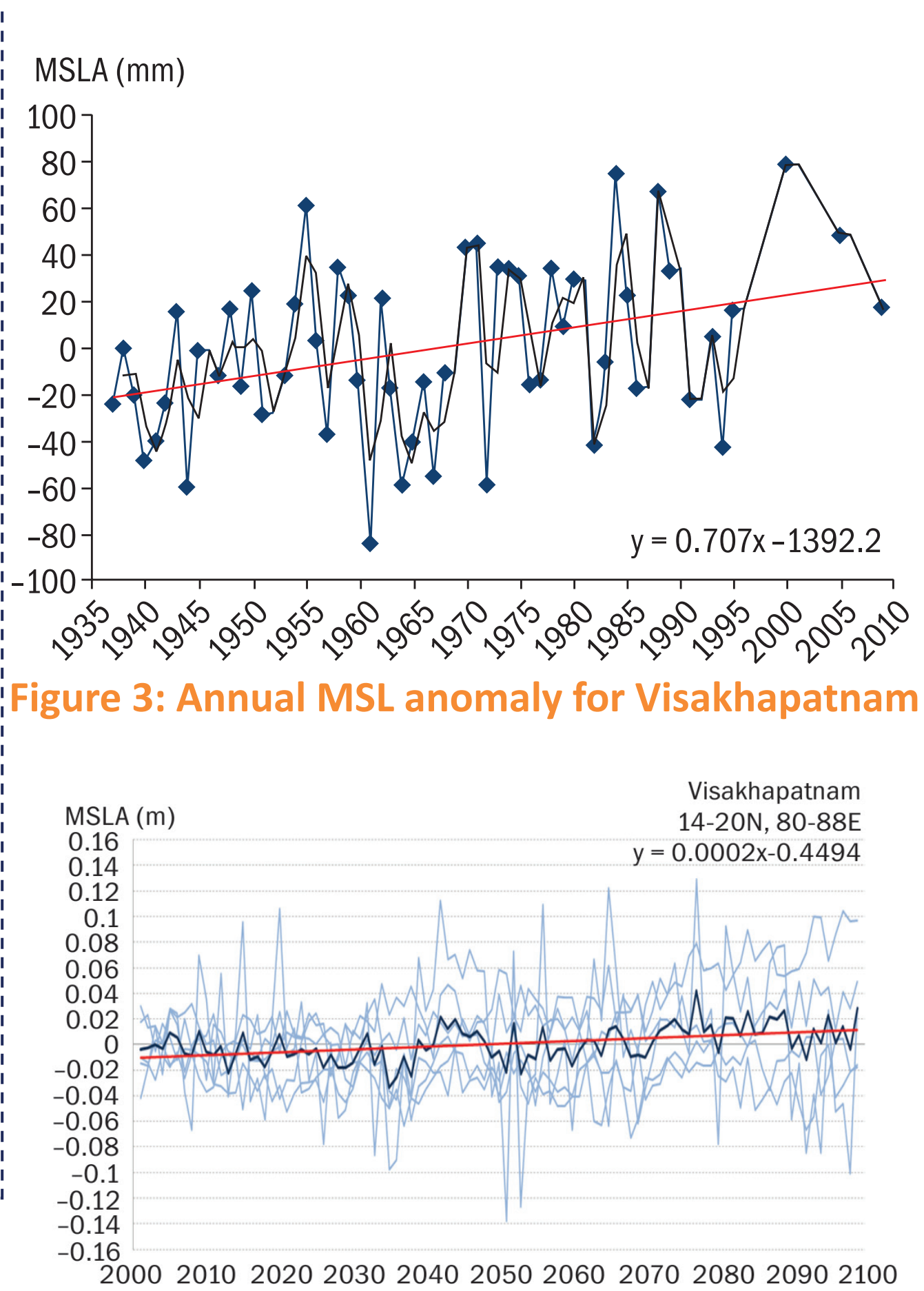


Figure 3: Annual MSL anomaly for Visakhapatnam

- This study particularly looks at SLR and extreme weather events as a **component of climate change** and how it affects the infrastructure and services of the city.
- Sea-level rise coupled with extreme events like cyclones and storm surges or rainfall extremes **will lead to** inundation, water logging, and floods in the city.
- Identification of hotspots, areas and assets that are likely to be affected under different SLR scenarios, **providing a concise spatial exposure profile** for the city.
- Ward nos. 5–7, 17, 18, 25, 26, 31, 42–46, 50–53, 55, 61, 65–68 were found to be **partially vulnerable**.

Figure 4: Projected sea level anomaly for Visakhapatnam

DATA AND METHODS

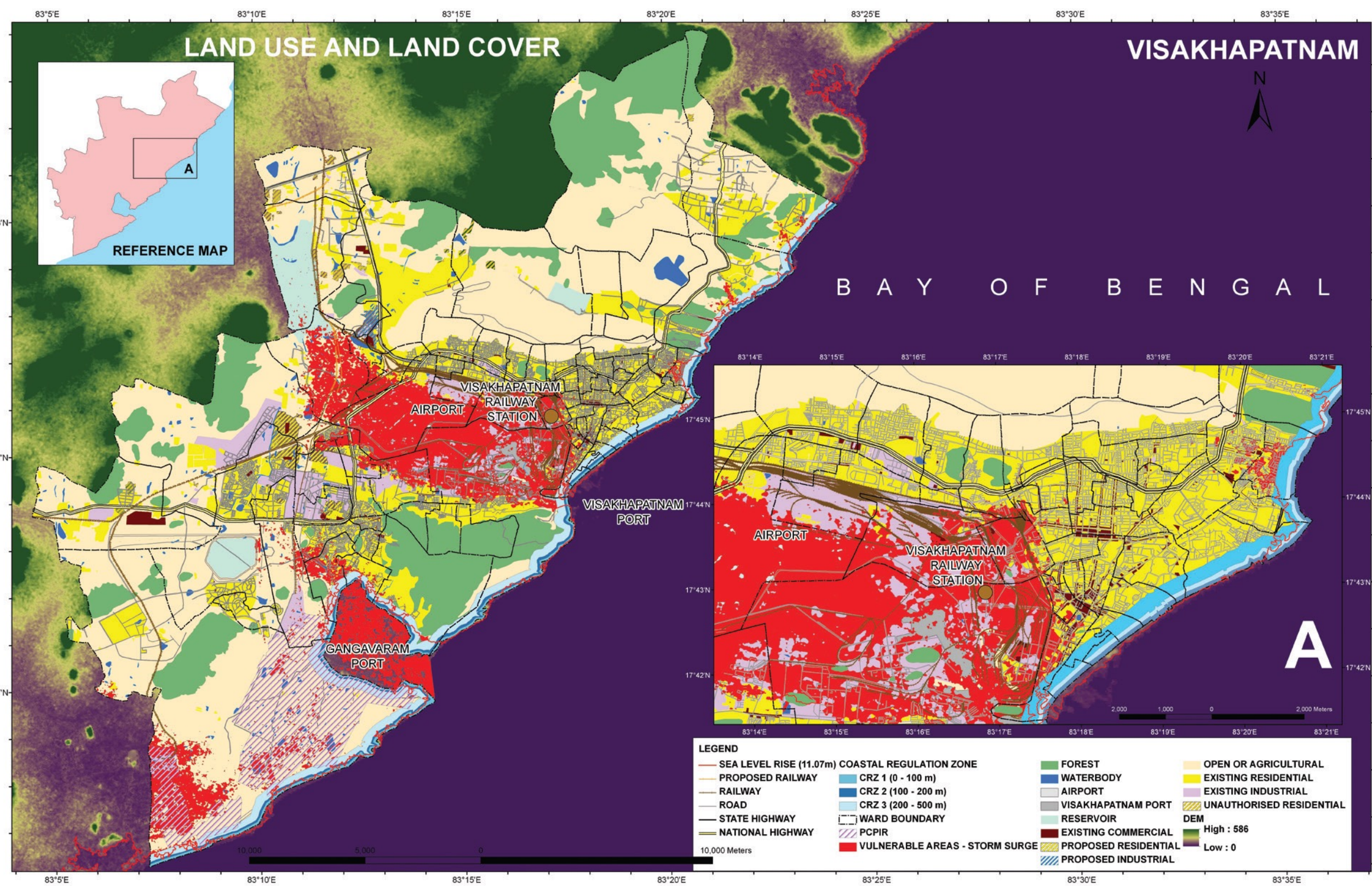


Figure 6: Exposure of Visakhapatnam under storm surge scenario

- In case of an extreme event, depending upon wind speeds and resulting storm surge heights, **further inland areas may be affected**.
- As per the vulnerability map, **the impact of storm surge** may be felt as far inland as Gopalapatnam in the north and Srinagar, Sramikanagar in the south.

DISCUSSION

Critical infrastructures identified for adaptation and mitigation strategies are as follows:

- Social infrastructure:** Some specific locations have been identified, where the **hospitals and schools** will be affected by **flooding either due to extreme rainfall or SLR**.
- Energy and telecommunication:** The power supply network, electric substations, petrol pumps, telecommunication lines, and cell phone towers have been mapped and identified in the vulnerable zones.
- Transport:** Vulnerable transport infrastructure including roads, airport, and railway has been mapped.
- Industries:** Major industrial area of the city falls under the vulnerable zone which has been mapped.
- Buildings:** Buildings in some of the residential areas that have been found within the vulnerable zone.
- Heritage and tourism:** These are the temples and churches that fall under the vulnerable zone.
- Sewerage and drainage:** This includes sewerage treatment plants, pumping stations, and surface and underground storm water drains.

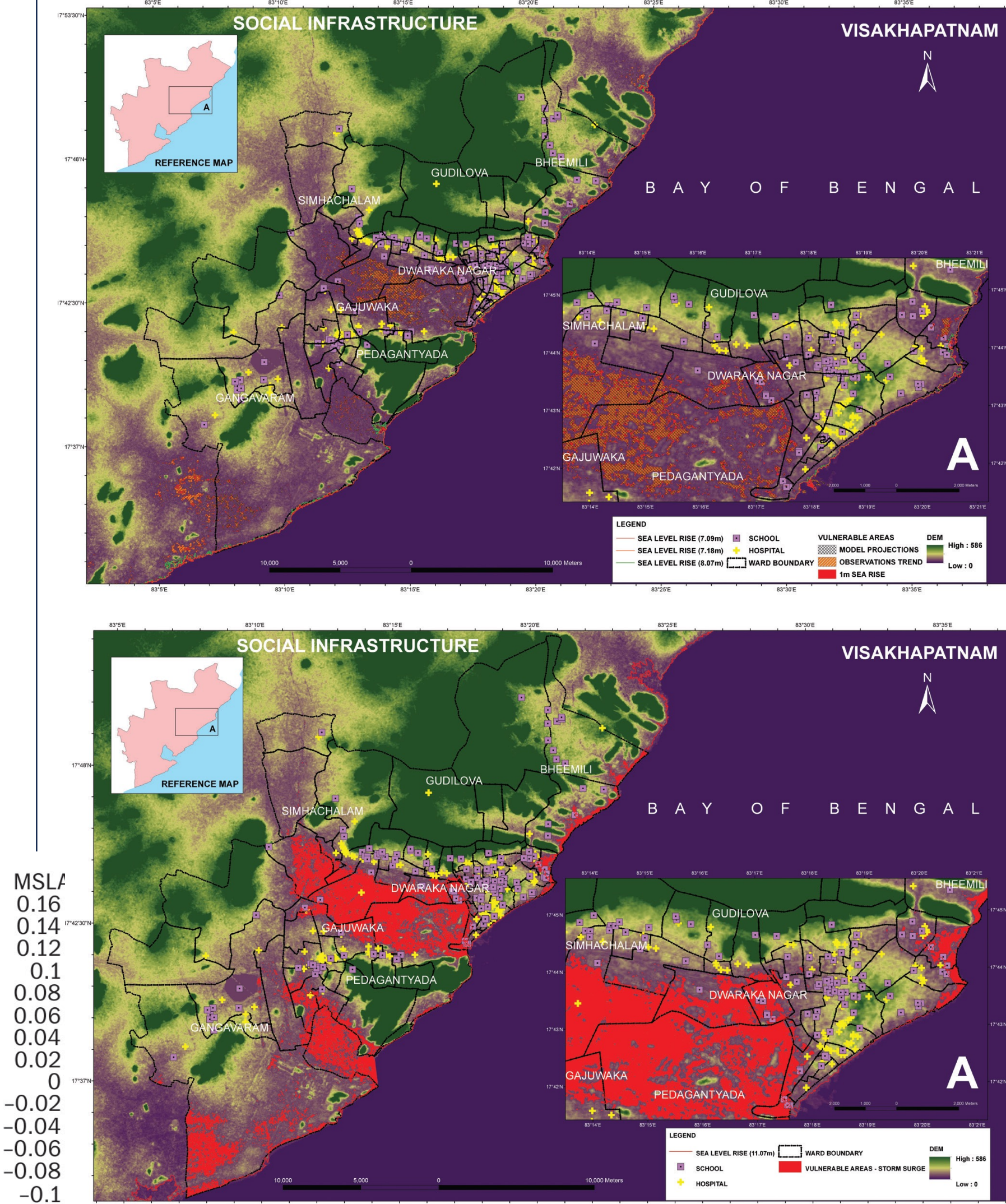


Figure 7: Social infrastructure (schools and hospitals) likely to be affected by flooding in SLR and storm surge

RESULTS

- Need for Detailed and Downscaled Climate Assessments
- Need for **Detailed Sector-specific Impact Assessments**
- Roadmap for Climate **Adaptation and Mitigation Strategies Planning Efforts**
- Optimization of Inventory
- The study resulted in a factual, updated, and multi-sectoral Database Management System, a scientific vulnerability mapping exercise with the help of which broad recommendations were suggested.
- However, it is only a first step in **demonstrating and initiating climate action** at a Visakhapatnam city level and for coastal cities in India, in general.
- It is really up to the **city to take this forward while envisioning and planning for a development that takes cognizance of the future shocks and stressors**.
- Besides, since infrastructure development and management for a number of sectors and services is beyond the powers and functions of the ULB, **an integrated multi-sectoral approach with dedicated institutional framework** needs to be formulated for coordinating infrastructure /development and management at city level.

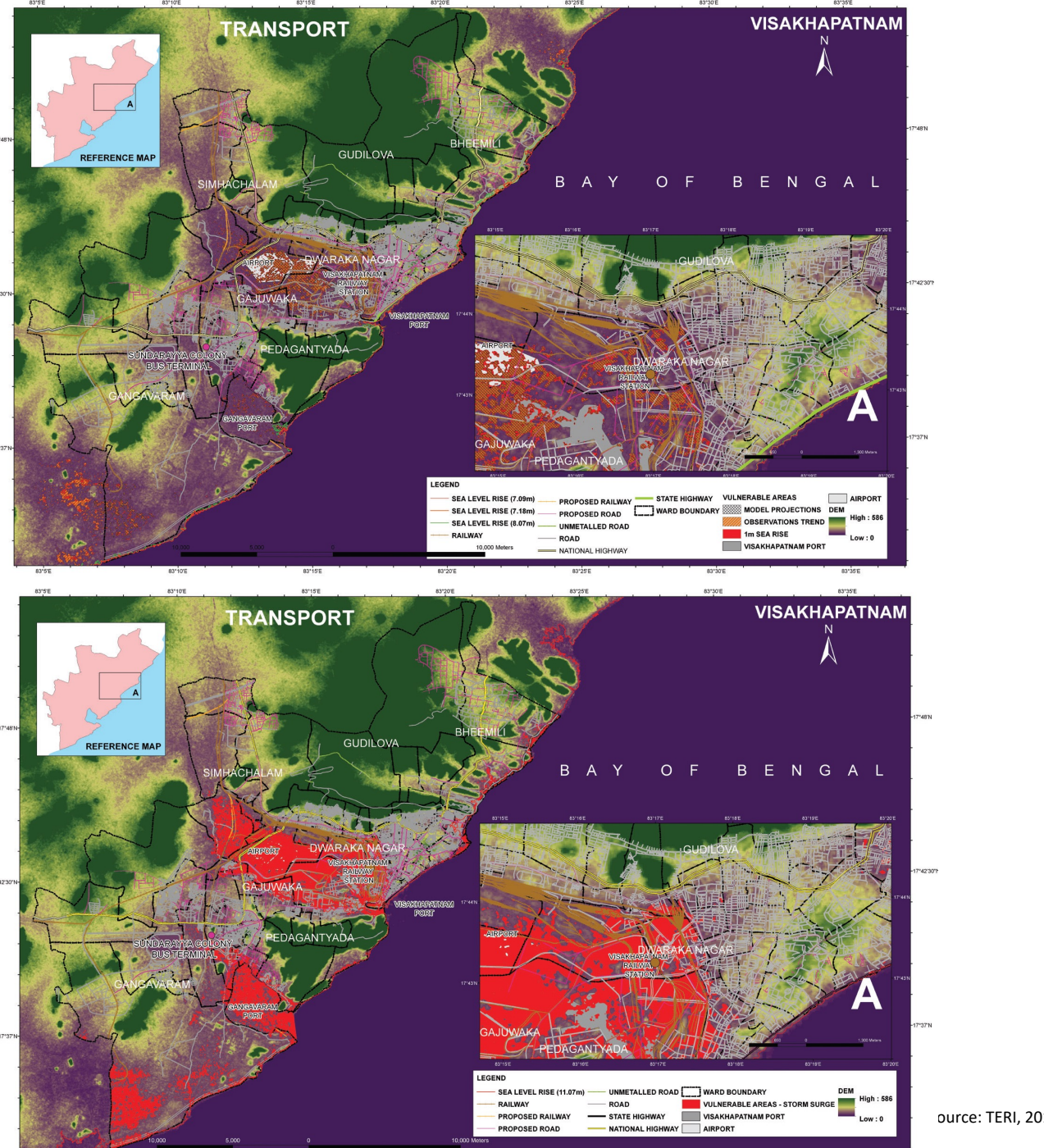


Figure 8: Transport infrastructure likely to be affected by flooding in SLR and storm surge scenario

THE WAY FORWARD

In order to implement the suggested measures and **build climate adaptation and mitigation Strategies**, the coastal city will need to come up with detailed recommendations and **action points for short, medium, and long-term period**, based on expert advice, scientific studies, and financial considerations.

Supporting and enabling mechanisms in terms of policy and regulatory frameworks, finance allocation, and sensitizing and **capacity-building of stakeholders** will be an integral part of **climate adaptation and mitigation strategies planning efforts**.

This **rudimentary measures** which are needed just to address **societal impact of climate variability and climate change in the coastal community due to interactions with ocean and atmospheric processes**, are necessary as a stepping stone to transformative pathways for addressing the **gaps and challenges for bridging science and society in southeast Asia and beyond**.

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