

Public Transport Access during Extreme Weather Events in Urban India

July 2022 | Ahmedabad University, Ahmedabad

Darshini Mahadevia, Saumya Lathia, Amitkumar Dubey

OPTIMISM
Project
(India)

Policy Brief 5

Introduction

In May 2022, India recorded the highest temperature in the past 122 years. This summer, India was home to ten of the fifteen warmest cities in the world. Cities like Dehradun and Dharamshala, located in India's Himalayan region, experienced a hike of about 9° to 11°C than their usual summer temperatures. The heatwave in India has killed nearly 17,000 people since 1971 and 6,000 in the past six years alone. Between 2001 and 2020, India lost 259 billion daylight hours of labour annually due to increased heat exposure leading to an annual decrease of 2.5-4.5% of the nation's GDP. Unsurprisingly, the urban poor form the worst-hit group as they (about 231 million workers) are often forced to work outdoors in the scorching heat and live in housing conditions that aggravate the impact of heat. The latest nationwide lethal heatwave galvanized the government to take rapid action to combat heat exhaustion. It highlighted the significance of embedding resilience from extreme weather events into their development plans.

Other extreme weather events have also increased in India on the whole by 200% since; as opposed to a total of 250 extreme weather events between 1970 and 2005, over 300 events had already hit India in the 15 years till 2020; incidences of heavy rainfall have increased threefold since 1950, and drought have increased by 30% since 2010. Over 80% (close to 388 million) of the Indian population is vulnerable to either flood, drought, or cyclone. The coastal zone population prone to sea-level rise makes up 33% of India's current population, of which the number of those living in low-elevation coastal zones (acutely vulnerable) is likely to triple by 2060 (216.4 million). As per the Central Water Commission, floods have killed over 100,000 people and caused infrastructural loss of about 38 million INR since 1957. The increasing intensity and frequency of extreme weather events cause an economic loss of about 9-10 million annually, making India the most "economically harmed" country by extreme weather events worldwide. India's agricultural land has decreased ten-fold since 1951, fuelling a 3.5% increase in extreme poverty. High density and inequities in urban India compound vulnerabilities and exacerbate extreme weather events' impacts on the already vulnerable population segments.



Indian cities experience compounding vulnerability to extreme weather events owing to their rapidly urbanizing landscape, high density, and inequities. Severe weather or high-pressure climate adversely affects each element of urban systems. Heavy precipitation-related events (floods, hurricanes, storms, typhoons, etc.) within the past two decades have often resulted in immediate loss of service to urban systems like water and sanitation, transportation, and communications across India's major cities- Hyderabad (2000), Ahmedabad (2001), Delhi in (2002, 2003, 2009 & 2010), Chennai (2004, 2015, 2019), Mumbai (2005), Surat (2006), Kolkata (2007), Jamshedpur (2008), Guwahati (2010) and Patna (2019) (NDMA). Chemical and biological contamination caused by surface run-off during floods and heavy rainfall in cities poses long-term threats to water and food security. The 2015 Chennai floods caused a drinking water shortage for about 90% of its citizen. The 2021 Chennai flood polluted the Couum river with sewage discharge and surface run-off, submerged informal settlements of the low-lying area in sewage water, and destroyed around 145,000 acres of agricultural land and 6,000 acres of horticulture land in and around Chennai district.

Loss of land and property from such events deepens poverty, especially for the most socio-economically vulnerable populations, as they often inhabit eco-sensitive areas prone to extreme weather events and have a lower adaptive capacity to combat the cascading effects of such events. The 2005 Mumbai Floods are a testimonial to this; the low-lying flood plains of Mithi river- 70% of which are inhabited by the city's poorest (slum- & pavement-dwellers)-remaining water-logged for over ten days without access to food, water, sanitation, power and other utilities. Similarly, the annual flooding of Delhi's Yamuna-Pushta region has deepened the poverty of its residents (mainly slum dwellers) due to frequent loss of assets and livelihood and increased health expenditure from subsequent dengue, malaria, and diarrhea outbreaks. While extreme temperature-related events (extreme heat/cold, droughts, etc.) don't bring urban systems to a standstill, they reduce the effective functioning of most systems, cause higher demand for water and power, loss of working hours and productivity, and higher health expenses. Bhubaneswar Municipal Corporation issued a red alert and suspended their city bus services between 1-4 pm throughout April and May to decrease heat exposure. Delhi Jal Board (water department) supplied additional 1,198 GPS-enabled water tankers across the city to meet soaring water demand.

In 2005, about 70% of the low-lying flood plains of Mithi River which are inhabited by the city's poorest remains water-logged for over ten days without access to food, water, sanitation, power and other utilities.



Transport systems are often the worst hit due to extreme weather events. Like in most cities of the Global South, any detrimental impact on transport (especially NMT and PT) adversely affects the socio-economically vulnerable population in Indian cities, as they largely depend on NMT and PT for tapping the economic opportunities or accessing basic life necessities such as education or healthcare facilities. Hence, there is a need for an in-depth investigation into how extreme weather events impact users in cities of the Global South; we take the case of Surat, a mega city in the western-most state of India. Surat is the perfect case study as it is among the world's fastest-growing cities, has a high concentration of migrant population (26% of the total population) owing to its labor-intensive textile and diamond industry, and is a part of the 100 Resilient Cities framework. Surat is also transitioning from road-based transport solutions to a more active & public transport-oriented approach. Surat's urban local body also shows a deep commitment to creating resilient urban systems. The piece details household experiences of transport access during extreme weather events like urban floods and extreme heat, based on the transport user surveys (sample size of 1260) and focus group discussions facilitated by Mahila Housing Trust (with 25 female neighbourhood representatives from Surat). The piece concludes with reflections from the fieldwork, supported by an online expert's survey conducted to understand transport interventions required to foster sustainable outcomes in urban India.

Surat's Climatic Constraints:

Surat is a coastal city with a moderate-humid climate. Daytime summer temperatures in Surat typically range from 36°C to 42°C. Like most cities in the western parts of India, Surat reports an increase in extreme heat days per year. It is also home to river Tapi's estuary and has several creeks cutting across its urban fabric. Surat received an annual rainfall of about 1,222 mm and reports an increase in extreme-point rainfall events (EPREs) since the 1950s. It has a tidal range of 5.8m which frequently causes flash floods in low-lying neighborhoods during high tides. Since 2006, the high tides have caused seawater inundation in Surat's slum settlements, leading to periodic evacuations. Surat's physiography, sea-level rise, increased annual rainfall, and EPREs maximize Surat's vulnerability to pluvial flooding.



36°C - 42°C



1222 mm



5.8m



Current Transport Landscape in Surat:

Surat is a compact, polycentric city with an incomplete ring-radial road network rapidly urbanizing along its radials. Former segregation of industrial land use now blends into the newly developed neighborhoods. Intensification of road-based transport solutions and disinvestment in public transportation over the past two decades has resulted in a 22% decline in non-motorized transport (NMT) mode-share and a 4.3% decline in public transport (PT) mode-share. Additionally, the rise in average household incomes increased dependency on personal motorized vehicles; traffic volume tripled over the last decade. Despite a dip in NMT mode-share, 42% of Surat's trips are via walking and cycling. Surat is also home to the largest BRT network in India; its integration with the existing city bus services doubled PT mode share in just one year. Yet PT mode share in Surat is much lower (3%) than the national average (21%) for similar-sized cities, owing to the poor last-mile connectivity in Surat; only 53% of households in Surat live within a 10-minute walk to a bus stop/ bus station. Even for those households that fall within a walkable distance to PT stop/ station, the poor state of NMT infrastructure deters them from accessing PT. The overall level of service (LOS) for Surat's PT system is 4 (lowest on the scale of 1-4) (CoE Urban Transport, 2014). Only 4% of the total households that use PT actively choose it. Over 90% of all PT users belong to the low-income group, dependent on PT to access economic opportunities, indicating captive users or 'no-choice' users form a large portion of PT ridership.

Transport Access during Extreme Weather Events in Surat:

The transport system in Surat requires resilience from extreme heat during hot summer days and urban floods during heavy monsoon, both common occurrences annually between April to September. Surat's Resilience Strategy identifies green and blue infrastructure- especially streets with green infrastructure- as crucial in creating climate-responsive systems, providing a bundle of ecological services, and generating ample co-benefits with sustainable transport. Co-benefits include improved air quality, moderate micro-climates, comfort during hot summer days through shaded streets, reduced risk of urban flooding during heavy monsoons (by catching, filtering, and redirecting stormwater), and reduced risk of severe droughts (by improving ground-water recharge). Hence, we first assess the current state of streets with green infrastructure, followed by an account of user experience of transport access gathered via in-person user surveys and focus group discussions.

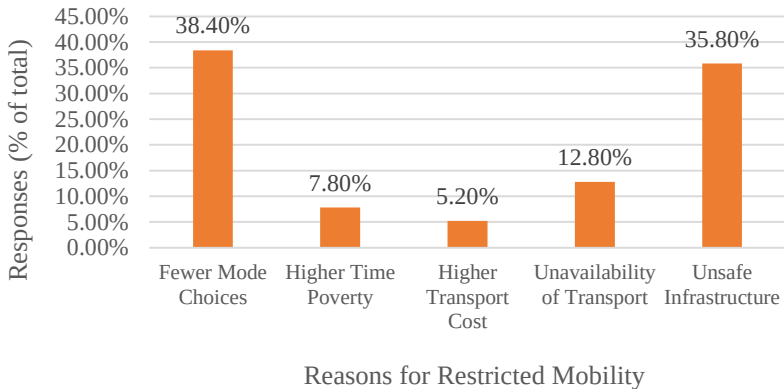


Owing to its history of severe urban floods and the alarming state of infrastructure, Surat joined Rockefeller Foundation's 100 Resilient Cities Network in 2013. Since then, Surat has incorporated urban resilience in all elements of urban planning, especially urban transport. Yet, the network of streets with green infrastructure remains fragmented and meager. About 80% of Surat's major street network has light to moderate tree cover. Still, the city lacks a robust network of permeable pavements, vegetated swales, and curb extensions that promote natural drainage, compromising the ease of transport access during urban floods. 85% of passenger transport users reported that it was uncomfortable/inconvenient to use PT, IPT, or NMT during heavy monsoon. 54% of passenger transport users experienced a complete loss of mobility. Of these, 43% experienced a loss of mobility throughout the monsoon season due to heavy water-logging in their neighborhoods.

30% of users reported restored transport access soon after a downpour, while 22% reported water-logging for a few hours after the downpour delayed restored access to transport. 46% of all passenger transport users experience restricted mobility throughout the monsoon season. Out of these, 38.4% of users reported restricted mobility due to fewer mode choices (mainly NMT modes), followed by 35.8% of users reporting the same due to unsafe infrastructure (lack of raised NMT lanes, risk of potholes/uncovered utility holes, water-logged/ slippery carriageway, lack of signalized junctions, etc.) (Table 1).

Surat's vulnerable groups experience exacerbated impacts, as they often live in areas disproportionately affected by extreme weather events, such as peripheral areas without storm water drains or even undevelopable lands, or are often solely dependent on public transport. They typically face curbed mobility due to unavailability or unaffordability (due to increased fares in adverse situations) of transport.

Table 1: Reasons for restricted mobility during heavy monsoon (Transport Users' Survey, 2020)



A middle-aged woman from Surat's Bamroli area narrated her concerns about curbed access to work and basic amenities,

“ My area faces severe water logging throughout monsoon.... During very heavy monsoon, our houses are often flooded for a few days and roads are completely submerged in water... we can't even go out for work... in cases of emergency, we walk in the water to get essentials.



Surat's highest recorded temperature was 46°C in 2022. As per the user surveys, transport access in extreme heat was “manageable” compared to heavy monsoon; during the floods, they struggled to find any transport modes and often experience loss of livelihood, productivity, and income. 15% of transport users reported an inability to access PT during hot summer days, compared to the failure to access PT during heavy monsoon reported by 70% of users. Yet, 66% of transport users stated that it was “very” uncomfortable/ inconvenient to use PT, IPT, or NMT during hot summer days. The top three most listed causes include (i) walking long distances in the heat to access PT in the absence of shaded footpaths, (ii) long waiting times due to low bus frequency, especially during hot summer afternoons, and (iii) discomfort in the bus due to overcrowding.

A local-area representative from Surat's Police Colony area reported road safety issues during monsoon,

“ *My area barely has any footpaths, so people often walk on the carriageway to the nearest bus stop... there is a constant conflict between pedestrians and vehicles, leading to frequent road accidents... all of this is even worse during monsoon-especially at the crossroads- as roads are often water-logged.* ”

A woman in her early thirties from Surat's Udhana (an industrial area) discussed accessibility challenges during hot summer days,

“ *My area doesn't get water-logged, and so mobility during monsoon isn't as bad as it is during summer... I have to walk a long distance to access the nearest bus stop in the scorching sun, with no footpaths or trees on the road... then once I am at the bus stop, there's no seating, shade, or drinking water available... This makes it very hard to take the bus during summers... I wish I owned a 2-wheeler!* ”



Reflections:

The discussion of Surat’s case in this article pertains to examples drawn from the low-income neighbourhoods, and low-income individuals dependent on PT or IPT. For them, a loss of a day’s work due to dysfunctional/ non-functional PT and IPT due to heavy rains and floods is a great loss. High temperatures continuing over long periods in Surat, like in India, make walking to and from the public bus stations exhausting and uninviting. But do PT users have a choice? The last quote from a woman about using the BRT during summer alludes to using an air-conditioned bus with higher fares than a regular public bus. Extreme events of rains and floods hit the low-income populations hard. There is a double whammy; low-income households tend to congregate in neighbourhoods with poor infrastructure - roads, drainage lines, and even green cover - compounding the impacts of extreme weather.

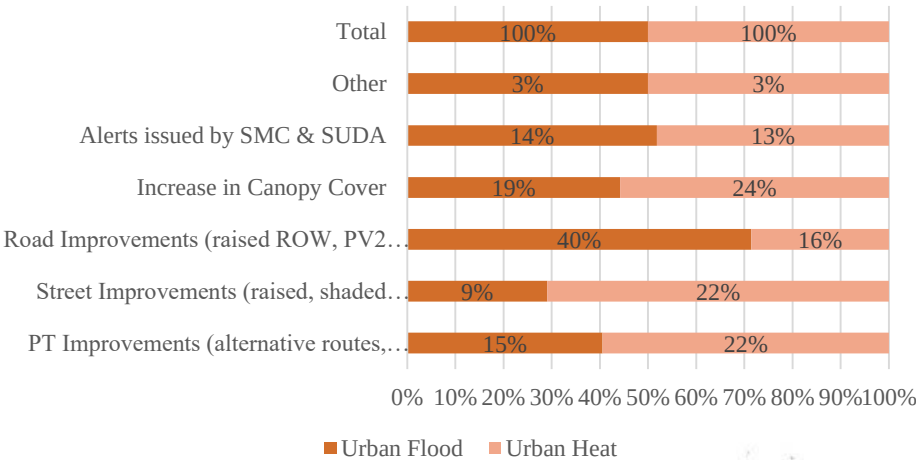
The propensity of any extreme weather event discourages public transit ridership by either rendering transport infrastructure non-serviceable or degrading the quality of service. Plausible solutions to solutions to ensure transport access during extreme weather events (urban floods and heat waves) need to be thought of, which we present based on the findings from in-person and online expert surveys.

90% of the surveyed experts on urban transport indicated that introducing a reliable feeder service and other convenient last-mile options were crucial in retaining transit ridership during extreme weather events, especially during heat waves. Nearly 70% of experts discussed the importance of green streets with canopy covers, bio-swales, and permeable pavements as the key to resilience during heavy monsoons as the permeable pavements and bio-swales ensure regular drainage during heavy rainfall. The canopy cover binds the soil beneath the pavements, effectively preventing the formation of sinkholes during and post-monsoon.

The in-person user survey findings reinforced the experts’ online survey findings. Road improvements like raised right-of-way (ROW), permeable pavements, and reduction in traffic congestion was the most recommended intervention (40%) for increasing the ease of using transport, followed by an increase in canopy cover (19%) and PT improvements (15%) like improved frequency, alternative routes, feeder services, etc. Similarly, the top three most recommended interventions for improving resilience and mobility during extreme heat are increasing canopy cover (24%), PT improvements (22%), and street improvements like raised and segregated and NMT lanes and drinking water fountains. Some of these are low-hanging fruits and can be implemented quickly. Ones requiring medium-term efforts- say for over ten years- that improve the overall transport system must be integrated within the city-level mobility plans.

Table 2: Mobility in Surat during Extreme Weather Events (Source: Transport Users’ Survey, 2020)

Recommendations for Improved Mobility



Acknowledgements:

OPTIMISM (Opportunities for Climate Mitigation and Sustainable Development) is an international multi-stakeholder partnership and research network, funded by the UK Natural Environment Research Council as part of the research council's "Towards a Sustainable Earth" program. The international team consists of four partners: (i) Imperial College London, UK, (ii) Lund University, Sweden, (iii) Waseda University, Japan, and (iv) Ahmedabad University, India.

Dr. Darshini Mahadevia (Principal Investigator- India) and Dr. Minal Pathak (Co-Principal Investigator) lead the project team placed in India, that is supported and funded by Department of Biotechnology (DBT), Government of India. They investigate low-carbon urban transport's interactions with Sustainable Development Goals (SDGs).

This document is a part of the Policy Brief series on Low-Carbon Urban Transport by the project team placed in India.

Contributors: Abir Mukherjee, Chandrima Mukhopadhyay, Kanika Gounder, Bandish Patel.

Suggested Citation: Mahadevia, D., Lathia, S., Dubey, A. (2022). Public Transport Access During Extreme Weather Events in Urban India (Policy Brief No. 5). OPTIMISM (Opportunities for Climate Mitigation and Sustainable Development) Project, Ahmedabad University.

Disclaimer: The comments and opinions in this document are of the author(s) alone and not of the School of Arts & Sciences at Ahmedabad University, Department of Biotechnology- Government of India or any other OPTIMISM project partners.



Contact Us: School of Arts & Sciences, Ahmedabad University, Commerce Six Roads Navrangpura, Ahmedabad – 380009, Gujarat, India;

Email: artsandsciences@ahduni.edu.in; **Phone:** +91.79.61911502

