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Rising Tides, Sinking Cities - The Race to Build Resilient Cities

Manish Priyadarshi[1]

Abstract

India's coastal cities are increasingly vulnerable to climate-induced hazards, including sea-level rise, cyclones, storm surges, and urban flooding, posing significant risks to economic growth and human security. This article evaluates India's institutional frameworks, technological innovations, and Nature-Based Solutions (NbS) while highlighting the importance of strengthening Urban Local Bodies, enhancing social inclusion, and leveraging climate finance. The article argues that resilient coastal urbanisation requires coordinated governance, ecological restoration, data-driven decision-making.

Keywords: *Climate Resilience, Coastal Cities, Nature-Based Solutions, Disaster Risk Reduction, Urban Governance*

India's coastal cities are not merely urban agglomerations; they are strategic economic assets central to national growth, trade, and employment. Metropolitan regions such as Mumbai, Chennai, and Kolkata serve as gateways to global markets, hosting major ports, industrial corridors, and financial ecosystems. However, these growth engines are increasingly exposed to systemic climate risks—sea-level rise, cyclones, storm surges, and recurrent flooding—that threaten macroeconomic stability. Evidence from the Intergovernmental Panel on Climate Change confirms that low-lying coastal zones globally face disproportionate climate risks (IPCC, 2022). In India, where nearly 30% of the population resides within 100 km of the coastline, and a significant share of critical infrastructure is concentrated, this exposure translates into a national economic risk (MoES, 2020; NITI Aayog, 2021).

[1] Urban and Climate Policy Expert
Email: manishpriyadarshijnu@gmail.com

From a national policy perspective, the challenge lies in shifting from reactive disaster response to anticipatory, risk-informed planning. India has made notable progress through scientific tools such as the Coastal Vulnerability Index (CVI), developed by the Indian National Centre for Ocean Information Services (INCOIS). The CVI integrates parameters such as shoreline change, coastal slope, tidal range, and wave exposure to identify high-risk zones. Findings indicate that states such as Odisha, Tamil Nadu, Gujarat, and West Bengal have significant stretches of "very high vulnerability," particularly in deltaic and low-lying regions (INCOIS, 2018). This spatial heterogeneity underscores the need for differentiated policy responses rather than uniform national strategies.

Institutionally, India's disaster risk governance architecture—anchored by the National Disaster Management Authority—has evolved significantly over the past decade. The National Cyclone Risk Mitigation Project (NCRMP), supported by the Government of India and the World Bank, represents a flagship intervention aimed at reducing cyclone-related risks. Investments in early warning systems, cyclone shelters, and evacuation planning have yielded measurable outcomes. For instance, during Cyclone Fani, large-scale evacuations and timely alerts significantly reduced mortality compared to the 1999 Odisha Super Cyclone (NDMA, 2020). Similarly, analyses reported by The Indian Express highlight how improved forecasting and institutional coordination have transformed India's disaster response capacity.

Despite these gains, a critical policy gap persists in the over-reliance on grey infrastructure. Traditional interventions—sea walls, embankments, and drainage systems—remain central to coastal defence strategies but often fail to address the systemic nature of climate risks. Recurrent flooding in Mumbai, widely reported by The Times of India, illustrates how infrastructure alone cannot compensate for wetland loss, drainage congestion, and unplanned urbanisation. Similarly, the 2015 Chennai floods exposed the consequences of encroachment on natural drainage systems and wetlands.

A systems-based approach is therefore essential, integrating ecological, infrastructural, social, and institutional dimensions. Within this framework, Nature-Based Solutions (NbS) offer a cost-effective and sustainable alternative. Coastal ecosystems such as mangroves, wetlands, and dunes act as natural buffers

against storm surges while providing co-benefits such as carbon sequestration and biodiversity conservation. The Sundarbans provide a nationally significant example, where mangrove ecosystems have demonstrably reduced cyclone impacts (Dasgupta et al., 2019; IPCC, 2022). Peer-reviewed studies in journals such as Nature Climate Change and Science of the Total Environment confirm that NbS can outperform or complement grey infrastructure in reducing climate risks (Kabisch et al., 2017; Seddon et al., 2020).

However, the integration of NbS into national policy frameworks remains limited. Urban planning continues to prioritise engineered solutions, often at the expense of ecological systems. Addressing this imbalance requires embedding NbS into Coastal Regulation Zone (CRZ) policies, urban master plans, and infrastructure investment decisions.

A national perspective also highlights the role of socioeconomic inequality in shaping climate vulnerability. Risks are not evenly distributed but mediated by access to housing, services, and financial resources. Informal settlements, particularly in coastal cities, are often located in high-risk zones. Reporting by Down To Earth demonstrates how marginalised communities in cities like Mumbai and Kolkata face recurrent flooding, inadequate infrastructure, and limited adaptive capacity. Migrant populations are especially vulnerable due to their exclusion from formal governance and social protection systems.

This aligns with the concept of “differential vulnerability,” which emphasises that resilience is shaped not only by exposure to hazards but also by social and institutional factors (Ribot, 2014; WRI India, 2024). National policy must therefore incorporate social vulnerability assessments into planning processes, promote community participation, and strengthen social protection mechanisms.

Technological innovation offers significant opportunities to enhance resilience, yet its integration remains uneven. Digital tools such as IoT-based flood sensors, geospatial mapping, and predictive analytics can transform urban risk management. Initiatives under the NCRMP, including web-based risk atlases, demonstrate the potential of data-driven planning. Cities like Chennai and Mumbai are beginning to adopt smart flood management systems. However, fragmented data systems and limited interoperability across agencies constrain their effectiveness.

From a national policy standpoint, there is a clear need to develop an integrated National Coastal Resilience Data Platform that consolidates hazard, infrastructure, and socioeconomic datasets. Evidence from international research suggests that such data integration significantly enhances adaptive capacity and decision-making (Meerow et al., 2019).

The economic rationale for investing in coastal resilience is compelling. Econometric analyses indicate that climate-related losses in coastal cities could increase substantially under high-emission scenarios, potentially eroding significant shares of GDP (Hallegatte et al., 2013). Conversely, investments in disaster risk reduction yield high returns, typically in the range of 4:1 to 7:1 (World Bank, 2019). In Mumbai, flood-related disruptions have resulted in substantial economic losses, affecting productivity and infrastructure. These findings reinforce that resilience investments are not merely protective but also economically efficient.

Aligning coastal resilience strategies with global frameworks further strengthens their policy relevance. Interventions contribute directly to Sustainable Development Goal 11 (Sustainable Cities and Communities), particularly targets 11.5 and 11.b on reducing disaster impacts, and Sustainable Development Goal 13 (Climate Action), which emphasises adaptive capacity and integration of climate measures into policy. India's National Action Plan on Climate Change (NAPCC) and State Action Plans provide a foundation for alignment, but stronger inter-sectoral coordination is required.

Looking ahead to 2030, national policymakers must prioritise five strategic actions. First, institutionalise risk-informed planning through mandatory use of CVI and multi-hazard assessments in urban development. Second, strengthen institutional capacity, particularly at the level of Urban Local Bodies. Third, mainstream Nature-Based Solutions through regulatory mandates and financial incentives. Fourth, ensure inclusive resilience by targeting vulnerable populations and integrating social protection systems. Finally, mobilise sustainable financing through blended finance mechanisms and access to global climate funds.

India's coastal cities face escalating, interconnected risks driven by climate change, unplanned urbanisation, ecological loss, and inequality. Cities like Mumbai, Chennai, and Kolkata show how these pressures are turning episodic disasters into persistent crises despite efforts led by the National Disaster

Management Authority. The future hinges on a decisive shift toward integrated, risk-informed, and inclusive planning. Without it, economic and social losses will intensify; with it, coastal cities can transition into resilient and sustainable growth centres by 2030.

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