Climate Resilience and Public Health in Indore

A Knowledge Compendium for Young Changemakers, Educators, and Organisers

Centre for Public Insights

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Climate Resilience and Public Health in Indore is a comprehensive knowledge compendium exploring the intersection of climate change, public health, and youth engagement in one of India's fastest-growing cities. Developed by Centre for Public Insights as part of the Indori Climate League project, this primer analyzes Indore's climate vulnerabilities—rising temperatures, water scarcity, air pollution, among others—and their health impacts, especially on its 600,000+ adolescents. Drawing on over 60 studies, community assessments, and local innovations, the document examines sectors such as spatial planning, transport, water systems, and education. It highlights gaps in policy and infrastructure, and presents evidence-based pathways for adaptation—ranging from traditional knowledge systems like the Pat irrigation model to youth-led resilience initiatives. The book makes a compelling case for centering youth in climate-health planning and transforming Indore into a learning city where innovation meets equity. With actionable insights, references, and sectoral analysis, this primer is essential for educators, grassroots leaders, NGOs, and city planners building healthier, more climate-resilient urban futures in India and beyond.

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Preface

For six consecutive years, Indore has claimed the title of India's cleanest, transforming from a struggling urban center into an unlikely champion of environmental stewardship. Yet beneath this celebrated success lies a more complex story. Community leaders and NGOs working at the grassroots level need to understand it more holistically as we navigate the intersection of climate change and public health in the city with a youth-centric approach.

Why Making Healthy Cities for Youth Matters for Indore

With adolescents forming approximately 20% of the population, the convergence of rapid urbanization, climate change impacts, and demographic transitions creates unprecedented challenges for Indore's young people. Climate change amplifies existing urban health inequities through multiple pathways: degraded air quality affects respiratory development; water stress disrupts educational continuity; extreme heat reduces outdoor activity and learning capacity; and climate anxiety impacts mental health. These challenges compound socio-economic vulnerabilities, particularly affecting adolescents from informal settlements, migrant youth, and those in precarious employment.

Indore represents a critical case study for urban climate resilience in India. Home to approximately 20% adolescent population—over 600,000 young people—the city demonstrates both remarkable achievements in environmental management and persistent climate vulnerabilities. While Indore achieved recognition as India's cleanest city through innovative waste management, it simultaneously faces severe air quality challenges, groundwater depletion, and intensifying heat island effects that disproportionately impact youth health and well-being.

Yet, we must note that Indore represents both inspiration and caution for India's urban future. The city's waste management miracle demonstrates what's possible when municipal leadership, community participation, and innovative approaches align. Door-to-door waste collection now reaches 100% of households, 95% of waste gets processed rather than dumped, and citizens actively participate in segregation at source. This transformation didn't happen overnight—it required sustained community engagement, behavior change campaigns, and systems thinking that connected environmental improvement with public health outcomes.

Despite Indore's achievements, significant gaps remain that community organizations are uniquely positioned to address. Longitudinal studies linking specific environmental interventions to community health outcomes are scarce. Documentation of community-based adap-

tation strategies, traditional knowledge systems, and indigenous coping mechanisms requires systematic attention. Most critically, the voices and experiences of those most affected by climate change—informal workers, slum residents, women, and youth—need greater prominence in both research and policy discussions. This document provides a foundation for evidence-based community action, but its real value will emerge through application in local contexts. The research consistently shows that sustainable environmental improvement requires authentic partnership between communities, civil society organizations, and government institutions. For those working daily with India's most vulnerable urban populations, understanding both Indore's successes and its ongoing challenges offers essential insights for building healthier, more resilient cities from the ground up.

The existing evidence is clear: climate change poses serious threats to urban health, but community-led action can make a meaningful difference. The question facing NGOs and community leaders is not whether to engage with these challenges, but how to do so most effectively, building from existing strengths while addressing persistent vulnerabilities. In Indore's ongoing experiment with urban sustainability, the most important lessons may come not from what the city has already achieved, but from what communities themselves discover as they work together toward a more equitable and resilient future.

About this Compendium

This comprehensive document synthesizes cutting-edge research on urban climate and health frameworks, combining international policy guidance with Indian city examples and Indore-specific initiatives. We review and synthesize available research on how climate change impacts health outcomes through urban systems in Indore, examining peer-reviewed literature, technical reports, and program documentation. This literature review emerges from a comprehensive analysis of over 60 research studies, government reports, and community-based assessments spanning the past decade. It synthesizes evidence from prestigious journals, international organizations like IIED and WRI India, and most importantly, action research conducted directly with Indore's informal workers, slum communities, and frontline service providers. The goal is not academic exercise, but practical understanding; in other words, to equip those working closest to the ground with evidence-based insights that can inform citizen campaigns, advocacy strategies, and youth organising efforts in Indore.

This literature review synthesizes current research across these critical domains:

- City profile
- Climate projections, Impact and Policy Architecture: Understanding urban climate projections, institutional frameworks, expected impacts, and policy gaps
- Climate and Environmental Challenges: air quality trends, heat island intensification, and health impacts specific to youth populations

- Water Security: groundwater depletion patterns, water access challenges
- Public Systems: waste, sanitation, transport
- Climate Adaptation, Youth Vulnerability and Resilience: climate-resilient infrastructure needs, climate-health linkages, mental health impacts, community-based adaptation strategies, and opportunities for meaningful youth engagement in city planning
- Bibliography and Resources: Comprehensive reference compilation for continued research; Brief notes on past community initiatives, government schemes, partnerships and networks

The evidence presented in this volume will reaffirms that effective climate action in cities like Indore holds the potential to deliver multiple, co-beneficial outcomes. Interventions targeting air pollution can prevent thousands of premature deaths annually. Urban heat adaptation measures can reduce health risks for vulnerable populations, especially children and adolescents. And integrated approaches that align international frameworks like the SDGs, the Paris Agreement, and WHO guidelines with locally driven innovation, such as Indore's Climate Action Plan can generate compounded benefits for climate resilience and public health alike.

While Indore has earned recognition for its leadership in urban governance and environmental management, it has not received equivalent academic or policy attention in relation to the health impacts of climate change in relation to adolescents. Academic research is beginning to build more sophisticated understanding of climate-health connections. IIT Indore's Migration and Development Research Group studies climate vulnerability assessment, while multiple published studies examine urban climate adaptation, water sector resilience, and community knowledge mobilization. However, critical research gaps remain in youth-centric studies, long-term health impact assessment, and quantitative epidemiological analysis linking climate variables to specific health outcomes.

This absence of youth-centric research is a barrier to fully realising the potential of integrated, evidence-based urban climate planning. For practitioners and planners, this represents both a challenge and an opportunity: to better connect climate and health agendas, to mainstream adolescent well-being into urban resilience strategies, and to ensure that Indore's model of innovation is also one of inclusion. This document brings together the available knowledge, spanning policies, programmes, datasets, case studies, and field-based learnings, that can support such integration. It is expected to be a practical resource for those working with youth at the intersection of climate action, public health, and urban planning in Indore and other comparable Indian cities.

Summary of Evidence

Health and Climate Context

- Indore, a city of over 3 million people, is Madhya Pradesh's largest urban center and economic engine, known for its clean city achievements and rapid growth. Historically a trade and military hub, it has evolved into a center for finance, manufacturing, and education.
- Once known for pleasant weather, Indore now faces extreme heat (up to 48°C), water stress, flash floods, and poor air quality. This is particularly harmful for the 30% of residents in slums or semi-permanent housing.
- Urban expansion is spreading toward Mhow and Ujjain, risking worsened heat island effects and infrastructure stress. Over 600 slums, many unrecognized, host seasonal and long-term migrants with limited access to basic services.
- Migrants face layered exclusion. Those newer to the city are less likely to have ID cards, toilets, or safe housing. Women and children in these areas are even more vulnerable to major health risks, especially during monsoons and heatwaves.
- Indore shows progress but there is disparity. While it leads in waste management and sanitation, it faces a double burden of disease: infectious illnesses like TB and diarrhea, and rising non-communicable diseases like diabetes and hypertension.
- Children suffer high rates of stunting; young people face road injuries, unsafe air, and substance abuse risks. Health access remains unequal despite over 300 hospitals and clinics.
- Future city plans should emphasize *green* growth, water security, and sustainable transport connectivity. Gaps in green space access, clean energy, NMT infrastructure, and health resilience need urgent attention to ensure Indore grows without leaving its most vulnerable behind.

Climate Projections

- Climate projections show Indore will get hotter, with temperatures rising 1.5–4.5°C by 2050 depending on pollution levels.

- Hot days above 40°C and short, heavy rains are expected to increase, leading to heatwaves and urban flooding.
- These changes will affect water access, public health, and energy needs, especially for vulnerable groups.
- Climate models help cities plan better systems, like green transport, cooler buildings, and early warning alerts.
- Youth can play a key role in shaping fairer, climate-ready cities by joining local action and learning green skills.

Spatial Planning and Biodiversity

- Indore gets high marks for green cover and planning but faces uneven access to parks and green spaces, especially in low-income areas.
- The city may get 2–4°C hotter by 2050, with more heatwaves and heavy rains. Green areas help cool cities and prevent floods.
- Projects like Sirpur Lake redevelopment show how ecological thinking can be part of city planning. Sirpur Lake has been recognised as one of the 19 important bird areas of Madhya Pradesh.
- Problems like poor drainage and rising glass buildings make things worse.
- Youth can help track urban heat, protect green zones, and push for climate-smart, fairer development.

Transport

- Indore's transport affects youth access to schools, jobs, and health, while also contributing to emissions and climate crisis
- Two-wheelers form 40% of daily trips; public transport 19%; and walking 15% (Climate Action Plan)
- Registered vehicles have grown over 150% since 2010, worsening congestion, air pollution, and road safety.
- Around 30% of trips are made by foot or bicycle, mainly by students, yet only 46% of roads have footpaths.

- BRTS, launched in 2013, covers just 11.7 km and serves 60,000 daily users—mostly youth—but is now being dismantled
- Girls' mobility is more restricted due to safety concerns, particularly during heatwaves and floods.\
- Youth face health risks: rising PM2.5 and PM10 levels, heat exhaustion, and injuries from unsafe roads.
- Summer temperatures may reach 50°C by 2030; flooding in 2020 submerged roads under 12 inches of water.
- Informal modes like autos and e-rickshaws fill gaps but lack regulation, safety, and climate resilience.
- Over 30% of youth use non-motorized or shared transport daily, yet lack shade, safety, or infrastructure.

Air Pollution and Health

- Indore's air is dangerously polluted: PM2.5 levels are above safe limits on 90% of days, with children and slum residents most at risk.
- Yet only 2 of 6 air monitors are near homes, which leaves major gaps in data and accountability.
- Vehicles and construction dust are the biggest culprits, but clean transport and stricter construction rules could change that.
- The city has the tools like CNG buses and EV policies but there is need of creating pressure to act faster.
- Young people can push for community air monitoring, green building advocacy, and the right to breathe clean air everywhere.

Water System

- Less than half of Indore's population has piped water, while 30% of supply is lost to leaks or theft.
- Poor communities pay more for worse access, and groundwater is being depleted dangerously fast.
- Floods and droughts are hitting harder every year but smart fixes exist.

- From rain gardens to wastewater reuse, from citizen water audits to community meters, youth can help reshape Indore's broken water system.
- The tech and solutions are already here; what's missing is public pressure and community-led action.

Solid Waste Management

- Indore turned its waste crisis into a national success by processing 1,175 tons of daily waste, cutting disease by 60%, and winning "cleanest city" six years in a row.
- But this came with new climate risks, especially for sanitation workers facing heat, disease, and unsafe conditions.
- The tech exists: bio-CNG plants, waste-reporting apps, door-to-door segregation.
- What if youth pushed for worker rights, community-level energy from waste, or made sure slums weren't left behind.

Energy and Green Buildings

- Energy use and buildings contribute nearly 60% of Indore's emissions, mostly from coal-powered electricity.
- While LED streetlights and rooftop solar projects show progress, renewables still make up less than 1% of energy supply.
- Transmission losses remain high, and building energy efficiency adoption is low.
- Passive cooling, green certifications, and cool roofs in affordable housing are gaining traction. The city aims for 25% renewables by 2030, but achieving this needs rapid scaling of solar, smart meters, building codes, and municipal retrofits.
- Climate resilience in energy infrastructure and stronger enforcement of efficiency standards remain critical for sustainable urban energy transitions.

Education and Employment

- Indore has lots of smart, young people and yet youth unemployment is high, and there are not enough green jobs.
- Women make up 72% of literate people, but only 16% work; a massive gap in the climate workforce.
- Green sectors like waste management, water conservation, solar energy, and green construction offer jobs, but skills training doesn't match these needs.
- Slum youth face the worst climate impacts but often get the least support.
- Young changemakers can push for climate skills in every course, gender-inclusive green enterprises, and training where it's needed most.

Community Resilience and Leadership

- Community resilience in Indore is the key to avoiding climate catastrophe, yet remains weak due to social fragmentation, urbanization, and exclusion of traditional knowledge.
- Nearly **30% of Indore's 5.56 million population lives in over 600 slums**, many of which are not formally recognized, limiting their access to climate adaptation resources.
- Traditional knowledge—like the *Pat* irrigation system and passive cooling architecture of Malwa—offers proven climate strategies but is absent from modern planning and youth education.
- Despite **temperatures projected to reach 50°C by 2030**, only **51 public health institutions** serve the city, with limited cooling infrastructure and no climate-health integration.
- Millet systems, once central to food resilience, are disappearing despite crops like finger millet having **3.5x more calcium than milk** and thriving in **64°C** heat with **70% less water**.
- Women's self-help groups showed adaptability during COVID-19, revealing potential for climate response if supported.
- Persons under 18 years of age make up about **38% of the city** but are not involved in city planning. Yet, they show informal leadership via plantation drives, social media alerts, and grassroots innovation.
- Projects like **community youth centers** and **participatory climate budgeting** can empower youth and integrate traditional wisdom for inclusive adaptation.

1 Introduction: Health and Climate Context of Indore City

Situated on the banks of the Kanh and the Saraswati rivers in the drought-prone Malwa Plateau, Indore is a city of more than 3 million inhabitants[1]. It is the largest city in Madhya Pradesh and is known as the business capital of the state and the a prominent hub of not just trade and commerce but also corporate and education institutions. Indore has a rich urban history as a settlement (now known as Juni Indore) that dates back to the end of 15th century. Indore developed as a commercial and military town at the junction of pilgrimage (Omkareshwar-Mahakaleshwar) and military (Agra-Deccan) routes. The Holkar dynasty established trade centers and infrastructure in 18th century. Indore's urban development took pace after the British defeated Holkars in 1817 leading to development of industries, roads, markets, and several heritage buildings such as Lalbagh Palace, Hawa Bungla, Sukhniwas Kothi, Gandhi Hall, Krishnapura, Bolia Chhatri, among others.

Indore's economy has shifted from traditional industries to finance and high-tech sectors. Key industries include engineering, pharmaceuticals, fabrication, and food processing. Major trade sectors encompass cotton textiles, chemicals, machinery, iron and steel, food products, confectionery, paper, construction materials, machine tools, electrical appliances, electronics, and educational services. The city hosts specialized industrial parks for pharmaceuticals, textiles, food processing, IT, apparel, gems and jewelry, software technology, and herbal products. In 2015, the Government of India launched the high-profile Smart Cities Mission, aimed at transforming the urban landscape across the country. Indore was chosen as one of the first twenty cities to be developed under this ambitious initiative. Indore has also been recognised as the 'cleanest city in India' according to the evaluation benchmarks set by the Ministry of Housing and Urban Affairs (MoHUA) under the Swacch Bharat Abhiyan (SBM).

Table 1.1: Demographic Overview: Indore

Urban population (estimated for 2025; million)	3.17
Urban population (Census 2011)	2.17
Proportion of state population (%)	4.5
Population density (persons per sq. km.)	841
Slum population	29.6
Houseless population	0.5

[1]Estimated projections based on the last Census of India conducted in 2011. Source: census2011.co.in

Sex ratio (females per 1000 males)	925
Child sex ratio (females per 1000 males)	895
Scheduled Caste population (%)	15.7
Scheduled Tribe population (%)	0.03
Literacy rate (% literate)	85.9
Workers per 100 persons (Male | Female)	36.3 (55.0 | 16.0)

Indore historically enjoyed pleasant weather with cool nights (below 25°C) and manageable summer days (around 40°C). Winters drop to 10°C. The city receives 943mm annual rainfall, with 90% during monsoon season. With the growth of its urban economy and population, Indore faces a confluence of environmental and public health challenges including water stress, extreme heat events, flooding, and air quality deterioration. The city's climate vulnerability is particularly pronounced due to its location in the rain shadow of the Western Ghats, resulting in a semi-arid climate with rainfall concentrated primarily during the monsoon months. The city experiences extreme heat (temperatures reaching 48°C), erratic monsoons, and rapid urbanization that strains infrastructure systems. These climatic changes pose significant risks to the city's infrastructure, economy, and particularly its vulnerable populations, with approximately 50% of residents living in informal settlements.

The youth demographic presents both opportunities and challenges. Boys face higher risks of exploitation and substance abuse, while limited safe spaces for self-expression exist in schools and public areas. Many 14-15-year-olds migrate to Indore alone for work and coaching, leading to high emotional and physical vulnerability, with substance abuse noted as an emerging issue, particularly in informal settlements.

1.1 Master Plan of Indore

Master plans in Indian cities serve as comprehensive statutory documents that guide organized urban development over specific time horizons, typically spanning 20-25 years. These plans operate under the framework of state Town and Country Planning Acts and follow guidelines established by the Ministry of Housing and Urban Affairs. The master planning process in India involves systematic land use distribution across key categories including residential, commercial, industrial, public and semi-public facilities, transportation, recreation, and agricultural zones.

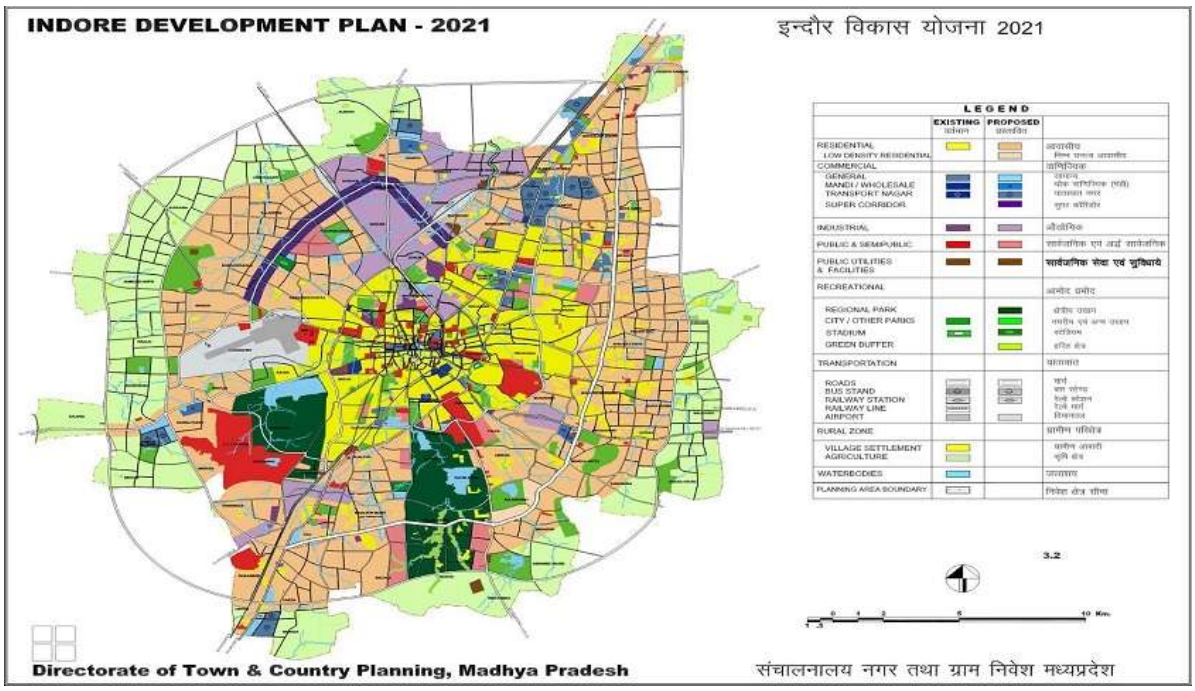

Figure 1.1: Indore Master Plan 2021

Indore has transitioned through multiple master plan iterations, with the current framework targeting 2041 as its planning horizon. The previous plan that expired four years back in 2021 was designed in 2008 for an estimated population of 3.56 million in 2021. It mainly distributed land use with residential zones accounting for approximately 45% of developed area, commercial zones comprising 7%, public and semi-public 8%, industrial areas occupying 7%, and transportation infrastructure claiming 16% of the total planned area. Green spaces and recreational facilities are allocated 14% of the land, reflecting the city's commitment to environmental sustainability which eventually developed into recognition as India's cleanest city. However, this is largely composed of big parks that are present only in the planned residential areas in the western part of the city and are non-existent in other areas. Also, parks and playground occupy only 6 Ha of land which is 4% of the total area, marking the deficiency in accessible green spaces for youth in the city.

Two main axes of urban expansion are visible: South-west (towards Mhow) and north (towards Ujjain). This spatial expansion pattern has implications for climate vulnerability, as the urban heat island effect and increased energy use density for space cooling can worsen with haphazard high-rise buildings blocking free flow of winds. Around 10% of households are semi-permanent and 1.21% are temporary structures, indicating inherent vulnerabilities to climate risks such as heatwaves, urban flooding, and health disorders. The proliferation of informal settlements, with 600+ slums, many denotified, creates challenges in service delivery, particularly for climate adaptation measures.

According to media reports, future projections under the Master Plan 2041 are likely to emphasize metropolitan expansion and creating more urban connectivity with expanded coverage to peri-urban clusters Incorporating 79 surrounding villages, transforming them into part of "New Indore" and improving connectivity via transport hubs and inter-state bus terminals in all four directions. The planning horizon has been extended from 2035 to 2041, with discussions underway to even push to 2050, to capture longer cycles of growth (population projected over 6 million by 2041; 8 million+ by 2050). The plan could also incorporate climate-resilient infrastructure, smart city solutions, and sustainable transportation systems to manage projected population growth to 4.5 million by 2041. Environmental conservation are also likely to feature prominently through city forests, river rejuvenation projects for Khan and Saraswati rivers, and comprehensive groundwater recharge systems addressing the city's growing water security challenges. An increase in permissible FAR, from current 2.5/3 to up to 6, can encourage vertical growth along major corridors while safeguarding green belts on the periphery. Multiple transport hubs, upgraded bus stands, along with metro integration, and safe and accessible non-motorised transport to address burgeoning traffic issues. Other amenities could include leisure gardens and sports grounds/stadiums in each assembly area to enhance health and quality of life.

1.2 Migration, Informality, and Exclusion

The driving forces behind migration to Indore reflect systemic rural distress across central India. Decreasing availability of farmland among marginal farmers, fragmentation of agricultural holdings through inheritance, and mechanization that reduces labor opportunities push people from villages in states like Bihar and Uttar Pradesh toward cities like Indore. At the same time, Indore is the largest economy in central India at a GDP of $14 billion and its flourishing industrial and commercial activities including pharmaceuticals, manufacturing, and real estate development create a pull factor by offering temporary and seasonal employment opportunities. This creates three distinct migration patterns that shape the city's informal landscape: rural-to-urban migration of displaced farmers and agricultural laborers, smaller cities to larger cities movement of people seeking better economic opportunities, and seasonal migration during festival and wedding seasons when short-term urban employment becomes readily available.The slums and informal settlements are areas that remain primary destination for migrants because formal housing is inaccessible, creating dense concentrations of vulnerable populations.

The exclusion experienced by migrants operates along multiple dimensions that become more severe the shorter their time in the city. This forms a hierarchy of marginalization that intersects with climate vulnerabilities. According to a study by IIED, seasonal migrants face the most extreme exclusion, with less than 1% having access to government identification cards that would enable them to claim basic services and social welfare schemes. Recent migrants who have been in Indore for less than one year have twice as much access to identification as seasonal migrants, while those present for one to two years have twice the access of recent arrivals. Older settlers who have lived in the city for more than five years demonstrate 15

times better access to universal identification compared to seasonal migrants, illustrating how exclusion gradually diminishes over time but never fully disappears. This exclusion manifests in practical ways that amplify climate risks. Eighty percent of all migrants who access any type of toilet must share it with other families, creating sanitation vulnerabilities that worsen during monsoon flooding. Most migrants rely on rental housing made of temporary or semi-permanent materials that provide little protection during extreme weather events. Their high dependence on private and low-quality healthcare means that climate-related health impacts, from vector-borne diseases to heat stress, create additional financial burdens and health risks for families already surviving on precarious informal sector incomes. These exclusion patterns imply that migration and informality create systematic vulnerabilities that climate change then amplifies, particularly affecting the most recent arrivals who lack the social networks and official recognition needed to access protective services.

1.3 State of Public Health

Despite being recognized as India's cleanest city for seven consecutive years (2017-2023) and achieving "Water Plus" status in 2021, Indore struggles with significant health inequities. Child stunting affects 39% of under-fives, while only 61% of pregnant women receive adequate antenatal care. The city demonstrates strong immunization coverage at 99%, yet maternal mortality remains concerning with 136 deaths per 100,000 live births. However, non-communicable diseases are rising alongside persistent infectious disease burdens. Tuberculosis incidence (312 per 100,000 population) in Indore exceeds the national average (199 per 100,000 population) by more than 50%. In two monsoon months of 2024, 3,543 acute diarrhoea cases were recorded (rising 26% in July alone) linked directly to contaminated tap water[2]. Seasonal spikes in typhoid, jaundice, diarrhea, dengue and malaria; patient numbers rose by over 30% during summer 2024[3]. Mental health consultations were reported to have increased by more than 250% in the six months after COVID indicating sharp rises in anxiety, depression, and related disorders[4]. Lifestyle diseases are also found increasing due to dietary shifts and reduced physical activity. Around three in five persons killed in road traffic crashes in Indore are under the age of 45 years, and one in three are under 25 years[5].

According to one assessment of health infrastructure in Indore, the healthcare infrastructure includes 313 public and private hospitals, 14 urban primary health centers, and 760 Anganwadi

[2] https://www.freepressjournal.in/indore/indore-3543-acute-diarrhoea-cases-reported-in-two-months-consumption-of-contaminated-water-major-reason

[3] https://www.freepressjournal.in/indore/indore-sees-over-30-increase-in-patients-due-to-seasonal-diseases-amid-changing-weather

[4] https://timesofindia.indiatimes.com/city/indore/pandemic-effect-mental-health-issues-surge-by-254-in-district/articleshow/94749984.cms

[5] According to an analysis based on the data of year 2019. Accident Cell, Traffic Department, Indore, as cited in Pomeroy-Stevens, Amanda, Monica Biradavolu, Damodar Bachani, Fareed Uddin, and Neha Yadav. 2018. "Building Healthy Cities Indore Health Needs Assessment." Arlington, VA: Building Healthy Cities (BHC) project.

centers, but access remains unequal between slum and non-slum populations[6]. Environmental health presents mixed outcomes; while sanitation has improved dramatically, air quality remains problematic with PM10 and PM2.5 levels exceeding WHO standards, particularly affecting outdoor workers and vulnerable populations. Inequality in health risk and outcomes is something to note here. The chart Figure 1.2 shows how noncommunicable disease (NCD) risk factors vary by wealth in Indore as analysed during an international study conducted in 2018[7]. Adequate physical activity is highest among the poorest (82%) and declines with wealth, while overweight and obesity rise sharply: from 22% in the bottom quintile to 54% in the top. Raised blood pressure also increases slightly with income. Tobacco use is far more common among poorer groups (35% vs. 12% in the richest), while heavy drinking remains low across all groups. Raised blood sugar shows a U-shaped trend, with higher prevalence at both ends of the wealth spectrum. These patterns show that poorer groups face risks from tobacco and physical hardship, while wealthier groups face lifestyle-related health risks.

While the city is known for its delicious street food, food safety is a priority issue in Indore. Although safe food preparation has been improved, high consumption of calorically dense, nutrient-poor foods contributes to an increase in obesity and lifestyle diseases like diabetes. This overlies an existing burden of micronutrient deficiencies in the city. According to the NFHS-4 data, 24 percent of women and 21 percent of men are overweight, and 46 percent of women are anemic across urban Indore[8].

Over 30% of households in Indore use bio-fuels (firewood, dung) on basic stoves. Women report respiratory symptoms but lack awareness of health risks[9]. Air quality has somewhat improved but still often ranks 'moderate' to 'poor' throughout the year[10]. In slums, air pollution combines outdoor PM levels with heavy indoor smoke which raises rates of COPD, pneumonia, and cardiovascular illness. Climate change compounds these challenges, with projected temperature increases of 1.3°C by 2030 potentially exacerbating heat-related health risks and vector-borne diseases. A significant share of households, especially in poorer areas, lack reliable piped water and sanitation. Primary health care staffing, diagnostics, outreach limit disease prevention and management in vulnerable areas. Rain-dependent disease surges during monsoons and unequal access to water and sanitation signal vulnerabilities, and water-borne illnesses are likely to worsen under climate change projections.

Recent initiatives show promise, including the multi-sector approach and systems mapping

[6]Pomeroy-Stevens, Amanda, Monica Biradavolu, Damodar Bachani, Fareed Uddin, and Neha Yadav. 2018. "Building Healthy Cities Indore Health Needs Assessment." Arlington, VA: Building Healthy Cities (BHC) project.

[7]Pomeroy-Stevens, A., Bachani, D., Sreedhara, M., Boos, J., Amarchand, R., & Krishnan, A. (2020). Exploring urban health inequities: the example of non-communicable disease prevention in Indore, India. *Cities & Health*, *6*(4), 726–737. https://doi.org/10.1080/23748834.2020.1848327

[8]International Institute for Population Sciences (IIPS) and ICF. 2017. "National Family Health Survey (NFHS-4), India, 2015-16: Madhya Pradesh." Mumbai: IIPS.

[9]https://www.newsclick.in/slum-women-india-cleanest-city-exposed-household-air-pollution

[10]https://timesofindia.indiatimes.com/city/indore/indores-air-quality-improves-in-fy-25/articleshow/121938987.cms

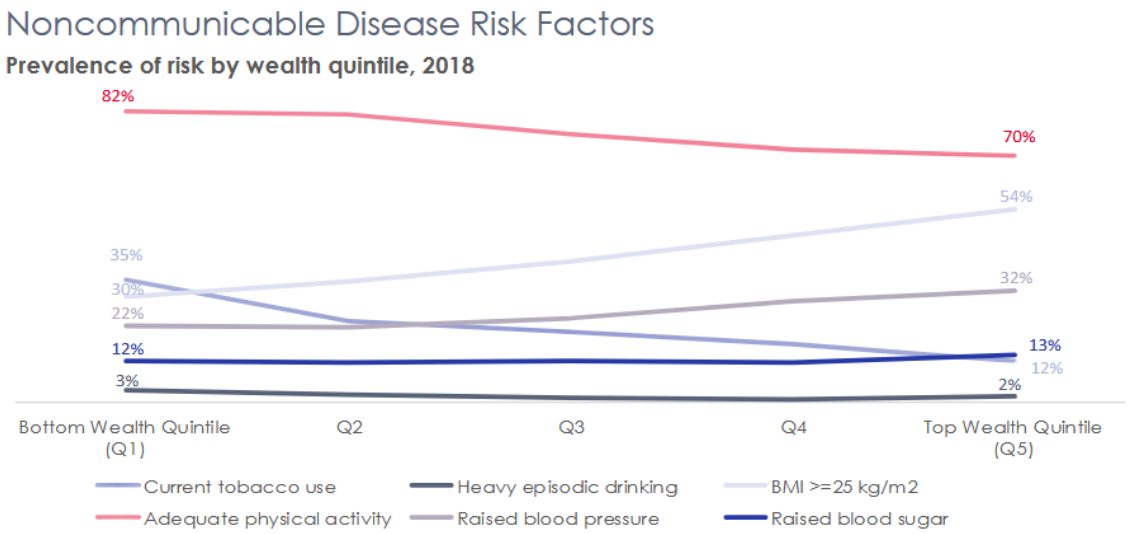

Figure 1.2: Prevalence of Non-communicable Diseases in Indore. Source: 2018 ISCDL/BHC NCD Survey Dataset as cited in Health-at-a-Glance City Profile. https://publications.jsi.com/JSIInternet/Inc/Common/_download_pub.cfm?id=24073&lid=3

exercises engaging a large number of stakeholders. The city's Integrated Command and Control Centre and citizen reporting systems (Indore 311 app) represent innovative governance approaches, though implementation gaps persist. Success requires addressing social determinants, strengthening primary healthcare, improving health data to identify disease hotspots and allocate resources effectively, and ensuring equitable access across socioeconomic strata while building climate resilience into health systems.

1.4 Performance in Climate-Smart Cities Assessment Framework (CSCAF)

Indore's performance across six thematic areas under the Climate-Smart Cities Assessment Framework (CSCAF) 2.0 is presented in Figure 1.3. The city scores highly overall, particularly in waste management (581), urban planning and green cover (404), and mobility and air quality (362). Key measures include widespread adoption of LED streetlights, efforts to retrofit older buildings, and the promotion of solar energy on redeveloped rooftops. In the urban green space category, vertical gardens and Miyawaki plantations are being introduced, covering about 20% of the municipal area.

On the mobility and air quality front, 10% of public buses use low-carbon fuels, and the city has implemented a Clear Air Action Plan. Shared scooter services have also been introduced, and a metro system is in the proposal stage. Water management efforts include the restoration

of 629 traditional water sources, the establishment of a water resource management plant, and planning for future water demand. Waste management emerges as a standout area, with 100% door-to-door collection, 92% dry waste recycling, and bioremediation in action at Devguradia, supported by a new 550 TPD processing plant.

Despite these advancements, there are highlighted key areas for improvement. In energy, transmission and distribution losses remain high at 24%, and only 0.8% of power comes from renewable sources. Urban planning shows uneven access to green spaces, and there is a need to better integrate green infrastructure with lake and riverfront development. In mobility, low coverage of non-motorized transport (NMT), limited clean-fuel buses, and weak last-mile connectivity pose ongoing challenges. Water and waste systems also require attention. Non-revenue water (NRW) is 30%, only 11% of wastewater is reused, and biomedical waste treatment needs to be made more scientific.

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
★★★★	★★★	★★★★★	★★★★	★★★	★★★★★
CSCAF 2.0 Score	330.5	404	362	350	581
Current measures being undertaken in the city	• 98% LED streetlights. • The city is promoting adaptive reuse of older buildings. • 65% of terraces of redeveloped buildings to have solar PV. • Pioneering a floating solar funding model	• 20% of the municipal area is under green cover. • Vertical gardens on the rivers / nullah bridges, Miyawaki plantations being implemented.	• 10% of public buses run on low-carbon fuel. • Metro is proposed. • Clear Air Action Plan is in place. • Shared scooter service in the city.	• 629 traditional water supply sources along with wetlands being restored. • City has a water resources management plant and has identified future water demand.	• 100% of door-to-door collection. • 92% of dry waste is recycled • Bioremediation already in practice in Devguradia trenching ground, 550 TPD plant inaugurated in February 2022
Areas of improvement	• Reducing high Transmission and Distribution losses which is currently 24%. • Increasing power generation from RE sources, which is currently 0.8%.	• Inequitable green and open spaces. • Need to integrate green infrastructure within lake redevelopment.	• Augmenting bus fleet and NMT coverage • Improving last-mile connectivity • Increasing uptake of EVs particularly for shared mobility and public transport (10% of buses run on clean fuels)	• Reducing NRW (currently 30%). • Poor access of tap water, 46% as of 2019. • Increasing use of treated water (currently 11% wastewater is recycled)	• Biomedical waste treatment to be made scientific. • Capturing of methane gas from STPs.

Figure 1.3: CSCAF evaluation of Indore (Source: CSCAF 2.0 assessment as cited in Indore City Climate Action Plan)

2 Climate Projections and Policy Architecture

Understanding long-term climate trends is essential for planning effective interventions in urban health, infrastructure planning, and disaster resilience. Climate projections are scientific estimates of how the climate might change in the future. They help us understand what could happen to temperatures, rainfall, or other weather patterns depending on how much pollution and other human interventions we put into the atmosphere. These projections are not exact predictions. Instead, they show different possibilities based on the choices we make as a society. Scientists use powerful computer models to create these projections. These models simulate how the Earth's systems like the atmosphere, oceans, and land—interact with each other. The results help us imagine what the climate might look like in 20, 50, or even 100 years from now.

The projections are usually compared to a "baseline" or past average, such as the weather between 1976 and 2005. If a projection says the temperature in Indore might rise by 2 degrees Celsius by 2050, it means it will be 2 degrees hotter on average than it was during that past period. Other important terms include "hot days," which are days when the temperature goes above 40 degrees, or "heavy rainfall days," when it rains more than 100 millimeters in one day. Scientists also measure changes in how much water evaporates from the land and how often extreme weather events occur. These projections help cities and governments plan better roads, water systems, and health services to protect people from the risks of a changing climate.

2.1 Climate Projections in Indore: Trends and Implications

Indore is experiencing unprecedented climate changes that will fundamentally reshape life in Madhya Pradesh's commercial capital. New analysis of historical data and climate projections reveals the city is already witnessing significant warming, with more extreme changes ahead.

2.1.1 Temperature Trends Paint Alarming Picture

The data shows warm days have increased by 9% historically, with summer peaks now reaching 44°C in May. Under moderate climate scenarios (RCP4.5), maximum temperatures could rise 1-2.5°C by 2030s, while high-emission scenarios (RCP8.5) project increases of 1.5-4.5°C. Most concerning: warm days are projected to increase by over 70% from current levels.

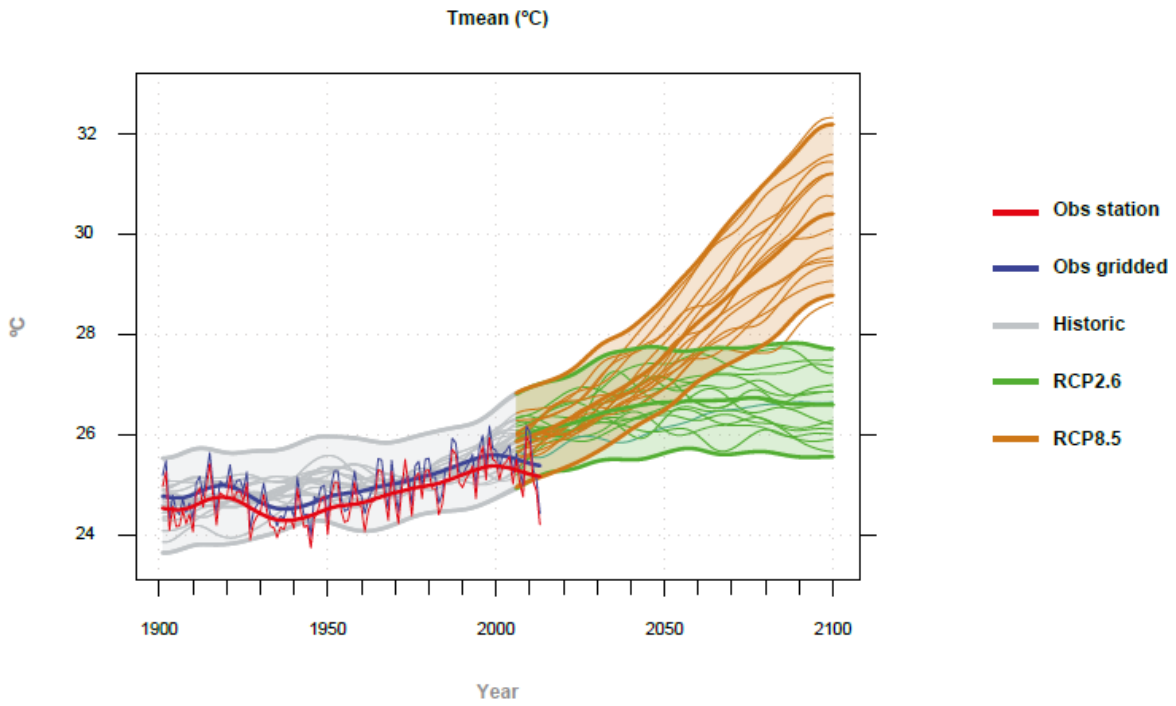

Figure 2.1: Increase in mean temperature for Indore (Source: CEEW, 2020 as cited in Indore City Climate Action Plan)

Winters are disappearing as cold days decrease drastically. This warming trend threatens to extend disease vector seasons and eliminate the cool relief that traditionally made Indore's climate manageable. Higher temperatures can increase ground-level ozone formation and worsen particulate pollution episodes, particularly during winter inversions.

However, the historical profile of Indore reflects a semi-arid climate with pronounced seasonality: hot summers, concentrated rainfall, and relatively cooler, dry winters (see the below chart).

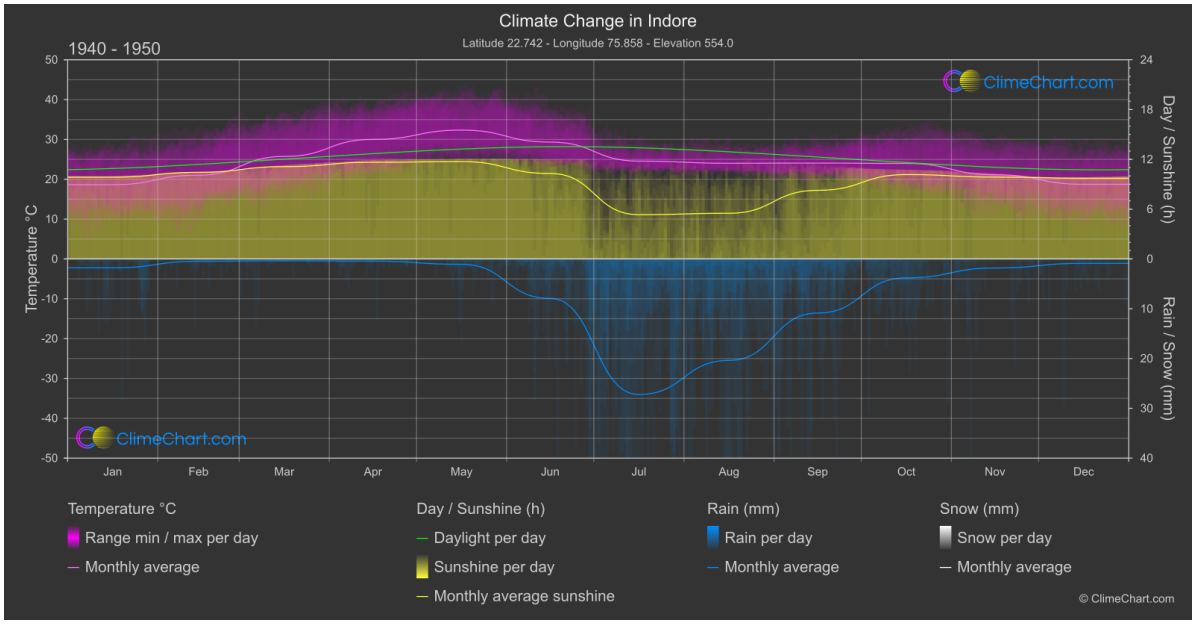

Figure 2.2: Indore Monthly Temperatures in 1940-50 (Source: ClimateChart.com)

During the 1940–1950 period, Indore exhibited:

- **Temperature**: Daily temperatures fluctuated mostly between 10°C and 35°C, with monthly averages (in pink lines) ranging from 18°C in winter to over 30°C in peak summer. There was a marked seasonal cycle, with a sharp cooling during monsoon months (June–September).
- **Rainfall**: Rainfall was highly concentrated in the monsoon, with average daily precipitation spiking dramatically in July and August. Non-monsoon months were largely dry.
- **Sunshine and Daylight**: Sunshine duration (in yellow) dropped significantly during the monsoon months due to cloud cover, while daylight (green) remained relatively constant throughout the year.

Building on national and regional projections from the IPCC and the Indian Ministry of Earth Sciences, climate forecasts for Indore additionally suggest:

2.1.1.1 Increased Heat Stress Days

The number of days with maximum temperatures above 40°C is projected to increase sharply. Night-time minimums are also rising, reducing recovery time from daytime heat and exacerbating cardiovascular and respiratory risks. This shift will likely lead to longer and more

intense heatwaves, increasing thermal stress, especially for outdoor workers, children, and the elderly.

2.1.2 Erratic Rainfall and Urban Flooding

Projections for precipitation in Indore show an increase in the quantum of rainfall during the monsoon months and season as a whole. There may be an increase in precipitation of 7% to 21% under RCP 4.5, and 16% to 42% under RCP 8.5, towards the end of the century. The number of rainy days is also projected to increase during the monsoon. While the total monsoon rainfall may remain similar or increase slightly, the distribution will become more erratic, with intense short-duration rainfall events becoming more frequent. This raises the risk of flash floods, especially in low-lying urban settlements.

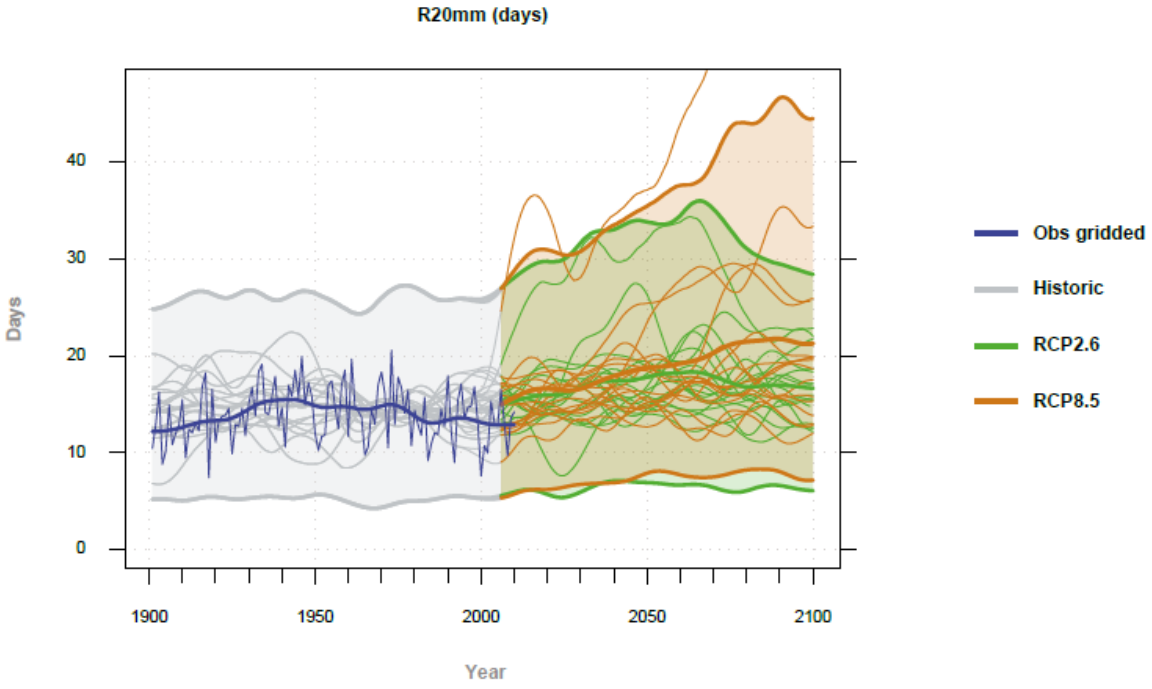

Figure 2.3: Number of heavy-rainfall days for Indore (Source: CEEW, 2020 as cited in Indore City Climate Action Plan)

Drier winters and longer dry spells are projected, which will affect water availability and potentially increase the city's reliance on groundwater and external water transfers.

2.1.3 Implications for Urban Health and Planning

For a city like Indore, these projections have critical implications.

Indore faces high vulnerability in terms of water resources, estimated using indicators such as water availability, crop water stress, extreme events of flooding and drought. The city has a higher baseline vulnerability value for drought, but it reduces towards mid-century. The city also faces increasing vulnerability to reduced surface water availability during the SW and NE monsoons. It will also face increasing water stress. It is estimated to have an increased vulnerability due to the reduced availability of groundwater. The city's groundwater is already severely exploited, and its natural water resources, such as the Kanh and Saraswati rivers, are in poor condition. Groundwater in the area is of medium to high salinity and unfit for drinking. Further, the increasing trend in temperature leading to extreme heat wave conditions will result in higher energy demand for cooling purposes. This gives an opportunity to tap renewable energy sources and create supporting infrastructure to meet most of this excess demand through cleaner fuel sources.

This historical grounding, when viewed alongside projections, underscores the urgency of embedding climate foresight into every aspect of Indore's urban planning and health programming. Building resilience now, especially for young populations, will determine the city's capacity to thrive in an increasingly uncertain climate future. Health systems must be prepared for a rising burden of heat-related illnesses, vector-borne diseases (due to shifts in mosquito breeding seasons), and respiratory conditions linked to worsening air quality. Infrastructure Planning must adapt to increased flood risks and the urban heat island effect. Green cover expansion, water-sensitive urban design, and heat-resilient building norms will be essential. Vulnerable Populations, including adolescents, informal workers, and those in informal settlements, must be prioritised in climate-health strategies to ensure equitable adaptation and access to protective services.

2.2 Climate Policy Architecture

2.2.1 SDG Integration: Cities as Implementation Hubs

The Sustainable Development Goals provide the fundamental framework connecting urban sustainability with health outcomes. SDG 11 (Sustainable Cities) and SDG 13 (Climate Action) work synergistically, with cities serving as the primary implementation sites where climate action delivers immediate health co-benefits. Target 11.6 directly addresses air quality management, potentially preventing millions of the 7 million annual deaths from air pollution globally.

Recent progress tracking reveals that 129 countries reported national disaster risk reduction strategies in 2023, up from 55 in 2015, but severe off-track progress on SDG 13 threatens health

outcomes. Cities like Indore demonstrate how local leadership can accelerate progress through integrated climate-health planning that addresses multiple SDG targets simultaneously.

Key Implementation Pathways for Indian Cities:

- Integrated climate action plans addressing health co-benefits
- Sustainable transportation investments reducing air pollution and promoting active transport
- Climate-resilient infrastructure protecting vulnerable populations
- Early warning systems for extreme weather and health risks

2.2.2 Paris Agreement and Urban Dimensions

The Paris Agreement recognizes cities as critical implementation actors, with over two-thirds of submitted Nationally Determined Contributions showing clear urban content. Cities generate approximately 75% of global emissions but face disproportionate health risks from climate impacts, including urban heat island effects that can increase temperatures by up to 4°C above surrounding areas.

The 2020-2025 period has seen enhanced focus on health co-benefits following COP28's Declaration on Climate and Health, with increased emphasis on nature-based solutions and recognition that health systems both drive climate solutions and face climate vulnerabilities. This creates opportunities for cities to develop health-centered climate policies that deliver multiple benefits.

2.2.3 WHO Climate-Health Guidelines: Practical Tools for Building Healthy Cities

The World Health Organization's Urban Health Initiative provides actionable frameworks for cities addressing the intersection of climate change, air pollution, and urban health. The integrated approach targets the 7 million annual deaths from air pollution while building climate resilience.

Essential WHO Tools for Urban Implementation:

- Health and Climate Change Urban Profiles for standardized risk assessment
- Integrating Health in Urban Planning Source book (updated 2024)
- Health Impact Assessment tools for evaluating climate policies
- COP29 Multisectoral Actions Pathways Declaration for Resilient and Healthy Cities

Implementation Strategies emphasize:

- Health in All Policies approaches integrating health considerations across urban planning
- Multisectoral collaboration spanning transport, energy, housing, and waste management
- Community engagement through participatory climate-health planning
- Evidence-based interventions using local health and climate data

2.2.4 India's National Frameworks: NIUA Leadership in Climate-Health Integration

2.2.4.1 Climate Smart Cities Assessment Framework: Systematic Urban Transformation

The National Institute of Urban Affairs has developed India's most comprehensive urban climate framework through the Climate Smart Cities Assessment Framework (CSCAF), now in its third iteration. The framework comprises 28 indicators across five critical categories: Energy and Green Buildings, Urban Planning and Biodiversity, Mobility and Air Quality, Water Management, and Waste Management.

Framework Architecture and Methodology

CSCAF represents a paradigmatic shift in urban climate governance, moving beyond traditional sectoral approaches to embrace holistic climate-informed development pathways. The framework's methodological rigor is evident in its comprehensive assessment structure, where each of the 28 indicators is designed to capture both mitigation and adaptation dimensions of urban climate action. The assessment employs a progressive scoring system that encourages cities to adopt appropriate climate actions and improve performance over time, initially covering 100 Smart Cities with expansion planned to 500 cities.

The framework's technical sophistication lies in its integration of multiple assessment tools. For greenhouse gas inventorization, CSCAF utilizes the CIRIS (City Investments to Reduce Greenhouse Gas Emissions) tool, following Global Protocol for Community-Scale (GPC) standards. This ensures standardized emission accounting across cities, enabling comparative analysis and benchmarking. The 2006 IPCC Guidelines form the methodological backbone for emission calculations, with higher-tier methodologies employed wherever possible and country-specific emission factors prioritized over default values.

Progressive Assessment and Continuous Improvement

CSCAF's progressive nature encourages cities to advance through assessment levels, with each level representing increased climate action ambition and implementation capacity. Cities begin with basic awareness and planning (Level 1) and progress through implementation phases toward advanced climate leadership (Level 4). This progression model recognizes that cities have varying capacities and starting points.

The regular monitoring and evaluation mechanisms aim to enable cities to track progress over time and adjust strategies based on performance data. The framework's design recognizes the cascading effects of climate risks and can be adapted to future uncertainties. It provisions for legal potential, where framework recommendations could eventually serve as mandated measures for state governments to ensure that 'the right to be free from adverse effects of climate change' is meaningfully addressed through collective effort. This adaptive management approach is crucial for addressing the climate challenges and evolving best practices in urban climate action.

Integration with National and International Frameworks

CSCAF aligns with multiple national and international climate frameworks, including India's Nationally Determined Contributions (NDCs), the UN Sustainable Development Goals, and the Paris Agreement objectives. This alignment ensures that city-level actions contribute meaningfully to broader climate goals while addressing local development priorities.

2.2.4.2 Climate Centre for Cities (C-Cube)

The Climate Centre for Cities (C-Cube) serves as a one-stop resource for climate-informed urban development, following a four-step approach: Planning, Implementation, Replication, and Scale-up. C-Cube represents institutional innovation in urban climate governance, providing technical assistance, capacity building, and knowledge sharing platforms for cities.

C-Cube's approach to climate action planning involves systematic stakeholder consultations, evidence-based assessment, and iterative improvement processes. The center develops city-specific Climate Action Plans (CAPs) that are informed by CSCAF performance analysis, greenhouse gas emissions inventories, and climate vulnerability assessments. This integrated approach ensures that climate actions are contextually appropriate and scientifically grounded.

2.2.4.3 Youth ACT

YouthACT is a comprehensive framework developed by the National Institute of Urban Affairs (NIUA) in partnership with Youth Ki Awaaz to bridge the engagement gap between youth and Urban Local Governments (ULGs) for climate action. The framework emerges from recognizing that while ULGs are at the forefront of tackling urbanization and climate challenges, there remains significant untapped potential in youth contributions to address these issues.

The framework's vision centers on facilitating "sustainable, resilient, and equitable urban futures" by fostering continuous and inclusive youth engagement while enabling ULGs to institutionalize this participation. YouthACT addresses six key climate action areas directly applicable to Indore's context: energy reduction, green cover and biodiversity, water security, circular economy, sustainable mobility, and resilient communities. These align with Indore's

climate action priorities identified in its Climate Action Plan, where the city's 2019 greenhouse gas emissions inventory showed 59% from stationary energy, 30% from transportation, and 11% from waste management.

The framework's three-pronged approach focusing on "What Can Be Done," "How and Who Will Do It," and "What Impact Will It Have" provides a structured methodology for implementing youth-led climate interventions. The framework also emphasizes inclusive participation formats that accommodate broader socio-economic segments of youth, extending beyond those with formal education backgrounds.

For Indore specifically, this framework holds particular relevance given the city's strong performance under the Climate Smart Cities Assessment Framework (CSCAF) 2.0, particularly in waste management and urban planning, though with scope for improvement in energy, green buildings, and water management sectors. Particularly relevant for Indore is the framework's emphasis on overcoming participation barriers through "aspirational rather than obligatory" approaches to climate action, making sustainability pathways appear as opportunities for self-fulfillment rather than moral mandates.

The documented case studies within YouthACT, including successful interventions like the Panchayat Climate Parliament in Kerala and hyper-local adaptation planning in Mumbai, provide tested models that could be adapted to Indore's specific urban context. These examples demonstrate how youth-led initiatives can contribute to data collection, community mobilization, policy engagement, and implementation of climate solutions at the grassroots level. More discussion on this is presented in the **?@sec-community-resilience**.

Part I

Sectoral Descriptions

3 Spatial Planning and Biodiversity

Spatial planning and biodiversity conservation represent the foundation of Indore's climate resilience strategy, directly addressing the city's most pressing environmental challenges while shaping its future development trajectory. This sector encompasses the strategic integration of climate considerations into urban planning processes, focusing on green cover enhancement, biodiversity conservation measures, urban forest development, and climate-resilient infrastructure planning. The significance of this sector becomes evident when examining Indore's current spatial dynamics: the city achieved an impressive "Five Stars" rating (404/500 points) for Urban Planning, Green Cover and Biodiversity under the Climate Smart Cities Assessment Framework, demonstrating strong policy foundations while revealing critical implementation gaps.

The urgency for comprehensive spatial planning stems from Indore's accelerating climate vulnerabilities. Climate projections indicate that mean temperatures will increase by 1.3°C by the 2030s, reaching 2.6°C by 2050, with Urban Heat Island effects adding an additional 2-4°C above surrounding areas. This temperature escalation, combined with projected increases of up to 45 more warm nights and 22% higher rainfall by 2050, creates complex challenges that require integrated spatial responses. The city's current green cover status presents both opportunities and challenges: while per capita green space stands at 16 square meters, exceeding Urban and Regional Development Plans Formulation and Implementation guidelines and constituting 20% of the total municipal area, this green infrastructure suffers from highly uneven spatial distribution. This inequitable distribution of green spaces directly impacts climate justice, particularly affecting vulnerable populations who bear disproportionate exposure to urban heat island effects while lacking access to cooling green spaces.

3.1 Urban Heat and Climate Vulnerability

Understanding Indore's heat vulnerability requires examining the intersection of climate change projections with rapid urbanization patterns. The city's location on the drought-prone Malwa plateau creates baseline climate challenges that are now being amplified by both global warming and local urban heat island effects. Historical climate data shows that Indore was traditionally known for its "salubrious climate with night temperatures less than 25°C and day temperatures reaching around 40°C in summers", but current projections paint a dramatically different future scenario.

The compounding effect of climate change and urbanization becomes particularly stark when examining temperature projections. Under high-emission scenarios, maximum temperatures on some summer days may reach close to 50°C, creating severe risks for outdoor workers, children, elderly populations, and those lacking access to air conditioning. The Urban Heat Island intensity of 2-4°C above surrounding areas means that the city center experiences significantly higher temperatures than its periphery, with concrete surfaces and limited green spaces exacerbating heat retention.

Recent assessments from the Indore Climate Mission (2024-2025) document extreme conditions with temperatures reaching 48°C during multiple heat waves, while night temperatures remain elevated at 30°C, preventing nocturnal cooling that traditionally provided relief. This extreme heat exposure particularly affects urban poor settlements lacking air conditioning and adequate ventilation, creating severe health risks that reduce productivity and income generation capacity. The health implications are substantial: research indicates that 17 out of 20 people in India are vulnerable to extreme weather, with outdoor workers, children, and elderly populations facing disproportionate risks in Indore's urban context.

3.2 Current Green Cover and Biodiversity Status

Indore's green infrastructure presents a complex picture of achievements and persistent gaps. The city's perfect score (100/100 points) for Indicator 2 (Proportion of Green Cover) under the Climate Smart Cities Assessment Framework reflects strong policy commitments, but implementation challenges persist in ensuring equitable distribution and biodiversity conservation. The city's green cover statistics reveal important disparities: while the overall coverage meets national guidelines, spatial analysis indicates concentration in certain areas while others, particularly low-income settlements, remain underserved.

The Urban Biodiversity indicator scored 75/100 points, indicating moderate performance with substantial room for improvement. Current biodiversity conservation efforts lack comprehensive mapping and systematic monitoring mechanisms. The city has not yet implemented a City Biodiversity Index calculation, which would provide essential baseline data for measuring conservation effectiveness and guiding future interventions. This gap represents a significant opportunity, as such indices can inform evidence-based biodiversity planning and track progress toward conservation goals.

Existing green spaces vary significantly in size, quality, and ecological function. The assessment reveals that about 15% of developed area is assigned for recreational buildings in the Indore Development Plan (IDP) 2021, demonstrating policy commitment to green infrastructure. However, the transition from policy to implementation faces challenges including land availability in dense urban areas, maintenance capacity, and coordination between various implementing agencies. The ongoing Sirpur Lake redevelopment project represents a significant opportunity to demonstrate integrated green infrastructure approaches, incorporating local

species introduction and Miyawaki forest techniques while addressing waterfront development pressures.

3.3 Land Use Patterns and Planning Challenges

Indore's rapid urban growth creates both opportunities and challenges for sustainable spatial planning. The Indore Development Authority has developed approximately 30,000 properties for residential, commercial and other uses, indicating substantial development activity that requires careful integration of climate considerations. Current land use patterns reveal concerning trends: the core area is experiencing population decline and commercial conversion, while outer areas face mounting pressure from population growth that threatens remaining open spaces.

The city faces a critical challenge in balancing development pressures with climate resilience needs. Population growth is likely to put pressure on existing open areas, particularly significant since land constraints primarily affect the core area rather than the city's periphery. The growth pattern along two main development axes - South-west (towards Mhow) and north (towards Ujjain) - creates opportunities for planned green corridor development if proactive spatial planning measures are implemented.

A particularly concerning trend involves the increasing construction of multi-storey buildings and glass cladding, which can worsen urban heat island effects and increase energy consumption for space cooling if implemented without climate-responsive design principles. The potential conversion of low height buildings (up to 3 stories) especially along main roads to high rise buildings presents both risks and opportunities. Without proper planning, this densification could block natural wind flows and exacerbate heat island effects. However, with appropriate green building standards and spatial planning integration, such development could incorporate climate resilience features.

3.4 Water Bodies and Ecosystem Services

Water bodies represent critical components of Indore's spatial planning framework, providing essential ecosystem services including flood management, urban cooling, and biodiversity habitat. The Rejuvenation and Conservation of Water Bodies and Open Areas indicator achieved Assessment Level 4 (74/100 points), indicating good progress with scope for enhancement. The city has developed GIS maps of water bodies and open areas, but these require enrichment with comprehensive attributes including area, depth, volume, current status for water bodies, and detailed foliage cover assessments for open areas.

The integration of water bodies into climate resilience planning requires understanding their multiple functions. During Indore's projected climate scenario of up to 22% increased rainfall

by 2050, these water systems will play crucial roles in flood management. However, current drainage challenges indicate significant vulnerabilities: the city's black cotton soil has low permeability, and existing very low coverage of storm water drainage and limited sewerage could prolong flooding duration under climate change scenarios.

The ongoing Sirpur Lake redevelopment project demonstrates integrated approaches to water body management, incorporating green infrastructure techniques including native species introduction and Miyawaki forests. This project serves as a model for incorporating climate adaptation benefits including urban cooling, biodiversity conservation, and flood management while addressing recreational and aesthetic needs. However, successful implementation requires careful attention to community engagement and ensuring that redevelopment doesn't displace informal settlements or restrict traditional water access patterns.

3.5 Disaster Resilience and Spatial Vulnerability

Indore's disaster resilience planning reveals significant gaps that require urgent attention, particularly given projected climate intensification. The Disaster Resilience indicator scored Assessment Level 4 (60/100 points), indicating moderate preparedness with substantial improvement needs. Current disaster management approaches lack the spatial detail and community integration necessary for effective climate adaptation.

The city's vulnerability assessment conducted across 1,250 households from 125 settlements reveals important spatial patterns of climate risk exposure. Three key vulnerability indicators were assessed: Drainage and Sewerage Vulnerability Index (DSVI), Loan and Insurance Vulnerability Index (LVA), and Water Scarcity Index (WSI). These assessments reveal that drainage and water logging risks are concentrated in specific areas, often correlating with socio-economic vulnerabilities.

Climate change projections indicate that increase in precipitation intensity can result in increased frequency and intensity of water logging. The combination of black cotton soil, limited storm water drainage, and poor solid waste collection creates compounding vulnerabilities. Without integrated storm water drainage and flood control planning, the city faces risks of more frequent and intense floods under climate change scenarios. The situation is further complicated by haphazard growth and blockage of natural drainage systems.

Current disaster management planning lacks adequate spatial documentation and ward-level detail. The framework requires development of Ward level Hazard Risk, Vulnerability and Capacity Assessment based on last five years of disaster profiling and socio-economic profile plus community participation. This planning must integrate risk assessment (disaster type, frequency, impact), vulnerability profiling (social, environmental, financial, physical), and capacity/asset mapping for quick response.

3.6 Sectoral Assessments and Priorities

The Climate Smart Cities Assessment Framework evaluation reveals Indore's strong performance in spatial planning policies alongside implementation challenges that require targeted intervention. The Five Stars rating (404/500 points) for Urban Planning, Green Cover and Biodiversity reflects comprehensive policy frameworks, but individual indicator performances highlight specific areas needing attention.

Green Cover achieved perfect scores (100/100 points), demonstrating strong policy commitment and adequate overall coverage levels. However, recommendations emphasize the need for dedicated budget allocation for green cover initiatives, documented annually by environmental cells with details of establishment, activities, and guideline compliance. The assessment recommends encouraging community level activities such as tree plantations, developing community gardens, urban agriculture, terrace gardening, and vertical gardening. Private sector engagement through Corporate Social Responsibility activities or carbon footprint reduction initiatives represents underutilized opportunities.

Urban Biodiversity scored 75/100 points, indicating good foundations with scope for enhancement. Critical gaps include lack of linkage between biodiversity planning and local/city plans, absence of City Biodiversity Index calculation, and limited buffer zone development between built and large natural areas. The assessment recommends developing biodiversity parks and implementing measures to increase biodiversity as part of urban planning processes.

Water Bodies and Open Areas achieved 74/100 points, demonstrating solid progress with enhancement opportunities. Recommendations include developing GIS-based maps of encroachments on water bodies and temporal map series for urban heat islands using remote sensing techniques. The assessment emphasizes need for spatial database development to monitor rejuvenated and conserved water bodies and open spaces and integration of conservation strategies within City Development Plans/Master Plans.

3.7 Governance of Spatial Planning and Biodiversity

Spatial planning and biodiversity governance in Indore involves complex coordination among multiple stakeholders spanning municipal, state, and national jurisdictions. Primary implementing stakeholders include Indore Municipal Corporation (lead), Indore Development Authority, State Knowledge Management Centre on Climate Change (SKMCCC), Madhya Pradesh Forest Department, and Madhya Pradesh State Biodiversity Board (Environmental Planning & Coordination Organisation 2023). The governance framework integrates multiple policy instruments including National Afforestation Program (NAP), Compensatory Afforestation Fund Management and Planning Authority (CAMPA), Green India Mission (GIM), and Nagar Van Project. The AMRUT scheme allocates 2.5% of project costs for park development

conducive for children and senior citizens, providing dedicated funding mechanisms for green infrastructure development.

Implementation challenges include inadequate inter-departmental coordination, limited technical capacity for biodiversity monitoring, insufficient community engagement in planning processes, and weak enforcement mechanisms for spatial planning regulations. The need for Biodiversity Management Committee, State Horticulture/Forest Department, Town and Country Planning Organisation (TCPO), and Urban Local Body coordination requires strengthened institutional frameworks.

Current governance gaps include absence of dedicated environmental cells with adequate technical staff, insufficient budget allocation for green infrastructure maintenance, limited GIS-based monitoring systems, and inadequate community participation mechanisms. Effective governance requires establishing climate change cells at city level with representation from relevant ULB departments, Smart City initiatives, citizen forums, academic institutions, and civil society organizations.

3.8 Suggested Climate Actions

3.8.1 Comprehensive Green Cover Enhancement

Implementing strategic plans for planned green spaces and their integration with urban development requires geotagging of trees and development of comprehensive tree census systems. The strategic approach should include broad goals to increase green cover within specific timeframes, sub-targets for urban green cover benefits including equity, transport, and health co-benefits, protection zones designation, and green corridor development. Implementation strategies encompass green roofs, urban gardens, urban forests, and integration with transportation infrastructure.

3.8.2 Integrated Green Infrastructure Development

The Sirpur Lake redevelopment project demonstrates potential for incorporating green infrastructure techniques including native species introduction, Miyawaki forest establishment, and water quality improvement systems. This approach can be scaled across multiple water bodies while ensuring community engagement and equitable access. Green infrastructure benefits include urban cooling, flood management, biodiversity conservation, and recreational space provision.

3.8.3 Equity-Focused Spatial Planning

Addressing uneven green space distribution requires developing equity indices to incorporate fairness in spatial distribution of urban forests and green infrastructure. Planning must actively prevent "green gentrification" that could negatively impact low-income communities through affordable housing integration, community ownership models, and accessibility planning. Implementation should prioritize areas with high heat vulnerability and limited existing green cover.

3.8.4 Climate-Responsive Urban Design

Integrating climate considerations into spatial planning requires mandatory climate impact assessments for new development projects, green building standard implementation, and urban heat island mitigation measures. Planning guidelines should promote passive cooling design, permeable surface installation, and wind corridor preservation. Development standards should encourage compact, mixed-use development that reduces transportation needs while incorporating green infrastructure.

3.8.5 Disaster-Resilient Infrastructure Planning

Implementing integrated storm water drainage and flood control planning requires systematic, large-scale mapping of flood plains along rivers passing through the city for identification of water logging prone areas. Infrastructure development should include improving disaster response plans including evacuation planning from water logging zones, flood plain risk zoning with advance warning systems, and systematic flood plain mapping.

3.9 Questions for Young Changemakers

3.9.1 Green Justice and Community Empowerment

Indore has decent green cover overall, but it's really unevenly spread around the city. Some neighborhoods have beautiful parks and tree-lined streets, while others, especially low-income areas, barely have any green spaces at all. This isn't just about aesthetics; it literally means some people are living in much hotter, more polluted conditions than others. How can young people push for green infrastructure that actually serves everyone equally? The tricky part is when cities do start "greening" low-income neighborhoods, these changes push out the very communities who needed those improvements most. What strategies could ensure that environmental improvements benefit existing residents rather than displacing them?

3.9.2 Data-Driven Advocacy and Technology Solutions

Indore doesn't have basic tools that some other cities use to track biodiversity and environmental health. This includes things like a City Biodiversity Index or comprehensive urban heat mapping. For a generation that grew up with smartphones, this seems like a huge missed opportunity. Could young changemakers and tech-savvy students fill these data gaps? Imagine developing apps that let citizens report green space conditions, track tree health, or map heat islands using simple temperature readings. What if neighborhood groups could crowdsource environmental monitoring and use this data to advocate for specific improvements?

3.9.3 Planning the City You Want to Live In

The city is growing fast, with new high-rises and development projects changing Indore's landscape every year. Right now, a lot of this growth is happening without much thought to climate resilience or community needs. But what if young people got seriously involved in urban planning processes instead of just watching from the sidelines? How could students, young professionals, and community groups actually influence where new parks get built, how public transportation connects their residences to places of education and leisure, or whether new developments include climate-smart design? The Sirpur Lake redevelopment project shows that it's possible to combine environmental restoration with community spaces - can we make this approach the norm rather than the exception for all of Indore's future development?

4 Transport

Transport in Indore is closely linked to climate risk, public health, and access for young people. It affects how people reach schools, jobs, and services. It also shapes how safe and included they feel in the city. Transport adds to greenhouse gas emissions, and is affected by climate events like floods and heatwaves. That makes it a critical area for climate action.

The transport system today is a complex mix of formal and informal, motorized and non-motorized, centralized and fragmented modes that create differential access patterns strongly correlated with age, gender, and economic status. Like many Indian cities, Indore has witnessed a rapid increase in private vehicle ownership over the past two decades, especially two-wheelers, with registered vehicles growing by over 150% since 2010. This surge has contributed significantly to air pollution, noise, traffic congestion, and road safety concerns. While private motorization has increased, public transport infrastructure has not kept pace, forcing young people into unsafe, uncomfortable, and climate-exposed travel conditions. Only 46% of roads have footpaths despite nearly 30% of daily trips made by foot or bicycle, creating dangerous conditions for students walking to schools and colleges. The city's Bus Rapid Transit System (BRTS), launched in 2013, covers only 11.7 km of the city's extensive road network, leaving vast areas, particularly peripheral settlements with high concentration of low-income youth, without reliable public transport access.

These mobility issues are entangled with climate vulnerability and public health outcomes that disproportionately affect young people. Many young people walk or use shared transport, especially in poorer areas. They are often the most affected when roads are unsafe or public transport is limited. To reduce emissions and protect people, Indore needs to improve its transport system and address the mobility inequalities. This includes better public buses, safer walking and cycling paths, and cleaner fuel options. Informal systems like shared autos must also be part of the plan.

4.1 Modal Split and Youth Travel Patterns

Understanding Indore's transport crisis requires examining the complex modal distribution that reveals stark inequalities in mobility access and climate exposure. According to the Climate Action Plan, two-wheelers dominate the modal share at approximately 40%, followed by public transport at 19%, and walking at 15%. However, these aggregate figures mask significant variations across age groups, with youth showing distinct patterns shaped by economic constraints, safety concerns, and institutional locations.

A 2019 survey conducted by the Municipal Corporation and Urban Mass Transit Company found that nearly 30% of all daily trips in Indore are made by foot or bicycle, with students comprising a substantial portion of these users. This high dependence on non-motorized transport among youth reflects both economic necessity—many cannot afford even subsidized public transport—and geographic concentration of educational institutions that enable shorter trips. However, infrastructure for these modes remains grossly inadequate: footpaths, where they exist, are often narrow, broken, or encroached upon; pedestrian crossings are scarce and poorly marked; dedicated cycling lanes are minimal, fragmented, and disconnected from major trip generators like schools, markets, and workplaces.

The gendered dimensions of modal choice create additional complexities. Surveys conducted by civil society organizations in Indore repeatedly highlight everyday harassment faced by women and girls in public and shared transport. Girls' mobility often relies on parents or rickshaws, with many rarely going alone to crowded markets. This restriction intensifies during extreme weather events—both heat waves and heavy rainfall—when families become more protective, further limiting girls' access to education, employment, and social opportunities. The lack of public safety mechanisms, including the absence of dedicated support systems for mobility security, forces many families to opt for more expensive but perceived-safer modes like private vehicles or accompanied travel.

Public transport usage among youth faces multiple barriers beyond basic availability. While students and older adults are eligible for subsidized fares—with monthly passes available at 200 compared to regular 800 passes—the reliability and safety of these services affect their usability. Overcrowded buses, lack of female staff, poor lighting at stops, and social stigma attached to certain modes all contribute to a sense of insecurity that restricts not only access to education and work but also participation in social and political life.

4.2 Climate Vulnerabilities in Transport Systems

Indore's transport infrastructure faces severe climate stresses that create compounding vulnerabilities for youth mobility. Temperature projections paint an alarming picture: daily maximum temperatures may increase 1.8–2°C by 2050 according to the state action plan on climate change, while other sources suggest even greater increases. By 2030, maximum temperatures may be close to 50°C on some summer days, with the average minimum temperature rising 2°C by the 2030s and by 3–4°C by the 2080s. The urban heat island effect could push temperatures 2–4°C higher within Indore, creating extreme conditions for anyone using non-air-conditioned transport or walking/cycling.

During the hotter months, the risk of heat exhaustion for cyclists and pedestrians increases substantially, yet climate projections suggest this will worsen significantly in coming years. Streets lack adequate shade, increasing heat exposure for the 30% of trips made by walking or cycling. This creates a vicious cycle where those who can afford it shift to private motorized

transport, increasing emissions and congestion, while those who cannot—predominantly youth from low-income families—face increasing health risks from heat exposure.

The transport-heat nexus manifests in multiple ways that affect youth mobility patterns. Heat stress leads to missed school days and reduced participation, creating direct links between climate impacts and educational outcomes. During peak summer months, many students attempt temporal adjustments—traveling during early morning or late evening hours—but this creates safety concerns, particularly for girls. Others seek shaded routes even if longer, adding time and distance to already challenging commutes. Those who can afford it switch to shared autos or private vehicles, but for many, the only option is activity reduction—simply moving less, with profound impacts on education, social life, and development opportunities.

Monsoon flooding creates different but equally severe challenges. In 2020, Indore witnessed severe urban flash floods with roads submerged under as much as 12 inches of water. Regular flooding and waterlogging occur due to low-lying areas and lack of adequate drainage facilities, creating particular risks for non-motorized transport users who must wade through contaminated water. The trouble for over 60,000 commuters regularly using i-buses multiplies in the monsoon, as ticketing systems falter and waiting times extend dramatically. Informal transport becomes unreliable or completely unavailable during heavy rainfall, stranding youth who depend on these services.

4.3 BRTS: Promise, Performance, and Dismantling

The Indore Bus Rapid Transit System (BRTS), branded as iBus, represents both the potential and pitfalls of sustainable urban transport planning in intermediate cities. Launched in May 2013 under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), the system was envisioned as a high-capacity, dedicated-lane network to decongest roads and reduce emissions. The 11.7 km AB Road corridor was designed to cater to 70,000 passengers daily, with 22 bus stops and 4 interchange stations promising fast, reliable, air-conditioned travel.

Initial public reaction ranged from strong opposition to enthusiastic support, reflecting the contested nature of road space allocation in Indian cities. To build public ownership, Atal Indore City Transport Services (AICTSL) held a naming contest in August 2012, selecting "iBus" where "i" signifies both "intelligent" and "Indore."

Performance metrics show significant adoption despite limited coverage: ridership increased from 23,000 in 2013 to over 50,000 in February 2024, demonstrating sustained demand for quality public transport. The system achieved 10% electric bus deployment and was positioned to become India's first fully electrified BRTS. However, operational challenges undermined user experience and political support. By 2022, commuters reported waiting 30 to 60 minutes just to get tickets due to system failures. The barcode-based entry system frequently malfunctioned, forcing manual gate operations that negated the rapid transit promise.

The December 2024 announcement by Chief Minister Mohan Yadav to dismantle the BRTS represents a critical juncture in Indore's transport evolution. The Chief Minister argued that "the BRTS lane is empty while traffic is spilling onto both sides, causing frustration for drivers." This framing privileges private vehicle flow over public transport efficiency, ignoring that 80% of iBus users oppose removal and that the system serves 60,000 daily passengers who lack alternatives.

For youth, BRTS dismantling means losing the only reliable, air-conditioned public transport option. Until the metro is operational, removing BRTS will leave them without a suitable alternative. iBus is relatively quicker during peak hours and without it, commuting will become far more difficult. The dismantling follows Bhopal's BRTS removal, suggesting a statewide retreat from sustainable transport despite mounting climate commitments.

4.4 Informal Transport: The Invisible Backbone

A striking feature of Indore's mobility landscape is widespread use of informal and shared transport modes that fill critical gaps left by inadequate formal systems. Auto-rickshaws, e-rickshaws, vans, and even tractor trolleys provide essential connectivity, especially in areas not served by formal buses. These modes are often the only available transport for low-income residents living in peripheral settlements, where walking or cycling may not be viable due to distance, road conditions, or personal safety.

The informal transport sector employs thousands of residents directly as auto drivers, e-rickshaw operators, bicycle delivery agents, and mechanics. Many are youth themselves, entering the mobility economy through family connections or as a survival strategy when formal employment remains inaccessible. These workers face extreme vulnerability: exposed to high levels of air pollution, long hours in traffic, and physically demanding labor, often without basic protections like social security, rest facilities, or clean drinking water.

Despite their essential role in low-carbon and demand-responsive mobility, these actors remain marginalized in climate and transport discourse. Vehicles are poorly maintained, creating safety risks and higher emissions. Fare structures are ad hoc, rising during peak demand or extreme weather when users are most vulnerable. Drivers lack formal recognition, training, or access to affordable finance that could enable vehicle upgrades or electric transitions.

The growth of app-based aggregators has partially formalized some informal transport, but benefits remain concentrated among platform companies rather than drivers or users. Youth increasingly rely on these platforms for safer travel options, particularly young women who value the ability to share trip details and track routes. However, surge pricing during extreme weather events—precisely when alternative options disappear—creates affordability barriers that force youth back to unsafe modes or mobility restriction.

4.5 Non-Motorized Transport: Essential but Neglected

Walking and cycling continue as vital but undervalued components of daily mobility in Indore, particularly for youth whose short-distance educational trips and economic constraints make these modes essential. The 30% modal share for non-motorized transport masks enormous infrastructure deficits that create dangerous, uncomfortable, and climate-exposed travel conditions.

Infrastructure inadequacy manifests in multiple dimensions. Where footpaths exist—on only 77% of roads according to official data—they are often narrow, broken, encroached upon by vendors or parked vehicles, or simply end abruptly. Pedestrian crossings are scarce and poorly marked, forcing dangerous road crossings particularly near schools and colleges. The lack of traffic calming measures near educational institutions creates daily hazards as students navigate high-speed traffic designed for adult vehicle users, not youth pedestrians.

Cycling infrastructure remains even more neglected despite recent token efforts. The iBike public bicycle-sharing system and limited cycle tracks under the Smart City Mission have not seen sustained uptake due to fundamental design failures. Factors limiting cycling adoption include lack of shade and protection from heat, poor quality road surfaces creating safety hazards, security concerns especially after dark, and persistent social stigma associating cycling with poverty.

The intersection of climate vulnerability and infrastructure inadequacy creates severe constraints on non-motorized transport. During peak summer, walking or cycling becomes a health hazard rather than sustainable transport choice. The absence of shade trees, water points, or cooling infrastructure along major corridors forces youth to choose between heat exposure and mobility. During monsoons, poor drainage turns walkways into streams, while absence of covered pathways exposes pedestrians to heavy rainfall.

Gender dimensions add another layer of complexity to non-motorized transport challenges. While boys may navigate the city on bicycles despite heat and poor infrastructure, girls face additional barriers including harassment, family restrictions, and safety concerns. The absence of secure cycle parking at schools and colleges means even girls who own bicycles cannot use them for education trips. Poor lighting, isolated stretches, and lack of "eyes on the street" create environments where parents justifiably restrict daughters' independent mobility.

4.6 Health Impacts at the Transport-Climate Interface

The convergence of inadequate transport infrastructure, extreme climate events, and youth vulnerability creates multiple health impact pathways that extend beyond immediate physical risks. Air pollution exposure during commutes represents the most pervasive health threat, with transport accounting for 30% of GHG emissions in the city, primarily from fossil fuel consumption. Youth face prolonged exposure during walking, cycling, or waiting at bus stops

without protection, with developing respiratory systems particularly vulnerable to PM2.5 and PM10 concentrations that regularly exceed safe limits.

Heat stress compounds air pollution impacts through multiple mechanisms. Physical exertion during walking or cycling in extreme temperatures creates cardiovascular strain, particularly dangerous for youth with underlying health conditions. Dehydration risks increase during long waits at shadeless bus stops or walks along sun-exposed routes. The urban heat island effect pushes temperatures 2–4°C higher in dense areas where many schools and colleges locate, creating micro-environments of extreme heat exposure.

Road safety emerges as another critical health risk amplified by climate events. Poor visibility during dust storms or heavy rainfall increases accident risks for pedestrians and cyclists already vulnerable on infrastructure designed primarily for motorized vehicles. Flooding forces pedestrians into roadways shared with vehicles, while waterlogged potholes create hidden hazards for two-wheeler users. The absence of safe crossing infrastructure near educational institutions means thousands of youth daily navigate dangerous intersections without protection.

Beyond direct physical impacts, transport inadequacy creates cascading health effects through reduced access to healthcare, limited physical activity opportunities, and mental health stresses. Youth in peripheral areas face particular challenges accessing health services, with transport barriers delaying or preventing care. The hostile walking and cycling environment discourages physical activity, contributing to sedentary lifestyles and associated health risks. Daily mobility stress—from harassment, overcrowding, uncertainty, and climate exposure—creates anxiety and mental health impacts particularly acute among adolescent girls facing additional safety concerns.

4.7 Emerging Mobility Solutions and Lost Opportunities

Indore's efforts toward promoting electric mobility represent both progress and missed opportunities in creating sustainable youth-friendly transport. Under schemes like FAME-II and Smart City funding, the city procured a limited fleet of electric buses operational on select routes but remaining a small fraction of overall public transport. Charging infrastructure remains minimal and largely limited to central nodes, without robust maintenance systems, route rationalization, or fare integration that could enable scalability.

The private sector shows more dynamic adoption, with electric two- and three-wheelers growing rapidly but largely outside formal policy mechanisms. E-rickshaws provide affordable last-mile connectivity crucial for youth reaching educational institutions from transport nodes, yet operate in regulatory grey zones without support for drivers or safety standards for passengers. The proposed conversion of i-ride rental scooters to electric could provide affordable access to clean mobility, but implementation remains stalled despite clear youth demand for such services. Digital platforms represent another arena of private sector innovation and challenge. While apps enable safer travel through tracking and sharing features valued by young women,

they also create new exclusions for youth without smartphones or digital payment access. The concentration of app-based services in central areas leaves peripheral youth underserved, while surge pricing during extreme weather events when alternatives disappear creates affordability barriers.

The dismantling of BRTS represents the starkest lost opportunity, removing the only high-capacity, climate-controlled public transport option just as climate impacts intensify. The decision reflects political prioritization of private vehicle flow over sustainable mobility, ignoring successful global examples where BRT systems anchor youth-friendly, climate-resilient transport networks. For the 50,000 daily users, many of them students and young workers, dismantling means returning to overcrowded and unreliable city buses, expensive autos, or dangerous and inaccessible non-motorized modes.

4.8 Governance and Institutional Challenges

Transport governance in Indore involves complex coordination among multiple agencies with overlapping responsibilities and often conflicting priorities. Atal Indore City Transport Services Limited manages public buses and BRTS, while the Regional Transport Office regulates private vehicles and licensing. Indore Municipal Corporation maintains roads and theoretically oversees non-motorized infrastructure, while traffic police focus on vehicle flow rather than pedestrian safety. This fragmentation creates gaps where mobility needs remain unaddressed.

Policy frameworks exist but lack implementation mechanisms or youth focus. The National Urban Transport Policy emphasizes sustainable mobility and transit-oriented development, while the Street Design Guidelines provide standards for pedestrian infrastructure. However, these remain largely unimplemented, with road projects continuing to prioritize vehicle capacity over walking and cycling infrastructure. The absence of mandatory Transport Impact Assessments for new developments means schools, colleges, and residential areas generate transport demand without corresponding infrastructure provision.

Critically, youth remain excluded from transport planning processes despite comprising 30% of the population and facing distinct mobility needs. No formal mechanisms exist for student representation in transport planning, while public consultations—when held—usually occur at times and locations inaccessible to a majority of young people. The technical nature of planning documents and absence of youth-friendly communication means even motivated young people cannot effectively engage with transport policy.

Financing mechanisms similarly disadvantage sustainable youth mobility. Road widening and flyover projects receive priority funding, while pedestrian infrastructure and public transport enhancement face budget constraints. The economic logic privileges vehicle throughput over

accessibility, ignoring that youth contribute minimally to congestion but bear maximum impacts from automobile-centric planning. Cost-benefit analyses fail to account for health impacts, educational access, or climate vulnerability that sustainable transport infrastructure could address.

4.9 Climate Actions and Youth-Centered Solutions

Creating climate-resilient youth mobility requires fundamental reimagining of transport planning paradigms, centering the needs of a 14-year-old girl walking to school or an 18-year-old cycling to work rather than peak-hour vehicle flow. Immediate interventions should focus on heat mitigation along key corridors connecting educational institutions, including shade trees, water points, and covered walkways that make non-motorized transport viable even in extreme weather.

Bus stop upgrades represent achievable quick wins: installing solar-powered fans, seating with shade, and real-time arrival information reduces climate exposure while waiting. Prioritizing stops near schools and colleges for upgrades demonstrates visible commitment to youth mobility. Similarly, creating safe walking and cycling zones around educational institutions through traffic calming, dedicated lanes, and crossing infrastructure addresses immediate safety while building constituency for broader changes.

Medium-term strategies must address systemic gaps through integrated planning. Developing youth mobility plans for each ward—mapping education and employment destinations, identifying infrastructure gaps, and designing connected networks—ensures interventions respond to actual travel patterns. Mandating Transport Impact Assessments for new educational institutions and large residential developments creates mechanisms for proactive infrastructure provision.

Institutional reforms should create dedicated youth mobility cells within transport agencies, with mandatory representation from student unions, youth organizations, and adolescent health groups. Earmarking percentage of transport budgets for youth-focused infrastructure ensures sustained investment. Creating grievance mechanisms specifically for student transport issues enables responsive governance that addresses problems before they become crises.

Long-term transformation requires reimagining Indore as a city where sustainable mobility is aspirational, not stigmatized. This means positioning cycling as modern and empowering through youth ambassadors, cultural events, and infrastructure that makes it comfortable and safe. It means ensuring public transport provides dignity through cleanliness, reliability, and respect for users. Most fundamentally, it means recognizing that youth mobility is not a transport issue but a development imperative determining whether Indore's demographic dividend becomes reality or remains unrealized potential.

4.10 Questions for Young Changemakers

4.10.1 Mapping Mobility Injustice

Every day, thousands of youth in Indore face mobility challenges that remain invisible to planners sitting in air-conditioned offices. What if youth groups created crowd-sourced maps showing exactly where footpaths end abruptly, where crossing the road means risking your life, where bus stops lack any shade or seating? Could student unions organize "mobility audits" of routes to major schools and colleges, documenting with photos and videos the daily hazards youth navigate? How can we use technology, even simply WhatsApp, to collect and present data that forces action on youth mobility needs?

4.10.2 Reclaiming Streets for People

The decision to dismantle BRTS reflects political calculations that privilege car owners over the 60,000 daily bus users, many of them youth. But what if youth organized to show different possibilities? Could student groups organize "car-free days" around colleges, demonstrating how streets transform when people, not vehicles, have priority? What would it take to pilot "school streets" that restrict vehicle access during arrival and departure times, creating safe zones for walking and cycling? The global movement for livable streets shows that change often starts with temporary interventions that help people imagine permanent transformation. How can Indore's youth lead this reimagining?

4.10.3 From Stigma to Aspiration

In Indore, cycling is stigmatized as transport for the poor, while car ownership represents success despite its role in creating pollution and congestion. How can youth flip this narrative? What if student influencers started promoting cycling as fit, modern, and environmentally conscious? Could youth organizations partner with local artists to create vibrant, Instagram-worthy cycle lanes that make sustainable transport aspirational? The climate crisis demands cultural transformation alongside infrastructure change. Young people have always driven cultural shifts, from fashion to music to social values. How can this generational power reshape *mobility culture* in Indore, making walking, cycling, and public transport symbols of progressive values rather than economic constraint?

5 Water Systems: Stress and Scarcity

Water systems represent the most fundamental intersection of climate vulnerability and urban development in Indore, creating cascading impacts that affect public health, economic productivity, and social equity across the city's diverse communities. This sector addresses both water security and climate adaptation through comprehensive evaluation of water conservation measures, wastewater treatment and reuse, flood management systems, and groundwater management. The framework recognizes water as both a climate vulnerability and an emission source through energy-intensive treatment and distribution processes that require urgent transformation.

Water scarcity emerges as Indore's primary climate-health threat, consistently identified across multiple research assessments as the city's most critical vulnerability. The Indore City Resilience Strategy developed through the Asian Cities Climate Change Resilience Network established water accessibility as the city's primary climate stressor, affecting 540 slum settlements prone to flooding and vector-borne diseases. This comprehensive multi-stakeholder assessment mapped vulnerabilities and developed adaptation strategies specifically addressing water-health connections that continue to shape the city's development challenges.

Current water supply challenges reveal the severity of this crisis: only 46% of the population receives piped water, creating a substantial 30% supply deficit where demand reaches 700 MLD while supply remains limited to 500 MLD. This forces 72% of households to rely on alternative sources including expensive private vendors, contaminated groundwater, and distant surface water collection that creates significant time burdens, particularly for women and children. The Environmental Planning & Coordination Organisation vulnerability assessment reveals the quantitative dimensions of this challenge: current water demand of 290 million liters per day is projected to reach 422 MLD by 2022, while climate change scenarios predict rainfall variations of -4% to +8% by 2046-2065 [Environmental Planning & Coordination Organisation (2023)]. This mismatch between growing demand and uncertain supply creates cascading health risks, particularly for urban poor populations who experience the most severe water stress while using the least water per capita.

5.1 Water Supply Sources and Infrastructure Challenges

Understanding Indore's water crisis requires examining the complex infrastructure network that struggles to meet growing demand while managing significant distribution losses. About

92% of Indore's water supply comes from surface water sources, with the Narmada Water Supply Scheme contributing 81%, while the remaining comes from Yeshwant Sagar Reservoir and Bilaoli Tank. Sub-surface water from tube wells constitutes about 8% of total water supply as a public source, though more than 30,000 private tube wells operate throughout the city with precise information regarding these wells currently unavailable.

The Narmada Water Supply Project represents the most important source, involving pumping water from a distance of 70 kilometers from the Narmada River and supplying it to the city through pipelines. This long-distance water transfer creates both energy-intensive operations and costly supply chains, making Indore's water among the most expensive in the country at INR 18/kl compared to INR 8-10/kl in other cities. Despite these substantial costs and infrastructure investments, per capita water availability remains below prescribed standards of the Central Public Health & Environmental Engineering Organization.

The total water supply to Indore reaches 273 MLD including the third phase of the Narmada project, but water is supplied on every alternative day in the city for a maximum of two hours. This intermittent supply pattern forces households to invest in private storage systems and creates additional costs for low-income families who lack adequate storage capacity. Water security studies report illegal water connections in the range of 20,000 to 40,000 accounting for 30-50% loss, indicating substantial governance challenges in ensuring equitable water distribution.

Local water sources face severe degradation challenges: the local reservoirs have silted up and lost nearly 25% of their capacity, while groundwater sources experience unsustainable extraction rates. The Central Ground Water Board reports that the Indore block is over-exploited by 148%, creating long-term sustainability concerns that climate change will further exacerbate. Groundwater levels declined from 150 meters in 2012 to 160 meters in 2023, indicating accelerating depletion rates that threaten the viability of private wells that many households depend upon.

5.2 Demand Projections and Climate Vulnerabilities

Indore's water demand projections reveal alarming gaps between current supply capacity and future needs that climate change will significantly worsen. Based on projections from past growth rates, the population is expected to increase to about 4 million by 2030, while industrial demand is expected to double from 30 MLD to 60 MLD by 2030. After deducting current supply, a gap of 360 MLD is expected by 2024, with total net requirement reaching 564 MLD by 2024.

Climate change amplifies these demand-supply mismatches through multiple pathways that create compounding vulnerabilities. Warmer conditions including more intense and frequent hot extremes and heat wave days increase water stress and drought-like events while creating

negative impacts on labor productivity, particularly for outdoor workers. Higher temperatures also drive potential increases in demand for air conditioning, which increases energy consumption and creates additional pressure on water resources used for power generation cooling.

Higher annual rainfall totals and more frequent heavy rainfall events create potential increases in flood risk while creating possible implications for water balance and the quantity and quality of water resources. This paradox means that Indore faces both increased flooding risks and continued water scarcity, as extreme rainfall events often overwhelm infrastructure without effectively recharging groundwater or filling storage reservoirs.

Climate change scenarios predict rainfall variations of -4% to +8% by 2046-2065, creating substantial uncertainty for water resource planning. The city faces high risk of drought and increasing vulnerability to reduced surface water availability during the Southwest and Northeast monsoons, while also experiencing increasing crop water stress that affects regional food security and may drive additional migration to urban areas.

The city's location in the semi-arid zone with high variability in annual rainfall and agricultural risk-prone region in the rain-shadow zone of Western Ghats creates baseline vulnerabilities that climate change will amplify. Any changes in climatic conditions can further increase risks to subsistence agriculture, forcing rural population migration to nearby cities. This creates both push migration from climate-stressed rural areas and pull migration toward Indore's growing economy, imposing additional pressure on water resources and infrastructure.

5.3 Non-Revenue Water and Distribution Losses

Non-revenue water represents one of Indore's most significant water management challenges, creating both financial losses for the municipal corporation and reduced access for residents. Non-revenue water losses remain at 30% according to CSCAF 2.0 data, indicating substantial inefficiencies in the distribution system that require urgent intervention. The city lacks efficient monitoring of consumption, leakage, and illegal exploitation of water, making it difficult to implement targeted reduction strategies.

Water security studies report illegal water connections in the range of 20,000 to 40,000 accounting for 30-50% loss, demonstrating governance challenges that extend beyond technical infrastructure issues. These losses disproportionately affect water availability for formal customers while creating equity challenges where informal connections may provide water access for low-income communities lacking formal service connections.

The Municipal Corporation faces serious revenue losses related to water supply systems, which seriously affects maintenance programs. This creates a vicious cycle where inadequate maintenance leads to increased leakage, further reducing revenue available for system improvements. Dedicated programs for leak detection are immediately required, focusing on maintenance-related matters as well as illegal water connection/water withdrawal practices.

Municipal Corporation's expenditure on tankers supplying water experiences heavy transportation losses, indicating inefficient emergency water distribution systems. Instead, amounts spent on this should be transferred toward leakage repair and formulation of active maintenance and vigilance teams. The city's plan to implement radio frequency smart water meters in 24,000 houses represents a significant step toward better consumption monitoring, though this requires scaling up across the entire service area.

As per CSCAF 2.0 data, the city does not have a metering policy to install water meters at consumer tap connections, making it difficult to estimate the quantity of water consumed and physical loss. This lack of consumption data prevents implementation of demand management strategies and makes it impossible to identify high-usage customers or detect leakage at the household level.

5.4 Wastewater Treatment and Reuse Systems

Indore's wastewater management infrastructure demonstrates both achievements and significant opportunities for expanding circular water economy approaches. The city has a 245 MLD sewage treatment plant at Kabit Khedi, with treated water supplied to farmers for irrigation and transmitted to 101 gardens and 35 hydrants for various municipal purposes. From decentralized STPs, treated water is pumped to 70 gardens, 38 hydrants and four lakes: Pipliapala, Naytamundala, Pipliyahana and Bijalpur.

However, wastewater reuse remains limited, with only 11% of wastewater recycled according to CSCAF 2.0 data. This represents a massive missed opportunity given the city's severe water scarcity. The city is planning to implement a 25 km pipeline to supply treated water to gardens, which could significantly expand reuse applications. Indore can issue city-level mandates requiring industries within the Municipal Corporation area to use treated wastewater for thermal power plant cooling and other non-potable purposes.

Environmental risk assessment reveals that over 20% of sewage waste enters Indore's water supply untreated, while 80% of sewers remain under-utilized or blocked. This creates exposure pathways for microbial pathogens including Giardia lamblia and Vibrio cholerae, particularly affecting vulnerable populations including children, elderly, and immunocompromised individuals. Climate change amplifies these risks through multiple mechanisms: monsoon flooding overwhelms inadequate wastewater infrastructure, extreme heat concentrates pollutants, and water scarcity forces reliance on contaminated sources.

The GHG emissions from wastewater treatment for Indore reached 0.3 mtCO2e in 2019, indicating opportunities for both emission reduction and energy recovery from wastewater treatment processes. The city has saved over INR 3 million through energy-efficient water supply systems until November 2019, though periodic energy audits for water supply systems should be carried out with energy consumption and savings tracked more consistently.

The implementation of green walls in buildings for grey water reuse represents innovative approaches to decentralized wastewater management. Such systems can reduce demand for freshwater by 120 liters per capita per day while providing on-site treatment solutions that reduce pressure on centralized infrastructure.

5.5 Flood Management and Storm Water Systems

Indore faces critical flood management challenges that climate change projections indicate will intensify significantly. In 2020, Indore witnessed severe urban flash floods with roads submerged under as much as 12 inches of water due to heavy showers. Regular flooding and water-logging occur due to low-lying areas and lack of adequate drainage facilities, creating public health risks and economic disruptions that disproportionately affect low-income communities.

Indore is located on the Kanh River basin and faces regular flooding, with contamination of natural drainage paths along the Kanh river due to waste dumping leading to water logging and flooding risks, especially in slums. This creates compounding vulnerabilities where inadequate solid waste management exacerbates flood risks while contaminated floodwaters create disease transmission pathways.

Climate Smart Cities Assessment Framework evaluation reveals poor performance for Flood/Water Stagnation Risk Management, scoring Assessment Level 2 (15/100 points), indicating urgent need for comprehensive flood management planning. Current flood management approaches lack adequate city-level structural and non-structural strategies including disaster management cells, early warning systems, emergency response plans, and contingency planning.

An integrated flood and storm water management plan is essential to reduce urban flooding risks through multiple interventions. Such plans should reduce road and building flood risks, incorporate storm water considerations into new developments, improve water reuse and water security, reduce infiltration of untreated sewage into water bodies, enhance and recharge groundwater tables, and improve coordination for flood risk management.

Sustainable urban drainage systems represent promising approaches, including permeable paving on driveways and footpaths, garden beds designed for infiltration (raingardens), lawns and vegetation, swales, and soak wells. These nature-based solutions provide multiple co-benefits including urban cooling, groundwater recharge, pollutant filtering, and recreational space creation.

However, low-income communities, informal residents, workers, and migrants are highly impacted by climate change-induced urban flooding. Nature-based solutions such as green infrastructure projects for residential properties typically have high one-time installation costs and inflexible payment schemes that may be expensive for these communities. Planning must

ensure that flood management investments don't inadvertently create "green gentrification" that raises nearby real estate prices and displaces low-income residents.

5.6 Sectoral Assessments and Priorities

The Climate Smart Cities Assessment Framework evaluation reveals mixed performance across water management indicators, demonstrating both achievements and critical improvement needs. Water Resources Management achieved Assessment Level 5 (100/100 points), indicating strong policy frameworks, while Wastewater Recycle and Reuse scored Assessment Level 4 (75/100 points), showing good progress with enhancement opportunities.

However, Non-Revenue Water management scored Assessment Level 3 (50/100 points), reflecting inadequate monitoring and reduction strategies, while Flood/Water Stagnation Risk Management received the lowest score at Assessment Level 2 (15/100 points), indicating urgent need for comprehensive flood management planning.

These assessment results highlight priority intervention areas where immediate action could deliver substantial improvements. Non-revenue water reduction requires specialized agency engagement for comprehensive NRW studies, including water supply audits, problem area identification, and SCADA monitoring system implementation. Ward-wise NRW mapping through GIS databases could enable targeted intervention strategies that address the most severe loss areas first.

Wastewater recycle and reuse enhancement requires expanding treatment plant efficiency and monitoring systems to increase recycled water quantities. Following CPHEEO guidelines for sustainable water supply systems and implementing enhanced monitoring of treatment plant effectiveness could significantly expand reuse applications.

Flood management planning requires both structural and non-structural strategies, including disaster management cell formation, early warning systems, emergency response plans, and contingency planning alongside infrastructure improvements including maintenance of existing creeks and stormwater drainage systems plus seepage control measures.

Current water management targets align with AMRUT funding priorities including sewerage facilities, septage management, and storm water drainage management alongside Smart Cities Mission initiatives and Madhya Pradesh Urban Services Improvement Project components. However, achieving these targets requires accelerated implementation with enhanced coordination among implementing agencies.

5.7 Suggested Climate Actions

Comprehensive Wastewater Reuse Expansion: Implementing mandatory use of treated wastewater for thermal power plant cooling and industrial non-potable uses following Maharashtra's successful model could significantly reduce freshwater demand. Nagpur's example shows thermal plants paying INR 3.4 instead of INR 9.6 per cubic meter while municipal corporations use revenue to operate additional treatment plants. This approach requires installation of tertiary treatment plants currently lacking in Indore while creating revenue streams for expanded wastewater treatment capacity.

Smart Water Management Implementation: Installing radio frequency smart water meters in 24,000 houses and scaling up further enables real-time consumption monitoring and demand management. AI-based water meters with remote reading capabilities and mobile apps showing consumption comparisons with neighbors could drive conservation behavior while enabling automated leak detection and consumption anomaly identification. Smart automatic water pumps prevent water loss from overflowing tanks while reducing energy consumption.

Integrated Storm Water Management: Developing comprehensive flood and storm water management plans incorporating sustainable urban drainage systems including permeable paving, raingardens, bioswales, and soak wells provides multiple co-benefits. These systems reduce flood risks, enhance groundwater recharge, improve water quality, and provide urban cooling while creating recreational and biodiversity benefits.

Traditional Water Source Revival: Reviving Yashwant Sagar dam and utilizing water from Sirpur lake could reduce dependence on expensive Narmada water pumping while demonstrating desilting, aquifer recharging, and river rejuvenation approaches. Assessment of abandoned traditional open wells and scientific approaches to their development could improve local groundwater resources while reducing external water dependency.

Non-Revenue Water Reduction: Establishing dedicated non-revenue water cells following Navi Mumbai's model enables systematic leakage mapping, reduction design implementation, and commercial practice reviews to address losses from billing and tariff issues. GIS database development for ward-level NRW mapping allows targeted interventions in the most problematic areas.

5.8 Governance of Water Systems

Water systems governance in Indore involves complex coordination among multiple agencies spanning municipal, state, and national jurisdictions with overlapping responsibilities that require enhanced coordination mechanisms. Primary implementing stakeholders include Indore Municipal Corporation (lead), Indore Smart City, Madhya Pradesh Jal Nigam, Madhya Pradesh Public Health Engineering Department, Department of Urban Development and Housing, water utilities, and Resident Welfare Associations.

The governance framework integrates multiple policy instruments including AMRUT funding for water reuse projects, Smart Cities Mission initiatives, Madhya Pradesh Urban Services Improvement Project, Smart Meter National Program, and Swachh Bharat Mission Urban components. Madhya Pradesh State Level Policy (2017) for Wastewater Recycle and Reuse provides regulatory frameworks, though implementation requires strengthened enforcement and monitoring mechanisms.

Critical governance gaps include inadequate inter-agency coordination, limited technical capacity for water system monitoring, insufficient community engagement in demand management, and weak enforcement of water conservation regulations. The city should identify overlapping responsibilities or jurisdiction gaps between water and sanitation authorities and coordinate short-, medium-, and long-term plans to address service gaps while decreasing non-revenue water and increasing reuse.

Community participation emerges as essential for effective water governance, particularly given that low-income and informal communities use the least amount of water per capita but face the highest levels of water stress from intermittent service and reliance on expensive private vendors. Increased awareness among communities about groundwater replenishment needs and water usage optimization requires systematic engagement programs that connect water conservation with economic benefits.

Water supply contingency planning requires developing responses for various drought stages or prolonged water shortages, including emergency water distribution protocols, demand restriction measures, and alternative source activation procedures. Current contingency planning lacks adequate detail for managing severe shortage scenarios that climate change projections indicate will become more frequent.

5.9 Questions for Young Changemakers

5.9.1 Water Justice and Community Monitoring

Only 46% of people in Indore get piped water, which means more than half the city is scrambling to find water every day. People in poorer and informal settlements pay way more for it than people with higher income and connections. Equally important thing to note is that the city loses 30% of its water through leaks and illegal connections before it even reaches people's homes. Meanwhile, the Municipal Corporation spends tons of money on water tankers but the underlying problems do not get fixed. What if we could track where water tankers go, document neighborhoods that never get piped water, and map which areas have the worst shortages? Could student groups or youth organizations create citizen-led water audits that show exactly how unequal water access is? Sometimes the most powerful tool for change is simply having data that officials can't ignore, and water inequality is so ubiquitous that you can simply observe and measure.

5.9.2 Tech Solutions for Ancient Problems

The city is planning to install smart water meters in 24,000 homes, but that's still a tiny fraction of the population, and most people do little to know how much water they're using or wasting. Meanwhile, groundwater levels have dropped 10 meters in just over a decade because everyone's digging private wells without any coordination. This is a perfect opportunity for young people to fill the gaps. What if communities could crowdsource water use monitoring, leak reporting, or even water quality testing? Could neighborhood groups organize to demand smart meters, or better yet, develop community-level water sharing systems that reduce waste? How can we increase the adoption of affordable water recycling systems for apartment buildings and small houses, so that wastewater can be turned into water for various household purposes? The technology exists; it's now about scaling and making it accessible.

5.9.3 From Flood Chaos to Green Infrastructure Champions

Every year, Indore gets hammered by floods that turn low-lying areas and streets into rivers and make life miserable, especially in slums and low-income areas. What's frustrating is that a lot of this flooding happens because the city has paved over everything and blocked natural drainage systems. The traditional solution is to build bigger drains and pumps, but what if young people pushed for a completely different approach? What would it take to advocate for "sponge city" solutions like permeable surfaces, rainwater gardens, and green spaces that actually absorb water instead of just trying to rush it away? Could youth groups partner with neighborhood associations to pilot small-scale green infrastructure projects that show how nature-based solutions work better than concrete? If at least some communities start building better alternatives in their own backyards, it will become easier for others to believe that there are intelligent ways to live with water instead of constantly fighting against it.

6 Solid Waste Management

Few cities can claim to have transformed their reputation as completely as Indore has done with solid waste management. The story begins with a crisis that many Indian cities still face today. In 2012, Indore was generating 850 metric tons of waste daily. Much of this waste ended up in open dumps or clogged drainage systems. The city suffered regular disease outbreaks. Poor waste management created breeding grounds for disease vectors. The health consequences were severe and measurable.

But Indore's transformation demonstrates something powerful about the connection between waste management and public health. Indore's systematic transformation of solid waste management now processes 1,115 metric tons per day (Global Methane Initiative and US EPA 2024). This change delivered measurable health improvements. The city achieved a 60% reduction in vector-borne diseases. Air quality improved significantly. RSPM levels decreased from 142 to 76 microgram per m^3 between 2014-2017 (Madhya Pradesh Pollution Control Board 2023).

This success demonstrates how climate-friendly waste management delivers health co-benefits. Methane capture for city buses reduces greenhouse gas emissions. Eliminating open burning improves air quality. The integration of door-to-door collection, waste segregation, and processing facilities shows how systematic utility management can simultaneously address climate mitigation and health protection. The city now collects approximately 1175 tons of waste daily. About 675 TPD is wet waste and 500 TPD is dry waste and plastic. Municipal Corporation has established comprehensive systems. These include door-to-door collection, segregation at source, transportation facilities, transfer points, and waste treatment facilities. IMC has installed a 550 TPD Bio CNG Plant for wet waste treatment. There is also a 300 TPD dry waste processing facility. The city operates Material Recovery Facilities and maintains a sanitary landfill site at Devguradia.

Today, Indore has earned the title of India's cleanest city for six consecutive years. More importantly, this transformation has created a model that other cities can follow.

6.1 Lack of Waste Management Created Conditions for Disease Outbreaks

Understanding how waste management affects disease patterns requires examining the specific conditions that create health risks.

Vector-borne disease outbreaks became more common in Indore over the last couple of decades. This happened due to combined effects of urban development without sufficient drainage. Poor solid waste management blocked natural drainage. Only about 20% of roads had drainage systems before the transformation. Water logging and dumping of municipal solid waste in open drains made them septic. The total quantity of septic mass generating methane, nitrogen oxides, and hydrogen sulfide exceeded 2000 metric tons. The polluted water from these drains contaminated surface water and groundwater sources. This contamination led to various diseases. Dengue, malaria, chikungunya, typhoid, and yellow fever became prevalent in the city.

The dengue epidemic of 2009 illustrates these connections clearly. This outbreak affected all socio-economic groups. It was believed to be due to prolonged water logging in the city. The threat to health was high due to poor water quality and vector-borne diseases. The disease surveillance system could not provide advanced information. Urban authorities were forced to take emergency control actions after outbreaks occurred. This created panic in the city. It became too late to take preventive actions except providing medical aid until winters reduced mosquito breeding.

Municipal Corporation health department reports from 2022-2024 document seasonal variations in disease outbreaks. Dengue, malaria, and chikungunya cases correlate with temperature and rainfall patterns. Climate change amplifies these health risks through multiple pathways. Increased temperatures extend disease vector viability periods. Higher humidity levels create better breeding conditions. Intense rainfall events overwhelm inadequate drainage systems. These conditions worsen health scenarios with increased vector-borne disease incidences. The situations are more severe in slum areas of the city. The poor remain most vulnerable to disease outbreak events. Enhanced surveillance systems now integrate climate data into disease early warning systems. However, predictive modeling capacity remains limited.

6.2 Systemic Improvements in Waste Management led to Public Health Gains

The transformation of Indore's waste management system involved systematic changes across multiple stages. Before 2016, waste was mixed at the point of generation. Wet, dry, hazardous, and e-waste all went into the same containers. Waste collection was irregular, disorganized, and unsystematic. Collection trucks did not have separate chambers for different waste categories. Mixed waste was transported to central waste bins. Some wet waste was treated at a composting facility. Most mixed waste from central bins was dumped in an open dumpsite.

The new waste management system adopted in 2017 changed everything systematically. Wet, dry, hazardous, and e-waste from households and bulk waste generators are now segregated at the point of generation. Segregated waste is collected door-to-door in collection trucks with separate chambers for different waste categories. Collection trucks move along predefined

routes. These routes are optimized by a command center. Trucks offload their collected waste to assigned compactors at transfer stations.

Processing and treatment now follow scientific principles. Wet waste is converted to clean energy at a bio-Compressed Natural Gas plant. Dry waste is sorted into recyclables and inert waste at material recovery facilities. Recyclables are sorted into different streams and cleaned. Hazardous waste is incinerated at a hazardous waste treatment facility. Around five to six percent of waste that is not bio-degradable, recyclable, or combustible gets disposed in two sanitary landfills.

The infrastructure improvements created measurable health benefits. Modern waste management infrastructure helped increase efficiency. It improved working conditions for waste workers. Environmental impacts were reduced significantly. Partitioned collection vehicles ensure that waste remains source-segregated throughout transportation. IMC uses vehicles divided into different proportions for wet and dry waste. Separate bins are attached to vehicle rears for domestic hazardous waste and e-waste.

6.2.1 Community Engagement and Behavioral Change

The success of Indore's waste management transformation required extensive community participation. This aspect often gets overlooked when cities try to replicate technical solutions. IMC launched multiple information, education, and communication campaigns. These campaigns educated the public on waste segregation and household composting. They engaged over 800 self-help groups. These groups comprised more than 8,000 women. The women spread awareness about source segregation and cleanliness.

To amplify the message, IMC involved local celebrities and religious institutions. They used talk shows, radio, street plays, and other media outlets. Across the city, IMC displayed advertisements, flags, and murals. They distributed pamphlets and infographics about individual waste management actions. Regular public meetings shared information about policy changes. These meetings also solicited feedback and input from citizens.

Successful pilot testing played a crucial role in building community confidence. In January 2016, IMC began their door-to-door collection pilot project. They started in two out of 85 wards. From this pilot project, IMC learned that door-to-door collection was viable for eliminating open dumping. They also learned that timely collection created confidence and built trust in citizens. The success of the pilot project helped gain leadership buy-in. This led to expansion to 10 wards. By the end of 2016, IMC achieved 100 percent door-to-door collection covering all 85 wards.

The city also developed technology solutions for citizen engagement. IMC uses the Indore 311 app for waste management issue reporting. Citizens can take pictures of issues and submit them through the app. Each complaint gets tracked until resolution. Issues are closed only

after the reporting citizen provides a satisfactory remark and uploads photographic proof of resolution.

6.3 Sanitation Gap has Implications for Health Equity

Sanitation gaps amplify climate and health vulnerabilities in ways that disproportionately affect the poor. Intervention studies on water and sanitation infrastructure in Indore slums provide critical evidence of health equity impacts. Poor sanitation infrastructure contributes to 50% of child mortality in urban slums. Climate change amplifies these risks through flooding and extreme weather events. These events can quickly overwhelm inadequate sanitation systems and create disease outbreaks.

Infrastructure improvements deliver measurable health gains when properly implemented. Facility renovation and household toilet construction is reported to increase sanitary facility usage, with increase in usage from 59.1% to 63.8% reported in a case study. Child toilet usage improved from 14.1% to 27.1%. These improvements are particularly critical under climate stress. Extreme weather events can quickly undermine sanitation systems without proper infrastructure.

The analysis also revealed two types of slums. One type has minimal to no drainage and sewerage. The other has fairly decent facilities. This difference resulted from focused investments under pro-poor programs. These included the Madhya Pradesh Urban Services for Poor program. Still, the condition of sewerage and drainage remained poor in most areas due to limited past investments and poor maintenance. Studies indicated that significant proportions of middle class and upper socio-economic classes also lacked adequate access to sewerage. This included septic tanks and soak pits. Drainage systems were inadequate across income levels. More than half the sample households, predominantly poor, reported dumping solid wastes in open areas or streams. This practice resulted in clogging of drainage systems. Clogged drainage further deteriorated the environment and increased water logging during rainy seasons. The low permeability of black cotton soils and poor solid waste collection systems further aggravated these situations. During and after rainy seasons, outbreaks of vector-borne diseases like malaria and dengue were common.

6.4 Sanitation Workers, Occupational Hazard and Worker Safety

The occupational health study of sanitation workers highlights an often-overlooked climate-health vulnerability. During Indore's intensive clean-up campaigns, studies of 200 randomly selected workers showed significant health risks. These risks came from inadequate protective equipment and limited control over workplace conditions.

Most sanitation workers are contractually and informally employed and their health, living conditions, and economic prospects remain marginalised. They face complex risks, challenges, and limited adaptation options. Measures to enhance informal workers' resilience to climate change and other risks could be adopted in India and other developing countries. These interventions can advance several Sustainable Development Goals. This includes SDG 11 on cities, SDG 13 on climate action, and SDG 8 on economic growth.

The health impacts extend beyond direct occupational exposure. Sanitation workers often live in areas with poor infrastructure. They face multiple vulnerabilities including poor housing, limited healthcare access, and economic insecurity. Climate change compounds these vulnerabilities through extreme weather events, heat stress, and changing disease patterns. Proper protective equipment becomes even more critical under climate stress. Higher temperatures increase heat stress for outdoor workers. Increased vector activity raises disease transmission risks. Extreme weather events can create additional workplace hazards. Training programs for workers need to incorporate climate-related health risks.

6.5 Sectoral Assessments and Current Performance

Indore's waste management performance under the Climate Smart Cities Assessment Framework demonstrates both achievements and areas for continued improvement. The city received Assessment Level 5 scores for multiple indicators. Wet Waste Processing scored 150/150 points. Scientific Landfill Availability & Operations received 50/50 points. Landfill/Dumpsite Scientific Remediation scored 60/60 points.

These perfect scores reflect Indore's systematic approach to waste management. More than 95% of wet waste is processed through either decentralized or centralized facilities. The city maintains proper door-to-door collection systems with 100% segregation at source. They use innovative processing methods including composting, bio-gas, and waste processors.

The city continues to engage NGOs for source segregation and awareness creation. They encourage home composting to reduce overall municipal solid waste generation. Wet waste from bulk generators gets collected through bulk collection systems and processed at premises. The city operates garbage transfer stations and semi-bulk collection centers. These facilities collect wet waste and transport it to composting plants. Both centralized and decentralized wet waste processing units operate effectively.

Construction and demolition waste management also shows strong performance. IMC has installed 19 C&D waste collection centers across 19 zones in Indore city area. The city has constructed a 100 TPD Construction & Demolition waste treatment plant at Devguradia. They have also installed additional 20 TPD and 15 TPD decentralized Bio CNG plants at Choithram Mandi and Kabitkhedi.

6.6 Governance and Implementation Framework

Effective waste management requires coordination among multiple stakeholders and sustained political commitment. Indore's success resulted from strong leadership buy-in, successful pilot testing, active citizen engagement, modern infrastructure, and innovative financing structures. The Municipal Corporation took a systematic approach to implementation.

The governance framework integrates national rules and local implementation. The Ministry of Environment, Forest and Climate Change notified Solid Waste Management Rules in 2016. As per these rules, local bodies have specified roles. The Madhya Pradesh Pollution Control Board enforces these rules through local bodies. Hon'ble National Green Tribunal orders provided additional implementation guidance. For effective implementation, the state constituted multiple committees. These include Apex Committee, Regional Committee, and State Committee structures. A State Level Monitoring Committee operates under retired judicial leadership. This governance structure ensures accountability and coordination across jurisdictions.

IMC has taken various measures for collection, transportation, treatment, and disposal of municipal solid waste and construction & demolition wastes. The city has been awarded the cleanest city of India title in Swachhata Survey for years 2017, 2018, 2019, 2020, 2021, and 2022. In 2018, IMC cleared 13 lakh metric tons of legacy waste. The area has been converted into a green park with thousands of plants.

6.7 Questions for Young Changemakers

Technology and Waste Innovation

Indore uses an app where citizens can report waste management problems and track solutions, but this kind of technology could go much further. The city's bio-CNG plant shows how waste can become energy, but could smaller-scale innovations work at the community level? Think about apartment buildings or college campuses where people could reduce the amount of waste and generate their own energy from waste that otherwise would pile up in landfills.

Worker Justice and Climate Adaptation

Something that often gets overlooked in all the talk about clean cities is the mention of people who actually collect and process waste and serious health risks they face. As climate change is going to make their work more dangerous through extreme heat and increased disease vectors, could young changemakers focus on ensuring that infrastructure and tech improvements also improve conditions for sanitation workers. What would it take to ensure that sanitation workers have proper protective equipment, fair wages, and healthcare access? What social factors enforce the continued employment in hazardous conditions? Could youth groups advocate for worker safety standards that account for climate risks and remind everyone

that making cities cleaner need not come at the expense of the people doing the hardest and most essential work.

7 Air Quality and Health

Air quality represents the most measurable and immediate climate-health intersection in Indore, creating a direct pathway for understanding how environmental degradation translates into public health impacts, particularly for the city's most vulnerable populations. The significance of this sector becomes evident when examining current air quality data: PM2.5 concentrations consistently exceed WHO guidelines, with readings reaching 191.4 g/m³ during peak pollution periods, while the current annual average of 99-124 AQI places Indore in the "Poor" category, with PM2.5 levels exceeding safe limits on 90% of days annually. These statistics reveal the acute nature of air quality challenges that demand immediate and sustained intervention.

The urgency of addressing air quality becomes more pronounced when understood within Indore's rapid growth trajectory. With population growing at 5% per year, air quality challenges will intensify without proactive intervention. However, recent assessment results also reveal encouraging trends that demonstrate the potential for effective municipal action. Indore achieved the #1 ranking in Swachh Vayu Survekshan 2023, indicating that systematic municipal interventions can deliver measurable air quality improvements with direct health benefits. This achievement stems from integrated approaches including CNG-powered road sweeping machines, complete conversion of the bus fleet to CNG, and cleaner fuel adoption across municipal operations.

The Transport sector emerges as a critical intervention point, accounting for 30% of Indore's total greenhouse gas emissions (Environmental Planning & Coordination Organisation 2023). This creates dual opportunities: addressing air quality challenges while simultaneously reducing climate emissions through integrated mobility solutions. Construction activities represent another rapidly growing source, including manufacturing of brick, cement and other construction materials, where pollution control measures are commonly violated and dust from construction activities creates significant local environmental impacts. Understanding these interconnected sources enables comprehensive intervention strategies that address both immediate health impacts and long-term climate resilience.

7.1 Air Quality Monitoring and Health Impacts

Indore's air quality monitoring infrastructure reveals both achievements and critical gaps that require urgent attention. The Madhya Pradesh Pollution Control Board (MPPCB) operates 6

air pollution stations in the city, but only 2 are located near residential areas. One significant development involves private sector partnership with IPCA for air pollution station installation, demonstrating potential for expanded public-private collaboration. Additionally, MPPCB has installed 6 display screens at strategic points, providing positive examples of increasing data accessibility and citizen awareness through innovative partnerships.

Current monitoring data presents a complex picture when evaluated against different standards. The average air quality index for Indore in 2019 was in the "satisfactory" category based on PM10 (94.57) and PM2.5 (49.25) against Indian thresholds of 50 and 30 respectively. However, using WHO thresholds of PM2.5 (10 g/m³ annual mean) and PM10 (20 g/m³ annual mean), these indices were 5 times above WHO recommended averages. This disparity highlights the importance of adopting international health-based standards rather than relying solely on national benchmarks.

The health impacts of poor air quality disproportionately affect Indore's most vulnerable populations. Children emerge as the most impacted demographic, especially through symptoms of respiratory diseases. The Clean Air Catalyst Project assessment provides comprehensive documentation of air quality-health linkages, establishing clear connections between exposure levels and health outcomes. Monthly air pollution data from 2018 reveals seasonal variations with PM10 levels ranging from 60.8 g/m³ to 88.6 g/m³ and PM2.5 levels fluctuating between 31.0 g/m³ and 38.4 g/m³, indicating persistent exceedance of safe exposure levels throughout the year.

The spatial distribution of air quality monitoring infrastructure creates equity concerns, as only 2 of 6 monitoring stations are located near residential areas. This monitoring gap means that exposure assessments may not accurately reflect conditions in high-density residential neighborhoods where health impacts are most severe. IMC has installed 4 additional CAAQMS (Continuous Ambient Air Quality Monitoring Systems) at Regional Park, Airport side, Residency Garden & Meghdoot Garden, which should improve spatial coverage once commissioned.

7.2 Transport Emissions and Clean Mobility Transformation

Transportation represents the largest controllable source of air pollution in Indore, with vehicle emissions identified as a major contributor alongside road dust, residential cooking fuel, and industrial sources. The sector's emission profile reveals significant opportunities for intervention: 55% of total vehicles registered between 2015-2020 run on petrol, 40% on diesel, and only 4% on CNG, with just 1% electric vehicles. This fossil fuel dependence creates both local air pollution and contributes significantly to climate emissions.

Indore has implemented several pioneering clean transport initiatives that demonstrate scalable solutions. The city completed phasing out of diesel buses older than 15 years and conversion of the entire bus fleet to CNG, while autos and taxis are allowed to run only on CNG. These interventions provide tangible models for expanding clean fuel adoption across vehicle categories.

Current transport modal share shows buses catering to only 19% of passenger trips, with significant potential for increasing public transport utilization through service improvements and fleet expansion.

Electric vehicle adoption represents a critical pathway for long-term air quality improvement. Current data shows that electric vehicles account for just 1% of Indore's total fleet, which consists of 87% two-wheelers, 12% three-wheelers and less than 1% buses and 4-wheelers. The Madhya Pradesh EV Policy provides e-rickshaws with free permits, exemption or reimbursement from road tax/vehicle registration fees for five years, and 100% waiver on parking charges at municipal parking facilities. However, uptake remains limited, indicating need for enhanced awareness, charging infrastructure, and financing mechanisms.

Indore currently has 37 charging stations and plans to install 100 more, demonstrating commitment to supporting electric vehicle adoption. The Atal Indore City Transport Services Limited (AICTSL) manages i-ride rental scooter services, which presents opportunities for demonstrating electric mobility solutions. Converting these services to electric scooters could provide visible models of electric vehicle viability while reducing emissions from rental transportation.

Freight vehicles account for 23% of total traffic entering the city, representing significant emission sources that require targeted intervention. Freight decarbonization initiatives should include preferential parking spots in freight collection centers with charging ports, reduced parking fees and road taxes for e-freight, and incentives for agencies using electric/CNG vehicles for solid waste management. Such measures could accelerate adoption while demonstrating the economic viability of clean freight solutions.

7.3 Construction and Industrial Emission Sources

Construction activities represent a rapidly expanding source of air pollution in Indore, with impacts spanning both direct emissions from construction sites and indirect emissions from building material manufacturing. Manufacturing of brick, cement and other construction materials entails significant emissions since pollution control measures are commonly violated. This sector requires enhanced regulatory enforcement alongside technological interventions to reduce emission intensity.

Dust from construction activities creates substantial local environmental impacts, particularly affecting communities adjacent to construction sites. Current regulations lack adequate enforcement mechanisms for controlling construction dust, creating opportunities for strengthened implementation of dust control measures. Effective interventions include mandatory dust suppression systems, covered material transport, regulated construction hours, and real-time air quality monitoring at construction sites.

The industrial sector's contribution to air pollution requires systematic assessment and targeted intervention. Source apportionment studies and emissions inventories remain incomplete,

limiting the ability to design effective mitigation strategies. The city should conduct scientific, CPCB/SPCB led source apportionment studies with technical partner support to quantify industrial emission contributions and develop sector-specific reduction strategies.

Continuous Emission Monitoring Systems (CEMS) for industrial plants operating continuously with high emission levels provide opportunities for real-time emission tracking and regulatory compliance monitoring. Expanding CEMS coverage across major industrial facilities would enable more effective pollution control while providing data for targeted enforcement actions.

7.4 Clean Air Interventions and Co-benefits

Indore's clean air interventions demonstrate significant potential for integrated approaches that deliver both air quality and climate co-benefits. The Indore Green Bond Project (2019) demonstrates health co-benefits of energy system transformation through the city's 60 MW solar installation preventing 1.26 lakh tons of CO emissions annually while reducing local air pollution. Combined with CNG-powered municipal equipment, these interventions show declining particulate matter trends that translate to reduced respiratory disease burden.

Regular plantation work on road dividers, gardens, parks, community places, schools, housing societies, and roadsides by Indore Municipal Corporation provides natural air filtration while supporting urban cooling and biodiversity objectives. About 100,000 plantations were completed in 2017-2018, demonstrating large-scale implementation capacity. However, these interventions require systematic monitoring to quantify air quality benefits and guide optimal placement strategies.

The mandate banning open burning of biomass and garbage addresses significant localized pollution sources while supporting waste management objectives. Enforcement of burning bans requires community engagement and alternative waste management solutions to ensure compliance. Regular pollution checks for vehicles provide ongoing emission control mechanisms, though effectiveness depends on enforcement consistency and penalty structures.

The Indore Climate Mission (2024-2025) represents an innovative approach to heat mitigation through community engagement, targeting 300,000-500,000 citizens for energy conservation education. This mission connects climate action with health co-benefits through reduced energy consumption and urban cooling, with projected 7-10% reduction in city-wide electricity consumption that could significantly reduce heat generation while improving air quality through reduced energy demand.

7.5 Sectoral Assessments and Priorities

The Climate Smart Cities Assessment Framework evaluation reveals mixed performance across air quality indicators, with Level of Air Pollution scoring Assessment Level 3 (35/100 points)

and Clean Air Action Plan scoring Assessment Level 4 (61/100 points). These scores indicate moderate progress with substantial room for improvement in both monitoring infrastructure and mitigation strategy implementation.

Clean Technologies for Shared Vehicles achieved Assessment Level 5 (100/100 points), demonstrating strong policy frameworks for promoting clean transportation options. However, Availability of Public Transport also scored perfectly (100/100 points), indicating that the foundation exists for expanding clean mobility solutions. The challenge lies in translating policy frameworks into scaled implementation that delivers measurable air quality improvements.

Non-Motorized Transport Network coverage scored Assessment Level 4 (66/100 points), indicating good infrastructure development with opportunities for enhancement. Expanding safe NMT environments including cycle lanes and footpaths, promoting cycle sharing schemes, and improving connectivity to motorized transport hubs could reduce vehicular emissions while promoting health through active transportation.

Current air quality improvement targets align with National Clean Air Programme (NCAP) goals to achieve 20-30% reduction in PM2.5 and PM10 concentration by 2024 using 2017 as base year. However, achieving these targets requires accelerated implementation of comprehensive intervention strategies across all emission sources. Ministry of Environment, Forest & Climate Change has approved funding for air quality improvement in Indore under XV Finance Commission: Rs 101 Cr in 2020-21, Rs 51 Cr in 2021-22, and Rs 39.75 Cr in 2022-23, providing substantial resources for scaled intervention implementation.

7.6 Governance of Air Quality Management

Air quality governance in Indore involves complex coordination among multiple agencies spanning municipal, state, and national jurisdictions. Indore Municipal Corporation has constituted an Air Quality Management Cell and City level Implementation Committee, providing dedicated institutional frameworks for coordinated action. The revised micro action plan submitted by IMC demonstrates ongoing refinement of intervention strategies based on implementation experience.

Key implementing stakeholders include Indore Municipal Corporation, Madhya Pradesh Pollution Control Board (MPPCB), Regional Transport Office (RTO), Traffic Police, Collector Office, Forest Department, Agriculture Department, and Indore Development Authority. Effective coordination among these agencies requires regular stakeholder meetings, shared monitoring protocols, and aligned enforcement mechanisms.

The Clean Air Action Plan implementation requires strengthening institutional capacity, including raising public awareness, incorporating air quality indicators in project design, and prioritizing mitigation actions by sector. Current implementation covers Construction & Demolition, industry, transport sector, and waste management, but requires enhanced enforcement mechanisms and real-time monitoring capabilities.

Community engagement emerges as a critical governance component, building on Indore's successful experience with the Swachh Bharat "Clean India" campaign. The city's track record for mobilizing citizens at every income level through wide outreach, effective feedback utilization, and demonstrating clear participation benefits provides models for scaling community-based air quality interventions. Training community workers as clean air guides to measure air pollution, identify emission sources, explore mitigation efforts, and raise citizen awareness represents scalable approaches for distributed air quality management.

7.7 Questions for Young Changemakers

7.7.1 Community Science and Air Quality Justice

Here's something that should really get under your skin - Indore has only 2 out of 6 air pollution monitoring stations located near where people actually live, which means we're basically flying blind about what kind of air most residents are breathing every day. And guess who's getting hit hardest? Kids, who are showing up with respiratory symptoms at alarming rates. This isn't just about numbers on a screen; it's about whether children in different neighborhoods have the same right to breathe clean air. What if young people took the lead on community-based air quality monitoring? Could student groups, neighborhood associations, or youth organizations crowdsource air quality data using low-cost sensors? Imagine having real-time air quality maps created by citizens that actually show what's happening in slums, near construction sites, or around schools. Sometimes the most powerful advocacy tool is simply having data that authorities can't ignore.

7.7.2 From Construction Chaos to Green Building Advocacy

Construction is booming in Indore, but it's also creating massive dust clouds and air pollution that's making people sick. The problem is that pollution control measures are commonly violated, and there's not much oversight of what construction companies actually do on job sites. But what if young people got serious about holding the construction industry accountable? Could student groups monitor construction sites, document violations, and push for enforcement of dust control measures? What about advocating for green building standards that don't just reduce emissions during construction, but create healthier indoor environments afterward? The city is growing rapidly - shouldn't young people have a voice in making sure that growth doesn't come at the expense of everyone's health? Sometimes the most effective environmental action happens when communities start paying attention to what's being built in their backyard and demanding better.

8 Energy and Green Buildings

The energy and green buildings sector represents the most critical pathway for climate action in Indore, accounting for 59% of the city's total greenhouse gas emissions, with electricity consumption alone contributing 57% of total emissions (Environmental Planning & Coordination Organisation 2023). This sectoral dominance reflects the fundamental role that stationary energy consumption plays in urban climate footprints across Indian cities. Indore's 2019 electricity consumption totaled 25,61,625 MWh, with a per capita consumption of 1,100 kWh—below the national average of 1,208 kWh (Environmental Planning & Coordination Organisation 2023). The city's emission intensity stems primarily from its dependence on fossil fuel-based electricity generation, particularly coal, oil, and gas, which powers the municipal grid.

The urgency for transformation in this sector becomes evident when examining projected emission trajectories. Business-as-usual scenarios indicate that Indore's emissions will increase by 10% by 2025 and 18% by 2030 compared to 2019 baseline levels (Environmental Planning & Coordination Organisation 2023). This trajectory underscores the critical need for immediate and comprehensive intervention in energy systems and building efficiency. The sector's complexity encompasses multiple dimensions: increasing renewable energy procurement, implementing stringent energy efficiency measures in existing and new buildings, promoting green building certifications, reducing transmission and distribution losses, and ensuring equitable energy access. For young climate advocates, this sector offers the greatest potential for impact while presenting intricate governance challenges spanning municipal, state, and national jurisdictions.

8.1 Access to Electricity and Clean Energy Infrastructure

Indore demonstrates relatively strong performance in electricity access, with 98% of the city's street lighting reported to have been converted to LED and energy efficient systems (Environmental Planning & Coordination Organisation 2023). The Energy Efficiency Services Limited (EESL) has established ambitious targets, aiming to convert 79,000 sodium and metal lights to energy-efficient LED systems to achieve 100% energy-efficient lighting citywide (Environmental Planning & Coordination Organisation 2023). This transition represents a significant step toward reducing energy consumption while maintaining essential urban services. However, the city faces substantial challenges in electricity distribution efficiency. Transmission and Distribution (T&D) losses stand at 24% (Environmental Planning & Coordination Organisation

2023), significantly higher than optimal levels and indicating substantial infrastructure improvement needs. The Electricity Act 2003, Section 55, mandates universal electricity metering (TARU Leading Edge 2012), yet implementation gaps seem to persist. Residential consumers account for 45% of electricity consumption, followed by commercial (28%), industrial (23%), public water works (2%), streetlights (1%), and agricultural irrigation (1%) (Environmental Planning & Coordination Organisation 2023).

The city's energy infrastructure requires substantial climate resilience improvements. Studies indicate increased rainfall and flooding risks due to climate variability. Energy transmission networks need to be upgraded to become capable of operating during water-logged conditions (TARU Leading Edge 2012). Priority interventions that have been suggested in past studies and technical analyses include GPS and GIS integration for energy distribution network mapping, replacement of conventional transformers with energy-efficient amorphous core transformers, and infrastructure assessment to ensure energy supply continuity during climate-related disruptions.

8.2 Access to Clean Fuel and Renewable Energy Sources

Indore's renewable energy portfolio remains critically underdeveloped, with renewable sources accounting for merely 0.8% of total electrical energy generation (Environmental Planning & Coordination Organisation 2023) as of 2020, generating only 31,272 MWh. This minimal contribution highlights the sector's transformative potential and need for scaling.

The city has initiated several pioneering renewable energy projects demonstrating commitment to clean energy transition. Notable initiatives include a 670 kW plant planned for the Devi Ahilya Vishwavidyalaya (DAVV) campus, a 10 MW tender for residential solar PV projects, and the Municipal Corporation's plans to install 100 MW solar under the Central Public Sector Undertaking (CPSU) phase II scheme. As a move that indicates significant financial commitment to renewable energy infrastructure, the municipal corporation has invested INR 5 billion in green bonds for a 100-120 MW solar power plant (Environmental Planning & Coordination Organisation 2023). Indore also aspires to achieve "Solar City" status under the national Solar City Program, with current installations totaling 160 kW on building rooftops. The municipal government has implemented solar applications across various infrastructure components: all BRTS traffic signals operate on solar power, 25 public gardens feature solar-powered lighting, and a 1.5 MW solar-powered Sewage Treatment Plant (STP) is operational. Additionally, the city has inaugurated the Gobar-Dhan plant for biogas generation and planned 58 kW rooftop capacity installation on the AICTSL building (Environmental Planning & Coordination Organisation 2023). The renewable energy sector demonstrates encouraging growth trends, with solar rooftop uptake increasing threefold over two years. However, achieving meaningful emissions reduction requires exponential scaling of renewable energy infrastructure and implementation of comprehensive renewable energy procurement strategies.

8.3 Energy Efficiency in Buildings and Industries

Building energy efficiency is a key intervention pathway. Studies indicate potential for 20% reduction in energy consumption through proper demand and supply management (TARU Leading Edge 2012). The city currently faces significant challenges in green building adoption, with less than 1% of municipal buildings eligible for green building or net zero building rating according to Indian Green Building Council (IGBC) data (Environmental Planning & Coordination Organisation 2023). Despite this low baseline, Indore demonstrates positive momentum in green building development, with IGBC data indicating 15% annual growth in green buildings as of 2019 (Environmental Planning & Coordination Organisation 2023). The city received a perfect score (100/100 points) for Indicator 5 (Promotion of Green Buildings) under the Climate Smart Cities Assessment Framework, demonstrating strong policy framework development (National Institute of Urban Affairs 2023).

Energy efficiency interventions span residential, commercial, and industrial sectors. Residential efficiency measures include promotion of Compact Fluorescent Lamp (CFL) and LED lighting systems, passive cooling design integration, and energy-efficient appliance adoption. The city has developed codes for passive cooling and energy efficiency applications in residential, commercial, and industrial buildings, with special emphasis on incorporation into affordable housing projects (TARU Leading Edge 2012). The Energy Conservation Building Code (ECBC) 2017 has been mandated for commercial buildings, though compliance monitoring requires strengthening. The Madhya Pradesh Energy Conservation Building Code 2021 provides state-level regulatory framework, but proper implementation would require robust monitoring mechanisms, permit requirements, calculation methods, regular inspections, and energy bill reduction tracking.

8.4 Cool Roofs and Passive Cooling Strategies

Climate-responsive building design emerges as a critical adaptation and mitigation strategy, with specific emphasis on increasing cool spaces in urban building and landscape designs. Cool roof technologies and passive cooling strategies offer dual benefits: reducing space cooling energy demands while enhancing thermal comfort in Indore's hot climate conditions.

The city's climate action framework prioritizes passive design strategies for thermal comfort in affordable housing projects, ensuring equitable access to climate-responsive building features (Environmental Planning & Coordination Organisation 2023). These interventions become particularly significant considering that about 30% of Indore's population comprises slum residents, lacking access to energy-efficient cooling solutions.

Implementation strategies may include integrating passive cooling principles into municipal building guidelines, developing climate-sensitive retrofit programs for existing structures, and establishing cool roof mandates for new construction projects. The Pradhan Mantri Awas

Yojana (PMAY) scheme is identified in the Indore City CAP as an opportiunity for large-scale implementation of climate-sensitive components in affordable housing, potentially reaching thousands of beneficiaries.

8.5 Governance of the Energy Sector in Indore

Indore Municipal Corporation, working with Indore Development Authority, builder associations, industrial associations, and distribution companies (DISCOMs). Private sector and NGO partnerships could also be essential for inclusive energy access initiatives. The city's climate actions align with multiple policies including the Energy Conservation Building Code (ECBC) 2017, India Cooling Action Plan 2018, UJALA Scheme 2015, Smart Cities Mission, and the Madhya Pradesh Renewable Energy Policy 2022. The Bureau of Energy Efficiency offers the Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE), which covers risks for municipal energy efficiency projects that demonstrate energy savings and use viable monitoring technology. SIDBI's Partial Risk Sharing Facility (PRSF) provides similar support for energy efficiency initiatives. However, Indore CAP suggests that these financing mechanisms remain underutilized.

8.6 Sectoral Assessments and Priorities

Indore's performance in the Climate Smart Cities Assessment Framework reveals a "Three Stars" rating (331/600 points) for Energy and Green Buildings (National Institute of Urban Affairs 2023), indicating moderate performance with substantial improvement potential. Key assessment findings highlight critical gaps:

- Electricity Consumption Management received Assessment Level 3 (50/100 points), indicating need for enhanced energy efficiency project implementation. Renewable Energy Integration scored Assessment Level 2 (25/100 points), reflecting the minimal renewable energy share in the overall energy mix. However, Green Building Promotion achieved the maximum score (100/100 points), demonstrating strong policy frameworks (National Institute of Urban Affairs 2023).
- Sectoral priorities include immediate renewable energy scaling, with ambitious targets established: 25% renewable electricity by 2030, 43% by 2040, and 60% by 2050. Solar PV installation targets include 30% of high-income residential buildings by 2030, 60% by 2040, and 90% by 2050. LED lighting penetration aims for 50% in existing buildings by 2030, 70% by 2040, and 100% by 2050 (Environmental Planning & Coordination Organisation 2023).

- The sector's emission reduction potential is substantial, with projections indicating 44% emission reduction possible through comprehensive energy and building interventions by 2050 (Environmental Planning & Coordination Organisation 2023). Priority interventions include municipal building energy retrofits, renewable energy procurement planning, green building certification acceleration, and smart metering system implementation.

8.7 Suggested Climate Actions

- Developing comprehensive renewable energy procurement plans involving energy needs assessment, governance structure establishment, stakeholder collaboration, and risk management strategies. Melbourne's Renewable Energy Project provides a successful model, employing energy market advisers for risk tracking, tender structure analysis, and cost optimization.
- Converting all municipal buildings to net zero carbon status through high-level energy efficiency integration and renewable energy generation (Environmental Planning & Coordination Organisation 2023). Thane Municipal Corporation's net zero municipal school demonstrates successful implementation, with their Urban Low Emissions Development Strategy (Urban LEDS) providing replicable frameworks
- Implementing large-scale retrofits under the PMAY scheme, incorporating energy efficiency, optimized water consumption, heating effect reduction, and efficient waste management. The Shakti Foundation's 2018 study provides technical guidance for mainstreaming energy efficiency in affordable housing.
- Implementing smart metering systems, upgrading transmission infrastructure, and establishing real-time energy monitoring capabilities. Infrastructure improvements include GPS/GIS integration for distribution network mapping and energy-efficient transformer deployment.

8.8 Questions for Young Changemakers

8.8.1 How do we make green energy fair for everyone

When cities rush to go green, sometimes the people who need help the most get left behind. Think about it this way: if solar panels and energy-efficient buildings become the norm, but only wealthy neighborhoods can afford them, what happens to everyone else? How can we make sure that when Indore switches to clean energy, it actually helps reduce inequality instead of making it worse? What creative ideas could ensure that low-income families get cheaper electricity bills and better living conditions, not higher costs they can't afford?

8.8.2 Can we get more creative with clean energy

Indore gets less than 1% of its power from renewable sources - that's pretty shocking for a city that wants to be climate-smart. This seems like a huge opportunity for young people to step in with fresh ideas. What if we thought beyond just putting solar panels on rooftops? Could there be new ways to fund these projects - maybe through community ownership or crowd-funding? And think about this way too: most of Indore's economy happens in small shops, street vendors, and informal businesses that rarely get included in official energy planning.

8.8.3 Rethink Energy Policy

Energy policy can feel pretty overwhelming with all these different government departments, agencies, and officials who seem to speak in acronyms. But the reality us that these decisions about renewable energy targets and building codes will shape Indore's future for decades. So how can young climate advocates actually get a seat at the table instead of just advocating from the outside? What would it look like to have citizens - especially young people - actively monitoring whether the government is keeping its promises about clean energy? Could neighborhoods organize their own energy planning meetings, track solar installation progress, or even crowd-source data about energy costs and efficiency?

9 Education and Green Jobs

Youth unemployment and skills mismatches emerge as Indore's primary human capital-climate threat, consistently identified across multiple assessments as critical vulnerabilities that climate change will exacerbate. With approximately 30% of the city's population comprising adolescents and youth, this demographic represents both the most vulnerable to climate impacts and the most capable of driving transformative change. Education and employment together would be the two most important sectors to shape how communities respond to environmental challenges and how young people move into the workforce. This area includes not just school education but also training systems, job opportunities, and small business support, all of which are becoming more relevant as the city plans for a sustainable future. Education, in this context, is both affected by climate risks and plays a role in helping people adapt. Current educational gaps include limited integration of sustainability into early employment structures and insufficient climate education access, while many 14-15-year-old migrants arrive in Indore alone for work and coaching, creating high emotional and physical vulnerability that climate-responsive education programs must consider and address.

9.1 Current Educational Infrastructure and Employment Challenges

The city maintains a literacy rate above 75%, with male literacy at 79% and female literacy at 71.6%, providing a strong foundation for advanced skill development programs. However, despite high female literacy rates, only 16% of women are employed, indicating significant untapped human capital that could be channeled toward green economy initiatives (Environmental Planning & Coordination Organisation 2023).

Around 28% of the city's population lives in slums, creating accessibility challenges for quality education and skill development opportunities. Youth in informal settlements face multiple barriers including limited access to quality institutions, financial constraints for skill development programs, and social barriers that prevent participation in formal training systems. Government Industrial Training Institutes require expansion and modernization to address climate-relevant skill demands, while linking ITIs with government schools in informal settlements could enable more youth to gain employable skills.

Current skill development programs demonstrate limited alignment with Indore's climate priorities and green economy opportunities. While the programs run by agencies like UNICEF aim to equip large number of children and youth to become climate conscious over the coming

years, local implementation requires strengthening through practical, hands-on learning opportunities that connect education directly with employment outcomes in climate-responsive sectors.

9.2 Climate-Responsive Employment Opportunities and Skills Gaps

Indore's diverse economic base creates multiple pathways for green job development that climate change will significantly expand. The city's strengths in automotive manufacturing, pharmaceuticals, food processing, and IT-BPM industries provide foundations for green transitions.

Waste management and circular economy sectors offer immediate employment opportunities building on Indore's status as India's cleanest city for five consecutive years. The city's 100% door-to-door waste collection, 92% dry waste recycling rates, and total waste generation of 1029 TPD create substantial employment potential in composting, biogas generation, material recovery facilities, and waste-to-energy systems. However, current workforce capacity lacks specialized training in waste processing technologies, environmental monitoring, and circular economy business models.

Renewable energy sector presents enormous growth potential given that only 0.8% of electricity currently comes from renewable sources (Environmental Planning & Coordination Organisation 2023). The city's pioneering floating solar funding model and 98% LED streetlight conversion demonstrate institutional capacity for scaling renewable energy employment, but require specialized workforce development in solar installation, maintenance, energy auditing, and smart grid technologies.

Green building and construction sectors face urgent skill demands as climate adaptation requirements increase. With requirements for 65% of terraces of redeveloped buildings to have solar PV, substantial employment opportunities exist in passive cooling design, green building certification, climate-resilient infrastructure, and building performance monitoring. However, current construction workforce lacks climate-responsive building techniques and energy-efficient design capabilities.

Water management and conservation sectors require immediate workforce expansion given the city's severe water stress challenges. With 30% Non-Revenue Water, only 46% access to tap water, and restoration of 629 traditional water supply sources, significant opportunities exist for youth employment in water efficiency systems, rainwater harvesting, smart water management, and nature-based solutions.

9.3 Addressing Educational Equity and Community Resilience

Climate education and green jobs must address Indore's significant socio-economic disparities to ensure that workforce transformation benefits all communities while building comprehensive climate resilience. With 28% of the population living in slums and substantial informal employment, programs must be designed for accessibility and relevance to diverse socio-economic backgrounds while addressing structural barriers that limit participation.

Targeting vulnerable youth requires specialized approaches for the many 14-15-year-old migrants who arrive in Indore alone for work and coaching, creating high emotional and physical vulnerability. Climate education programs can provide structured learning environments and livelihood pathways that offer alternatives to precarious informal employment. Linking Industrial Training Institutes with government schools in informal settlements will enable more youth to gain employable skills with options to advance through subsequent courses.

Gender-responsive programming must address the stark disparity where only 16% of women are employed despite high female literacy rates at 71.6%. Green job programs must actively address barriers to women's workforce participation through flexible training schedules, safe transportation, childcare support, and targeted outreach addressing social norms. Intensive outreach can guide girls towards both technical training and non-technical employment options in climate-responsive sectors.

Community-based approaches require development of ward-level youth climate councils that combine learning with local action, building on successful models that empower youth to identify and address local climate risks through data collection and community mobilization. Complex problem-solving is achievable through youth involvement in their own local communities, requiring support from Urban Local Governments.

9.4 Sectoral Assessments and Priorities

Assessment of Indore's education and green jobs landscape reveals mixed performance across key indicators, demonstrating both achievements and critical improvement needs. While the city demonstrates strong foundational literacy rates and established industrial base, significant gaps exist in climate-responsive skill development, youth employment generation, and institutional coordination for green economy transition.

Skills Development Infrastructure shows moderate performance with established ITIs and educational institutions but lacks specialized climate-responsive curricula and equipment. Current technical training capacity requires substantial enhancement to meet green economy demands, particularly in renewable energy, waste management, and water conservation technologies.

Youth Employment Generation demonstrates poor performance with high unemployment rates among youth and limited pathways from education to green job opportunities. The disconnect between educational outcomes and climate-responsive employment represents a critical gap requiring immediate intervention through apprenticeship programs and industry partnerships.

Gender Inclusion in Workforce reveals the most significant challenge, with only 16% female employment despite 71.6% female literacy. This represents enormous untapped potential for green economy participation that requires targeted intervention through gender-responsive programming and barrier removal.

Community Accessibility shows varied performance across different areas, with strong performance in central areas but significant gaps in slum settlements and informal areas where 28% of the population resides. Enhanced outreach and community-based programming represent priority intervention areas.

These assessment results highlight priority intervention areas where immediate action could deliver substantial improvements. Skills development requires specialized program development for climate-responsive technologies with industry partnerships ensuring employment outcomes. Youth employment generation requires systematic linking of education with green job opportunities through apprenticeship programs and startup incubation. Gender inclusion requires comprehensive barrier assessment and targeted programming addressing social norms and practical constraints.

9.5 Suggested Climate Actions

Comprehensive Green Skills Development Centers: Establishing ward-level Green Skills Centers providing climate-responsive technical training in renewable energy, waste management, water conservation, and green building technologies. Following successful models like EcoChirp Sustainability School in Delhi, these centers would connect youth to sector leaders through learning sessions while providing practical exposure and potential employment opportunities. Centers should offer certification programs aligned with industry standards while providing entrepreneurship support for youth-led green enterprises.

Youth Climate Innovation Incubators: Creating youth-focused incubators for climate tech startups and social enterprises, providing technical assistance, seed funding, and market linkage support. Building on the Green Rise Alliance model that aims to equip 50 million youth to become climate conscious, these incubators would focus on locally-relevant climate solutions including waste reduction technologies, water conservation systems, and energy efficiency innovations. Incubators should connect youth with private sector partners through CSR and ESG funding while providing mentorship from climate professionals.

Community-Based Climate Education Networks: Implementing peer-to-peer climate education programs where trained youth volunteers deliver climate awareness and skill development in their own communities. Following the Maharashtra Youth for Climate Action model that provides three-level engagement through training, field immersion, and policy advocacy, these networks would focus on practical action including waste audits, energy conservation, and water management while building advocacy capacity for youth-led climate policy engagement.

Green Apprenticeship and Placement Programs: Developing formal apprenticeship programs connecting educational institutions with private sector employers in climate-responsive industries. These programs should provide guaranteed pathways from training to employment while offering hands-on experience in real workplace settings. Programs should prioritize vulnerable youth including migrants and those from informal settlements while ensuring gender-inclusive participation through targeted outreach and support services.

Climate Education Integration in Formal Systems: Systematically integrating climate science, sustainability principles, and green technology applications across all educational levels from primary through technical training. This requires curriculum development, teacher training, and equipment upgrades while ensuring accessibility for all socio-economic backgrounds. Integration should emphasize practical application and local relevance while connecting learning with employment and entrepreneurship opportunities.

9.6 Governance of Education and Employment Systems

Education and employment systems governance in Indore involves complex coordination among multiple agencies spanning educational institutions, skill development authorities, economic development organizations, and community groups with overlapping responsibilities that require enhanced coordination mechanisms. Primary implementing stakeholders include educational institutions, Indore Municipal Corporation, Indore Smart City, skill development agencies, private sector partners, and community organizations.

The governance framework integrates multiple policy instruments including the National Education Policy 2020 with its emphasis on skill development and experiential learning, Skill India initiatives, Smart Cities Mission components, and various youth development schemes. However, implementation requires strengthened coordination between education departments, environment agencies, and economic development authorities to align skill development with climate action priorities.

Critical governance gaps include inadequate coordination between formal education systems and green economy development, limited technical capacity for climate-responsive curriculum development, insufficient private sector engagement in workforce development, and weak linkages between skill development programs and actual employment outcomes. Enhanced coor-

dination mechanisms require development to ensure systematic implementation and outcome tracking.

Community participation emerges as essential for effective education and employment governance, particularly given that youth from informal settlements and vulnerable communities face the highest barriers to accessing quality education and employment opportunities. Systematic engagement programs require development to connect education and skill development with community needs and local climate action priorities.

The governance framework should establish clear accountability mechanisms for education and employment outcomes while ensuring youth voices are central to program design and implementation. This requires formal youth representation in governance structures and systematic feedback mechanisms ensuring programs remain responsive to evolving needs and opportunities.

9.7 Questions for Young Changemakers

Skills Revolution and Community Impact

Indore has tons of young people but most of them end up in jobs that have nothing to do with the city's biggest challenges like water scarcity, waste management, or extreme heat. Meanwhile, the city is spending billions on climate action but there's a huge shortage of people who actually know how to install solar panels, fix water leaks, or run composting programs. What if young people organized to demand that every technical training program in the city had to include climate-related skills? Could student groups partner with the businesses that are already working on these problems to create apprenticeship programs that guarantee jobs? How can we make it so that learning climate-relevant skills becomes the obvious path to good employment instead of an afterthought?

Breaking the Gender-Jobs Deadlock

Seventy-two percent of women in Indore are literate but only 16% have jobs, which is completely insane when you think about how much work needs to be done on climate action. Traditional jobs often don't work for women because of safety concerns, inflexible hours, or social pressure, but many climate jobs like energy auditing, waste reduction consulting, or water quality monitoring could be more flexible and community-based. What would it take for young women to organize and create their own green enterprises instead of waiting for traditional employers to change? Could groups of women start their own solar installation cooperatives, water testing services, or waste reduction consultancies? How can young women use the climate crisis as leverage to create the kinds of work opportunities that actually fit their lives instead of forcing themselves into systems that were never designed for them?

From Slums to Green Leaders

Twenty-eight percent of people in Indore live in slums, but these are also the communities that are most creative about surviving with limited resources and most directly affected by climate impacts like flooding and water shortages. What's frustrating is that formal education and job training programs rarely reach these areas, even though slum youth often have the most motivation to solve problems and the most understanding of what actually works on the ground. What if slum communities became the testing grounds for climate solutions instead of being left out of green job training? Could youth from informal settlements organize to demand that climate job programs come to them instead of expecting them to travel to formal training centers? How can the practical knowledge that already exists in these communities be combined with technical training to create locally-led green enterprises that serve both the immediate community and the broader city?

Part II

Innovation & Adaptation

10 Community Resilience and Leadership

Community resilience represents the foundational capacity that determines whether Indore's climate challenges become catastrophic crises or catalysts for transformation, creating pathways that either perpetuate vulnerability or enable adaptive evolution across the city's diverse neighborhoods. This sector addresses both traditional knowledge preservation and contemporary innovation through comprehensive evaluation of community-based adaptation strategies, health system strengthening, youth leadership development, and institutional coordination mechanisms. The framework recognizes community resilience as both a climate buffer through social capital and local knowledge, and a transformation driver through collective action and participatory governance that requires urgent strengthening to meet intensifying climate impacts.

Community fragmentation emerges as Indore's hidden vulnerability, consistently undermining adaptive capacity across multiple assessments despite the city's economic dynamism and infrastructure investments. The rapid urbanization that transformed Indore from a regional trading center to a metropolitan hub of 5.56 million people has simultaneously eroded traditional support systems, created new social divisions, and weakened collective response mechanisms. With over 600 slums housing 30% of the population, many denotified and invisible to formal systems, the city faces profound challenges in building inclusive resilience that reaches its most vulnerable residents—particularly the 30% youth population who inherit both climate risks and adaptation responsibilities.

Current resilience challenges reveal systemic gaps between traditional wisdom and modern systems: while the Malwa region possesses sophisticated indigenous knowledge for climate adaptation developed over centuries, these practices remain marginalized in urban planning and disconnected from youth who could carry them forward. The disconnect manifests starkly in health systems where only 51 public health institutions serve millions, community engagement remains tokenistic despite recognition as a critical leverage point, and climate projections are absent from health planning despite mounting evidence of climate-health linkages. This creates conditions where communities face intensifying climate impacts—extreme heat reaching 50°C by 2030, erratic monsoons, flooding, and water scarcity—without adequate collective capacity for response or adaptation.

10.1 Traditional Knowledge Systems

Understanding Indore's resilience potential requires recognizing the sophisticated traditional knowledge systems that enabled communities to thrive in the semi-arid Malwa region for centuries, creating sustainable relationships with challenging environments through innovation, social organization, and ecological wisdom. These systems, developed primarily by Bhil and Bhilala tribal communities alongside agricultural castes, offer immediate applications for contemporary climate adaptation yet remain largely excluded from urban planning discourse.

The Pat system in nearby Jhabua district exemplifies community-managed climate adaptation through integrated water-social management. This indigenous irrigation system uses stone bunds lined with teak leaves to divert stream water, with each family maintaining channels during designated turns. The technical innovation—using natural materials that expand when wet to create watertight seals—combines with social organization that ensures equitable water distribution and collective maintenance. This demonstrates how resilience emerges not from infrastructure alone but from social systems that sustain collective action across seasons and generations.

Traditional Malwa architecture offers passive cooling strategies increasingly relevant as temperatures soar toward projected 50°C peaks. Historical buildings feature raised plinths protecting from flooding while enabling air circulation, pointed arches creating stack ventilation effects, central courtyards functioning as thermal regulators, intricate jaali work filtering harsh sunlight while maintaining airflow, and integrated water features providing evaporative cooling. These design principles, refined over centuries, achieve comfort without energy consumption—critical lessons for adapting modern buildings, particularly schools and health facilities where youth spend significant time.

The sophistication extends to building materials and construction timing. Traditional lime plaster provides superior thermal mass compared to cement, absorbing heat during day and releasing at night. Construction occurred during specific seasons to ensure proper curing, while orientation responded to solar angles and prevailing winds. Community participation in construction created shared knowledge and maintenance capacity—elements absent from contemporary contractor-driven development that produces buildings requiring constant mechanical cooling.

Millet cultivation systems demonstrate food system resilience with profound health implications. Traditional varieties including pearl millet (bajra), finger millet (ragi), and sorghum (jowar) withstand temperatures up to 64°C while requiring 70% less water than wheat or rice. These crops provide superior nutrition—finger millet contains 3.5 times more calcium than milk, pearl millet offers high iron content addressing anemia, while all varieties provide B-vitamins crucial for heat stress management and low glycemic indices preventing diabetes.

Beyond nutrition, millet systems create ecological resilience through deep root systems improving soil structure, natural pest resistance reducing chemical inputs, and staggered planting spreading risk across seasons. The social organization around millet—seed sharing networks,

collective processing facilities, traditional recipes—created community bonds now fractured by wheat-rice monocultures dependent on external inputs and vulnerable to climate shocks.

10.2 Contemporary Community Resilience Mechanisms

The transition from traditional to contemporary resilience reveals both innovations and critical gaps in Indore's adaptive capacity. The Ek Panch Ek Talaab (One Panchayat One Pond) Program demonstrates successful traditional knowledge integration at scale. Launched in 1999 following severe drought, this initiative renovated 3,412 existing tanks and constructed 500 new ones by 2004, with communities contributing Rs 4.85 crore worth of voluntary labor—demonstrating latent capacity for collective action when appropriately channeled.

The program's success emerged from respecting traditional water management principles while providing modern technical support. Communities identified tank locations using indigenous knowledge of watersheds and soil types, maintained traditional governance systems for water distribution, and integrated tank systems with agriculture and livestock management. Government support came through materials and technical guidance rather than imposing external designs, enabling community ownership that ensures long-term sustainability.

However, contemporary Indore shows weakening community resilience mechanisms. Rapid urbanization has fragmented traditional neighborhoods, replacing extended family networks with nuclear households lacking mutual support systems. The influx of migrants—including many adolescents arriving alone for work or education—creates populations without local knowledge or social connections. Meanwhile, original communities lose youth to outmigration, breaking intergenerational knowledge transfer essential for maintaining traditional practices.

Community-based organizations attempt to fill these gaps with mixed results. Resident Welfare Associations (RWAs) in middle-class areas organize around specific issues—water tanker distribution, security, cleanliness—but rarely address systematic climate adaptation. Their exclusion of renters, informal residents, and youth limits representativeness and adaptive capacity. In slum areas, community organizations focus on immediate survival needs—securing basic services, resisting eviction—with little bandwidth for long-term climate planning despite facing the highest vulnerabilities.

Women's self-help groups show greater promise for building inclusive resilience. Groups like Aprajita Mahila Sangh combine savings and credit functions with health education and environmental action, creating trusted networks for information dissemination and collective response. During COVID-19, these groups demonstrated rapid adaptation—producing masks, disseminating health information, supporting vulnerable families—suggesting latent capacity for climate response if appropriately supported and connected to youth networks.

10.3 Health System Vulnerabilities and Adaptation Needs

Indore's health system faces mounting pressure from climate impacts that existing infrastructure and approaches cannot adequately address, creating vulnerabilities that cascade through communities with particular severity for youth populations. The Building Healthy Cities research (2018-2022), representing the most comprehensive health systems analysis, engaged 247 multi-sector stakeholders through systems mapping workshops that revealed critical gaps between health needs and system capacity.

Current infrastructure serves the city through 51 public health institutions including two tertiary care facilities, four community health centers, and 14 urban primary health centers. Secondary public care is provided via district hospital and civil hospital, while primary care occurs through urban primary health centers targeting slum areas. However, this network serves 5.56 million people with severe maldistribution—peripheral areas where many youth reside face acute shortages while central areas have overlapping facilities.

Private healthcare dominates service provision with over 760 hospitals and nursing homes, creating a two-tier system where quality care requires payment capacity. This particularly disadvantages youth from low-income families who face barriers accessing both public services (due to distance and overcrowding) and private care (due to cost). The fragmentation between public and private systems prevents coordinated responses to climate health threats that affect entire populations regardless of economic status.

Climate change amplifies existing health system weaknesses through multiple pathways inadequately addressed in current planning. Heat stress increases emergency department visits and hospitalization needs, yet facilities lack cooling capacity during power outages common in extreme weather. Vector-borne diseases expand with changing temperature and rainfall patterns, but surveillance systems remain reactive rather than predictive. Flooding disrupts health service delivery precisely when waterborne disease risks peak, yet contingency planning remains minimal.

The workforce challenges intensify under climate stress. Community health workers—ASHAs and ANMs serving as frontline providers—must work in extreme heat without adequate protection or modified schedules. Their training lacks climate-health modules despite mounting evidence linking heat exposure to maternal complications, vector-borne disease expansion, and mental health impacts. Youth volunteers could supplement workforce capacity while gaining health careers exposure, yet no systematic programs exist for such engagement.

Mental health services remain virtually absent despite growing climate-related psychological impacts. Heat stress correlates with increased aggression, anxiety, and depression, particularly among youth facing uncertain futures. Displacement from flooding, loss of livelihoods from drought, and general eco-anxiety create mental health burdens the system cannot address with only one government psychiatrist serving the entire city. Traditional healing systems that integrated mental and physical health have weakened without modern alternatives emerging.

10.4 Youth Agency in Climate Adaptation

Despite comprising 30% of Indore's population and facing disproportionate climate impacts, youth remain marginalized in formal adaptation planning yet demonstrate remarkable innovation in grassroots responses that suggest transformative potential if appropriately supported. The disconnect between youth capacity and institutional recognition creates both current vulnerabilities and missed opportunities for building inclusive resilience.

Existing youth engagement remains largely tokenistic or narrowly focused. The Smart City consultations included 591,965 citizen interactions with some student participation, but youth-specific climate adaptation priorities were not differentiated from general feedback. The Health Promoting Schools initiative reached 148 schools establishing "Health Promotion Corners," yet focused on individual behavior change rather than systematic climate adaptation or community resilience building.

The recent Indore Climate Mission launched in December 2024 represents explicit recognition of youth climate agency through energy conservation competitions among educational institutions. However, this approach remains limited to awareness building rather than empowering youth as adaptation leaders. The narrow focus on energy conservation misses opportunities for youth to contribute traditional knowledge preservation, community vulnerability mapping, health system strengthening, and innovative solution development.

Informal youth responses demonstrate untapped potential. Student groups organize tree plantation drives responding to urban heat, though without systematic planning for species selection, maintenance, or integration with broader cooling strategies. Youth use social media to share heat wave alerts and cooling center locations, creating informal information networks that could be strengthened through official support. Young entrepreneurs develop cooling solutions—from modified desert coolers to reflective roof coatings—that remain small-scale without investment or policy support.

The gendered dimensions of youth climate agency require particular attention. Young women face restricted mobility that limits participation in community activities, yet possess crucial knowledge about household water management, family health practices, and social networks. Programs must create safe spaces for girls' participation while recognizing their potential as change agents within families and communities. Boys often have greater freedom but less connection to household climate impacts, requiring different engagement strategies that connect climate action to employment opportunities and social status.

Migrant youth represent a particularly vulnerable yet potentially transformative population. Many arrive in Indore alone at 14-15 years for work or education, lacking family support or local knowledge. These youth could bridge rural traditional knowledge with urban innovation if provided platforms for sharing and integration. Their experiences of climate impacts across rural and urban contexts create unique perspectives on adaptation needs and possibilities.

10.5 Institutional Ecosystem and Coordination Challenges

Indore's institutional landscape for climate-health-youth action demonstrates remarkable organizational density yet suffers from fragmentation that limits collective impact and systemic transformation. Understanding this ecosystem reveals both assets for building resilience and critical gaps requiring urgent bridging.

Government agencies operate in silos despite interconnected mandates. The State Knowledge Management Centre on Climate Change develops technical resources without clear pathways for community application. The District Health Department implements disease surveillance without integrating climate projections. The Education Department manages schools experiencing extreme heat without coordination with health or environment agencies. Municipal Corporation departments for health, environment, and planning rarely coordinate despite managing interdependent systems.

Civil society organizations show innovation within narrow domains. Vasudha Foundation's development of Indore's Climate Change and Environment Action Plan demonstrates technical capacity for evidence-based planning, while their role in shaping Madhya Pradesh's Electric Vehicle Policy 2025 shows policy influence potential. However, their work remains largely technical without deep community engagement or youth leadership development components.

Educational institutions create knowledge without application pathways. IIT Indore's Sustainable Energy & Environmental Materials Lab conducts cutting-edge research on CO2 capture and climate adaptation technologies, yet these innovations rarely reach communities needing simple cooling solutions. The Indore Institute of Science & Technology's Green Waves Club implements comprehensive campus sustainability—organic cultivation, solar energy, water harvesting—creating replicable models that remain unscaled due to missing linkages with community organizations.

Youth organizations demonstrate energy but lack resources and recognition. The Indian Youth Climate Network's 80+ members participating in COP deliberations since 2008 shows policy engagement capacity, yet their insights rarely influence local planning. Earth5R's UNESCO recognition and 1.3 million citizen network across 65 countries provides proven models for environmental action, but Indore-specific programming remains limited without local government partnership.

Community-based organizations address immediate needs without long-term visioning. Grow Billion Trees Foundation's large-scale plantation drives directly address urban heat, yet species selection and maintenance strategies lack climate projection integration. Local NGOs like Jan Vikas Society provide health services in underserved areas but without climate adaptation planning. Women's groups organize around savings and credit without leveraging their networks for climate resilience building.

The missing connective tissue prevents synergistic action. No platform exists for regular coordination among climate, health, and youth stakeholders. Funding streams remain sectoral,

preventing integrated programming. Knowledge products from one sector rarely reach others—health workers lack climate projections, climate planners miss health data, youth programs ignore both. Success stories remain isolated without systematic documentation or scaling mechanisms.

10.6 Building Integrated Resilience Pathways

Creating climate-adaptive healthy cities requires fundamental reimagining of community resilience that centers youth leadership while bridging traditional knowledge with contemporary innovation through inclusive institutional mechanisms. Immediate actions should focus on visible demonstrations that build confidence and constituencies for deeper transformation.

Community resilience hubs represent an actionable starting point. These physical spaces in vulnerable neighborhoods—beginning with those facing highest heat exposure and flood risk—would integrate multiple functions: cooling centers during heat waves with backup power and water access; traditional knowledge centers where elders teach youth about indigenous practices; health outreach posts where community workers provide climate-adapted services; youth innovation labs for developing and testing local solutions; and emergency response nodes for extreme weather events. Starting with 3-5 pilots in diverse neighborhoods would demonstrate feasibility while enabling learning for scaled implementation.

Traditional knowledge integration requires systematic approaches beyond tokenistic inclusion. Documenting Malwa building techniques through youth-led video projects creates engaging content while preserving wisdom. Training young architects and engineers in traditional cooling strategies enables contemporary applications. Establishing millet cultivation demonstrations in urban agriculture projects connects food security with climate adaptation while providing youth entrepreneurship opportunities. Creating intergenerational dialogue platforms where elders share seasonal health management practices with young health workers bridges knowledge systems.

Health system strengthening must embed climate adaptation throughout service delivery. Training all health workers on climate-health connections with locally relevant examples enables responsive care. Modifying service timings to avoid extreme heat exposure protects both providers and patients. Establishing youth health volunteers specifically for climate events creates surge capacity while providing career pathways. Integrating traditional healing knowledge with modern protocols offers holistic approaches resonating with communities.

10.7 Transforming Governance for Resilience

Institutional transformation requires new mechanisms that enable rather than constrain integrated action. Creating a Youth Climate Corps modeled on successful international exam-

ples provides structured pathways for youth leadership. Members would receive training in climate science, traditional knowledge, and community organizing, work on specific projects—vulnerability mapping, cooling center management, health education—for 6-12 month terms, and receive stipends and educational credits creating economic incentives. This creates a cadre of climate-literate youth with practical experience who can bridge community needs with institutional resources.

Participatory budgeting for climate resilience democratizes resource allocation while building community ownership. Allocating percentage of municipal climate funds for community-proposed projects, with youth comprising mandatory percentage of decision-making bodies, ensures responsive investments. Providing technical support for proposal development enables participation regardless of formal education. Transparent tracking of implementation and impacts builds accountability and learning.

Knowledge integration platforms must connect currently fragmented insights. Regular "Resilience Dialogues" bringing together traditional knowledge holders, scientists, youth innovators, and practitioners create cross-learning opportunities. Documentation in accessible formats—videos, infographics, local language materials—enables broad dissemination. Youth-led social media campaigns can amplify reach while creating engaging content. Academic institutions can provide research support while community organizations ensure grounded application.

Long-term transformation requires reimagining Indore as a learning city where climate adaptation becomes embedded in culture and daily practice. This means education systems that integrate traditional knowledge with climate science from primary levels, health systems that combine indigenous and modern approaches for holistic care, urban planning that respects ecological wisdom while embracing innovation, and economic development that values resilience alongside growth. Most fundamentally, it means recognizing youth not as future leaders but as present change agents whose energy, creativity, and stakes in climate outcomes position them uniquely to drive transformation.

10.8 Questions for Young Changemakers

10.8.1 Bridging Wisdom and Innovation

Your grandparents likely know exactly which local trees provide the best shade, which foods prevent heat exhaustion, and how buildings stayed cool without electricity. But this knowledge is disappearing as elders pass away without documentation and youth pursue "modern" lifestyles. What if youth groups created "Wisdom Exchanges" where elders teach traditional practices while youth share digital documentation skills? Could you develop apps that gamify learning about local climate adaptation—like Pokémon Go but for finding medicinal plants or identifying traditional architecture? The climate crisis demands both ancient wisdom and

modern innovation. How can Indore's youth become bridges between knowledge systems rather than choosing sides?

10.8.2 Health Systems by and for Youth

When extreme heat strikes or flooding hits, youth often become first responders in their communities—helping elderly neighbors, sharing information on social media, creating makeshift cooling spaces. But these efforts remain informal and unrecognized. What if youth organized "Climate Health Brigades" that receive proper training and resources? Could student groups partner with health centers to create youth-friendly services addressing climate impacts—from heat stress to eco-anxiety? The health system needs transformation, and youth understand their peers' needs better than distant bureaucrats. How can young people move from informal helpers to recognized health system partners?

10.8.3 Redefining Resilience Metrics

Current resilience planning focuses on infrastructure—drainage systems, cooling centers, early warning systems. But true resilience lives in communities—social networks, mutual aid, collective action. What if youth developed new ways to measure and strengthen community resilience? Could you map trust networks showing who helps whom during crises? Document informal support systems that planners miss? Create "resilience report cards" rating neighborhoods not just on infrastructure but on social cohesion, traditional knowledge preservation, and youth leadership? The metrics we use shape the city we build. How can Indore's youth ensure resilience measurements reflect what actually helps communities survive and thrive despite climate chaos?

11 Future Pathways

Indore stands at a critical juncture where remarkable achievements in urban cleanliness and waste management must be matched by equally ambitious climate-health adaptations for its youth population. The convergence of intensifying climate risks, persistent health inequalities, and existing organizational capacity creates both unprecedented challenges and exceptional opportunities for transformation.

11.1 Research Gaps

Several significant research gaps emerged from this literature review:

Longitudinal health impact studies connecting climate variables to health outcomes remain absent. While cross-sectional studies document health challenges and climate risks separately, rigorous epidemiological research linking climate exposure to specific health outcomes is needed to guide intervention prioritization.

Youth agency research represents a particularly important gap. Despite institutional commitment to youth engagement, scholarly research has not captured the transformative potential of youth as agents of climate adaptation in Indore's urban context. Participatory action research with youth on envisioning climate-resilient environments could inform more effective adaptation strategies.

Integrated vulnerability assessments for specific populations remain incomplete. While studies document health disparities and climate risks separately, comprehensive assessments examining how climate change differentially affects urban poor, women, children, and elderly populations are needed.

Health system adaptation planning under climate change scenarios lacks systematic documentation. Integration of climate projections with health system capacity planning could improve preparedness for extreme weather events and changing disease patterns.

11.2 Key Themes and Analytical Synthesis

11.2.1 Urban utilities as climate-health intervention points

The literature reveals that urban utilities represent critical leverage points for addressing climate-health challenges. Indore's success in waste management, water system improvements, and air quality initiatives demonstrate how integrated utility management can simultaneously address climate adaptation and health protection. This finding challenges sectoral approaches to urban planning and suggests the need for more integrated climate-health frameworks.

Infrastructure interdependencies amplify both risks and opportunities: water scarcity affects sanitation systems, which influence disease patterns, which strain health systems during extreme weather events. Conversely, coordinated improvements across utility systems (as demonstrated in Indore's waste management success) can deliver synergistic benefits for both climate resilience and health outcomes.

11.2.2 Community engagement as an essential adaptation strategy

Research consistently identifies community engagement as critical for effective climate-health adaptation. The Building Healthy Cities systems mapping approach, UHRC's community mobilization programs, and municipal citizen engagement initiatives all demonstrate that local knowledge and participation enhance both adaptation effectiveness and health equity.

Bottom-up approaches complement top-down investments: while infrastructure improvements require municipal investment, community-based strategies for water conservation, heat protection, and disease prevention prove essential for reaching vulnerable populations. This finding supports integrated approaches that combine infrastructure development with community capacity building.

11.2.3 Health co-benefits justify climate investments

Multiple studies document how climate action delivers measurable health improvements: waste management reduces vector-borne diseases, renewable energy improves air quality, and water system improvements reduce waterborne illness. Quantifying health co-benefits can strengthen the economic case for climate investments while building political support for adaptation measures.

This literature review reveals that while academic research on climate-health linkages in Indore remains limited, available evidence demonstrates significant vulnerabilities and promising intervention approaches. Indore's experience shows that integrated urban utility management can simultaneously address climate adaptation and health improvement, offering valuable lessons for other rapidly growing Indian cities.

Key findings include: water scarcity emerges as the primary climate-health threat requiring urgent attention; air quality improvements through transport and energy interventions deliver measurable health benefits; waste management systems demonstrate how climate action can directly improve health outcomes; and community engagement proves essential for effective climate-health adaptation.

Critical research needs include longitudinal epidemiological studies linking climate variables to health outcomes, comprehensive vulnerability assessments for specific populations, and systematic documentation of health system adaptation planning. Investment in youth agency research could unlock innovative approaches to climate-health challenges while building long-term adaptive capacity.

Policy implications suggest the need for integrated climate-health planning frameworks that recognize urban utilities as critical intervention points, prioritize community engagement in adaptation strategies, and systematically quantify health co-benefits to justify climate investments. Indore's experience provides a foundation for developing these approaches, but sustained research investment is needed to fully realize the potential for climate-health co-benefits in urban India.

11.3 Way Forward

The path forward requires integrating traditional wisdom with modern innovation, scaling successful pilot programs, and prioritizing youth-centered climate adaptation. Indore's experience offers valuable lessons for other Indian cities facing similar challenges - that comprehensive systems thinking, community engagement, and cross-sectoral collaboration can create climate-resilient health systems even in rapidly urbanizing environments.

The ultimate test will be whether Indore can leverage its demonstrated capacity for innovation to protect its most vulnerable populations from climate change impacts while maintaining its status as a model sustainable city. The foundation exists through strong research partnerships, policy frameworks, and organizational networks - success will depend on translating this foundation into scaled, integrated interventions that prioritize youth health and climate resilience.

Additional Resources

[Work-in-progress]

This compilation provides comprehensive documentation relevant to climate action and youth engagement in Indore. The resources span technical reports, research studies, program evaluations, and implementation frameworks that offer evidence-based insights for developing climate interventions.

Climate Vulnerability and Resilience

Indore Climate Action Plan (WRI India and EPCO, 2022)

This comprehensive planning document provides Indore's strategic framework for climate mitigation and adaptation through 2050 (Environmental Planning & Coordination Organisation 2023). The plan establishes baseline greenhouse gas emissions at 3.6 million tons CO2e (2019), identifies sectoral contributions (59% stationary energy, 30% transportation, 11% waste), and models three emission scenarios. The document outlines six sectoral goals addressing water resilience, low-emission transport, urban greening, renewable energy, and waste management, with specific targets and implementation pathways.

Climate Change and Environment Action Plan for Indore District (Vasudha Foundation, 2022)

A district-level analysis documenting a 291% increase in greenhouse gas emissions between 2005-2019, with detailed sectoral breakdowns and projections through 2100 (Vasudha Foundation 2022). The report provides granular climate projections showing temperature increases of 1.3°C by 2030s and up to 2.6°C by 2050, alongside precipitation variability analysis. It includes vulnerability assessments across sectors and recommendations for district-level climate governance.

Indore City Resilience Strategy (TARU, 2012)

Developed under the Asian Cities Climate Change Resilience Network (2008-2017), this foundational document established Indore's early climate vulnerability assessment framework (TARU Leading Edge 2012). The strategy documents urban heat island effects, flood risks, and water stress patterns while proposing integrated adaptation measures. As one of three Indian cities selected for comprehensive climate resilience research by the Rockefeller Foundation, Indore's experience informed national urban climate planning approaches.

Youth Engagement Frameworks and Implementation Guides

Youth ACT Framework (NIUA and Youth Ki Awaaz, 2024)

A national framework providing structured approaches for youth-led urban climate action across Indian cities (Driver and Shankar 2024). The document presents 22 case studies of youth interventions across six climate action areas, methodological guidance for youth engagement formats, and templates for proposal development. It establishes principles for meaningful youth participation beyond tokenism, emphasizing institutionalization, sustained engagement, and measurable outcomes.

Health-Climate Integration Research

Building Healthy Cities Project (2017-2022)

This USAID-funded systems research initiative engaged 247 multi-sectoral stakeholders in dynamic systems mapping to understand climate-health interactions in Indore (Building Healthy Cities 2022) . The project developed integrated Health Action Plans addressing interconnections between air quality, transportation, waste management, education, and health services. The participatory research methodology produced evidence-based interventions while building local research capacity [Pomeroy-Stevens et al. (2022)].

Health-at-a-Glance City Profile: Indore (JSI/USAID, 2020)

Epidemiological profile documenting health indicators relevant to climate vulnerability. The report identifies that 28% of Indore's population lives in slums with 313 public and private hospitals serving nearly 3 million residents. It documents child stunting rates at 39%, immunization coverage at 99%, and establishes baseline health system capacity for climate-related health impacts.

Urban Health Resource Centre: Research on Informal Workers

Multi-city comparative research examining climate vulnerability among informal sector workers in Indore, Harare, and Masvingo. The study documents adaptation strategies employed by youth in informal economies, occupational health risks exacerbated by climate change, and community-based interventions for strengthening social protection systems. Qualitative interviews with 90 workers revealed interconnected vulnerabilities affecting health, livelihoods, and wellbeing [Agarwal, Jones, and Verma (2016)].

Community-Based Research and Monitoring

IIED Informal Settlements Research

Participatory research involving over 80 community sessions across informal settlement clusters in Indore. The study documents climate vulnerabilities, collective adaptation strategies, and municipal engagement frameworks. Findings highlight disproportionate climate impacts on informal settlements where youth comprise significant populations (Agarwal 2016).

State Climate Fellows Program

Capacity building initiative training government officials in climate science, impact assessment, adaptation planning, and stakeholder consultation. While targeting officials, the curriculum and methodological approaches provide models for youth capacity building programs.

Successful Implementation Models

Surat Heat and Health Action Plan

India's first coastal city heat-health action plan demonstrating measurable mortality reduction from 800 deaths (2010) to 25 deaths (2019) through systematic interventions. The plan established early warning systems, public awareness campaigns, capacity building for health workers, and inter-departmental coordination mechanisms. Multi-stakeholder workshops identified governance and finance as primary resilience factors.

Ahmedabad Heat Action Plan

The world's first comprehensive municipal heat action plan, now replicated in over 130 cities globally. The plan's success derives from integration of meteorological forecasting with public health surveillance, targeted interventions for vulnerable populations, and sustained political commitment. Evaluation studies document significant reductions in heat-related mortality and morbidity.

Kochi Youth Climate Engagement Model

Municipal-university partnership model demonstrating effective youth integration in local governance. The model operates through education standing committees managing volunteer databanks, student-led watershed mapping projects, and experiential learning programs. Institutional mechanisms ensure sustained engagement beyond project cycles.

Shaktika Entrepreneurship Program (Kerala)

District-level initiative demonstrating youth-led solution delivery for water, sanitation, and agriculture challenges. The program provides recognition, outreach support, and space provision through local government bodies. Documentation includes business models, impact metrics, and scalability assessments.

Government Programs and Institutional Frameworks

National Programme on Climate Change and Human Health

Federal framework providing technical guidelines for climate-health vulnerability assessment and adaptation planning. While implementation remains fragmented, the program establishes institutional mechanisms for state-level coordination and capacity building. Integration with existing health programs presents opportunities for leveraging resources.

Smart Cities Mission - Climate Components

Funding mechanism enabling climate-resilient infrastructure development through technology integration, green building standards, citizen engagement platforms, and public-private partnerships. Indore's smart city initiatives provide entry points for youth engagement in digital governance and sustainable development planning.

Madhya Pradesh State Action Plan on Climate Change

State-level strategic framework addressing sectoral adaptation and mitigation across agriculture, water resources, urban planning, transportation, forests, and biodiversity. The plan establishes institutional mechanisms including Climate Change Cells with multi-departmental representation and progress monitoring systems [Government of Madhya Pradesh (2013)] .

Capacity Building and Technical Training

National Urban Learning Platform (NULP)

NIUA's systematic capacity building approach targeting 5,000 urban professionals by 2027. The platform offers Leaders in Climate Change Management certification, combining online modules with in-person training. Peer learning networks and communities of practice support sustained knowledge exchange.

Pradhan Mantri Kaushal Vikas Yojana - Green Skills Component

National skill development program increasingly incorporating climate-relevant training including renewable energy technologies, green construction, waste management, and environmental monitoring. The program provides certification and placement support, addressing youth employment alongside environmental objectives.

Climate Smart Buildings Initiative

Technical assistance program supporting thermal comfort and climate resilience in affordable housing. Youth training components cover green construction techniques, monitoring technologies, and integration with building regulations. The program demonstrates pathways for green job creation in the construction sector.

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