Children Focused City Resilience Strategic Directions for Bhopal

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Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BMC	Bhopal Municipal Corporation
CDP	City Development Plan
CLD	Causal Loop Diagram
DRR	Disaster Risk Reduction
FGD	Focused Group Discussion
GoMP	Government of Madhya Pradesh
HFA	Housing for All
HH	Household
KII	Key Informant Interview
LPCD	Litre Per Capita Per Day
MLD	Million Litre Per Day
MP	Madhya Pradesh
NFHS	National Family Health Survey
SBM	Swachh Bharat Mission
SEP	Solar Evaporation Pond
SLD	Shared Learning Dialogue
ULB	Urban Local Body
UT	Union Territory

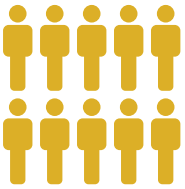
1. Introduction

With the advent of climate change, urbanization is now leading to greater uncertainties and an increasing impact on human lives.

In today's world, where there is a steady increase in population and where migration is a major issue, the biggest challenge we face is to cater to the basic needs of people in urban areas, which is generally dealt by the urban government and its systems in the cities. India stands at the threshold of a new day, boasting of the second largest population in the world with a large number of young minds. India will contribute 404 million people to its urban population between 2014 and 2050. The annual growth in urban population in India between 2010 and 2015 was 1.1 per cent, the highest among major economies, according to the UN World Urbanization Prospects Report 2014. Already, Indian cities contribute more than 62 per cent to our national GDP.

Scarcity of resources is the foremost challenge most of the cities deal with, in today's world. Some of the other issues at the forefront are: limited institutional capacities, constrained municipal finances, large-scale in-migration and growing population, ageing or inadequate infrastructure, all leading to inadequacy in the provisioning of urban basic services. These all unitedly form an urban system where their functions are interdependent and their capacities interwoven, to cater to the urban inhabitants of the city for easy living. Where these essentials are lacking, such as access to transportation infrastructure, water and sanitation, education, healthcare and housing needs, it invariably makes life a struggle for its citizens in these same cities.

With the advent of climate change, urbanization is now leading to greater



India is projected to add **404 million people** to its urban population between 2014 and 2050.

uncertainties and an increasing impact on human lives. In urban areas with its complex systems that cater to the inhabitants in these cities, this is leading to problems which are further aggravated by the additional stress of climate change impact on critical urban basic services, especially where the urban ecosystems consequently affect the livelihood and well-being of the urban population. Keeping pace of infrastructure development with the growing economy, the Government of India has been working to turn 100 cities into Smart Cities. Urban Local Bodies (ULBs) too are pushed to their limits in providing basic facilities to the residents, even as they agglomerate more villages within the urban areas, in a bid to provide better living conditions for its residents.

Madhya Pradesh (MP) is a centrally located land locked state, with undulating topography and diverse physiography. The state, at the heart of the country, is no exception to the growing urban population. The State in 1951 had an urban population of 14.6 per cent which gradually increased to 27.6 per cent in 2011 (Census of India, 2011). It too is considered to be vulnerable to the changing climate scenario, as is the country. The State has a rich bio-diversity, vast forest cover and plenty of mineral wealth and changes in climatic conditions can bring irreversible shifts to these systems. Some of the projected climate risks of MP are variations in the maximum and minimum temperatures, changes in spatial and temporal distribution of monsoon, increase in frequency and intensity of rains, loss of rainy days, extended summers etc. Climate change will not only affect the natural resources, but would also impact human health and availability of safe habitats in times to come. Uncertain climatic conditions, developmental challenges and the associated upheavals, together with reduced adaptive capacities are making MP, highly vulnerable to the impacts of climate change (SAPCC, 2014). Table 1 gives the climate change projections of MP.

Table 1: Projected changes in climate parameters of MP

Projected changes in climate	2021-2050	2071-2100
Daily Maximum Temperatures	1.8-2 °C increase	3.4-4.4 °C increase
Daily Minimum Temperatures	2.0-2.4 °C Increase	› 4.4 °C increase
Monsoon Precipitation	Increase in precipitation by 1.25 times the current observed rainfall in most parts of Madhya Pradesh; No change in Morena, Shivpuri, Gwalior and Bhind; Increase in precipitation in eastern parts of Hoshangabad, northern/north eastern part of Betul and Southern part of Sehore	More than 1.35 times increase in precipitation with respect to observed climate in most parts of Madhya Pradesh. With major parts of Hoshangabad and Damoh, Mandla and northern parts of Balaghat will experience rain in excess of 1.45 times the observed climate now. The extreme northern and western part of the state will also experience excess rainfall but less than most of the other areas.
Winter Precipitation	Decrease in precipitation	Substantial increase in precipitation in Central and South western part of Madhya Pradesh increasing between 1.45 and 1.85 times

(Source: SAPCC, MP, 2014)

The rapid urbanization and infrastructure development has a darker side to it. The number of slums and its population has been increasing, which is further leading to a crisis in infrastructure and basic needs. Along with rapid urbanization and growing population, climate change as a phenomenon is increasing concern towards quality of resources (water, air and eco-systems). Climate change challenges faced across cities worldwide include extreme weather conditions like excessive rains, flooding and drought in summers and extreme drop in temperature during winters. Authorities not only face an uphill task in providing basic facilities to their citizens, but now also face the added burden of dealing with extremities due to climate change.

Madhya Pradesh had an urban population of **14.6 per cent** of the total population in 1951 which had gradually increased to **27.6 per cent** in 2011

The urban population in India is increasing at a rapid pace and it is expected that in a few decades, this urban population will equal the rural one, particularly in the secondary cities in India. These are at particular higher risk due to high population density, constrained basic services, expansive informal settlements and urban expansion occurring on risky sites. Among these inhabitants the more strongly affected by the climate change impacts are the urban poor children living there, as they cannot afford basic hygiene and health care due to lack of resources, safeguards and adequate care. Madhya Pradesh has the 3rd highest slum population of children between 0-6 years (31.1 per cent, Census of India, 2011) after Andhra Pradesh and Chhattisgarh. Children, especially living in slum areas are the most vulnerable to the rapid transformations occurring in the urbanizing world. The type of climate risk confronting children are diverse, ranging from direct physical impacts, such as cyclone, storm surges and extreme temperature, to impacts on their education, psychological stress and nutritional challenges. For the children growing up in slums, the urban experience is one of poverty and exclusion. As the prevalence of diseases is high in slums, inadequate access to safe drinking water and scarce sanitation services put the children at an increased risk to illness, malnutrition and even death. Children also face issues of safety and security. The number of cases of child trafficking, labour and sexual harassment is also increasing and has become a challenge not only for administration but for the society as well.

2. Research Objectives and Methodology

We aimed at understanding the existing and future risk profile of the city based on the shocks and stresses, specifically focusing on the vulnerabilities of children and marginalized population

2.1 Objectives of the Study

- To understand city level vulnerability, and identify the impacts of potential climate variability and climate change on Bhopal City
- To provide evidence and understanding on the nature of vulnerabilities of urban poor children due to climate change
- To evolve city specific urban climate change resilience directions, with particular focus on improving the resilience of poor and vulnerable population, such as children, to climate change impacts
- To explore opportunities for child-centred and climate-sensitive Disaster Risk Reduction (DRR) through systematic dialogue and interaction with urban administrators

2.2 Methodology

The Methodological Framework (Figure 1) of the study consisted of the following steps, in order to understand the city, its urbanisation, climate change together with development plans, as well as the vulnerabilities of children and their issues, leading to identification and assimilation of resilience directions:

2.2.1 Literature Review

To understand urban children, and the issues and challenges faced by them, current literature related to urbanization, climate change and urban poverty was reviewed. These were drawn from recent commissioned researches in this area of study. Further, research and reports related to development plans, master plans etc. were sourced and reviewed.

The National Action Plan on Climate Change (NAPCC), State Action Plan on Climate Change for MP (SAPCC), Disaster Management Act (DM Act, 2005), State Disaster Management Plan of MP, National Policy on Children, Municipal Acts, Vulnerability Assessment Reports, City Resilience Strategies, National Family Health Survey - 4 (NFHS – 4) Report, Crime in India Report- 2016 etc. and other reports related to Health, Education, Nutrition, WASH and Child Protection were also reviewed.

2.2.2 Stakeholder Consultation

Stakeholder consultation was done to understand the city's vulnerability and access local knowledge, and understand the immediate issues and challenges. This helped in identifying key actors and assessing their strengths. These also helped in developing cross-sectoral direct and indirect relations. Key stakeholders of this study were the state and local government agencies, academic institutions, NGOs working on child, health education, WASH and child protection issues, and citizens/ community representatives. All these interactions were useful to collect information and gain local knowledge. It also helped understand the different institutional mechanisms and their responsibilities.

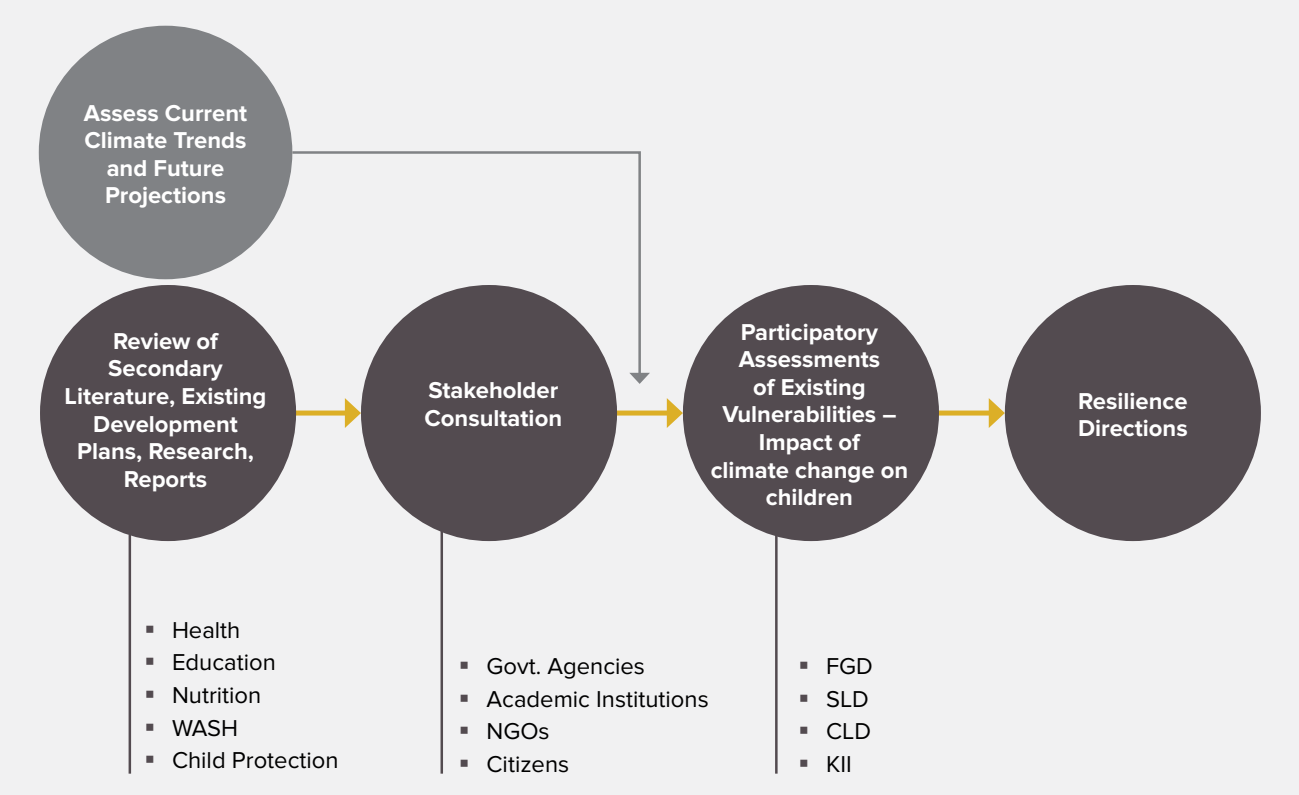


Figure 1: Methodological Framework

2.2.3 Vulnerability Assessment

The main objective of a vulnerability assessment is to understand the different facets of risks and quantify the component of vulnerability across the city, to create an adaptation framework that is focused on the poor and vulnerable urban residents.

To identify city vulnerability and its impacts on poor children, Shared Learning Dialogues (SLDs), Focused Group Discussions (FGDs) were carried out with different stakeholders. SLDs and key interviews were undertaken with Government and Municipal officials and other stakeholders primarily on climate vulnerability (Population groups, priority sectors, impact on key dimensions etc.), programs and schemes. Discussion and key interviews were held with leading NGOs who work on children issues in the city. All the interaction helped in identifying the vulnerable sectors and the key vulnerable groups of the city.

The main objective of a vulnerability assessment is to understand the different facets of risks and quantify the component of vulnerability across the city

FGD is a basic tool that facilitates exchange of qualitative and quantitative data. FGD enables specific actors to be brought together to share information in a concentrated format. Field visits were made to communities and discussions were held with community representatives, women and children groups. Participatory approaches were conducted during discussions with children and women groups. With the use of different tools, the resilience directions were identified for the urban poor children.

2.2.4 Causal Loop Diagram (CLD)

Casual Loop Diagram (CLD) tool was one of the most important tools used in this study. CLD helps in understanding the inter-linkages between different variables and sectors for a research. The diagram consists of a set of nodes and edges where nodes represent the variables and edges are the links that represent a connection or a relation between the two variables. A link marked positive indicates a positive relation and a link marked negative indicates a negative relation. A positive causal link means that the two nodes change in the same direction, i.e., if the node in which the link starts decreasing, the other node also decreases. Similarly, if the node in which the link starts increasing, the other node increases as well. A negative causal link means the two nodes change in opposite directions, i.e. if the node in which the link starts increasing, the other node decreases and vice versa. Several linked causes to a particular problem related to children were analysed through this tool (Wajih and Mani, 2016).

3. Bhopal City

Bhopal is the second largest city in terms of population in Madhya Pradesh

3.1 City Profile

Bhopal is one of the most populated districts, and the capital of Madhya Pradesh. The average elevation of this place is 500 meters. The upper limit of Vindhya Mountain Range is just north of the Bhopal city, and the city has an uneven elevation and small hills within its boundaries. The prominent hills in Bhopal are Idgah Hills and Shyamla Hills in the northern region. There are two main man-made lakes, named Upper Lake and Lower Lake in the city. The geographical location of the city and the climate variability in the region has close interrelations, and may affect primary sources of livelihood.

Location, the physical geography of the city, the perennial flow of river systems, plentiful of forest cover, low relief and a large number of water bodies render a unique micro-climate to the city. The rapid pace of urban expansion, however, is gradually eating up the natural ecosystems around the city, by either filling low-lying areas with solid waste or building new constructions on it. It is perhaps giving birth to some new ecosystem and building greater climate risks in the city.

The Municipal area of Bhopal city is 413 sq km and is divided into 19 zones and 85 wards (Map 1). Bhopal is the second largest city in terms of population in Madhya Pradesh. The total population of the city was 14,37,354 in 2001 which increased to 17,98,218 in 2011 with a decadal growth of 20.06 per cent. During 1951-61, the population growth was nearly 120 per cent. With industrial and commercial development in and around

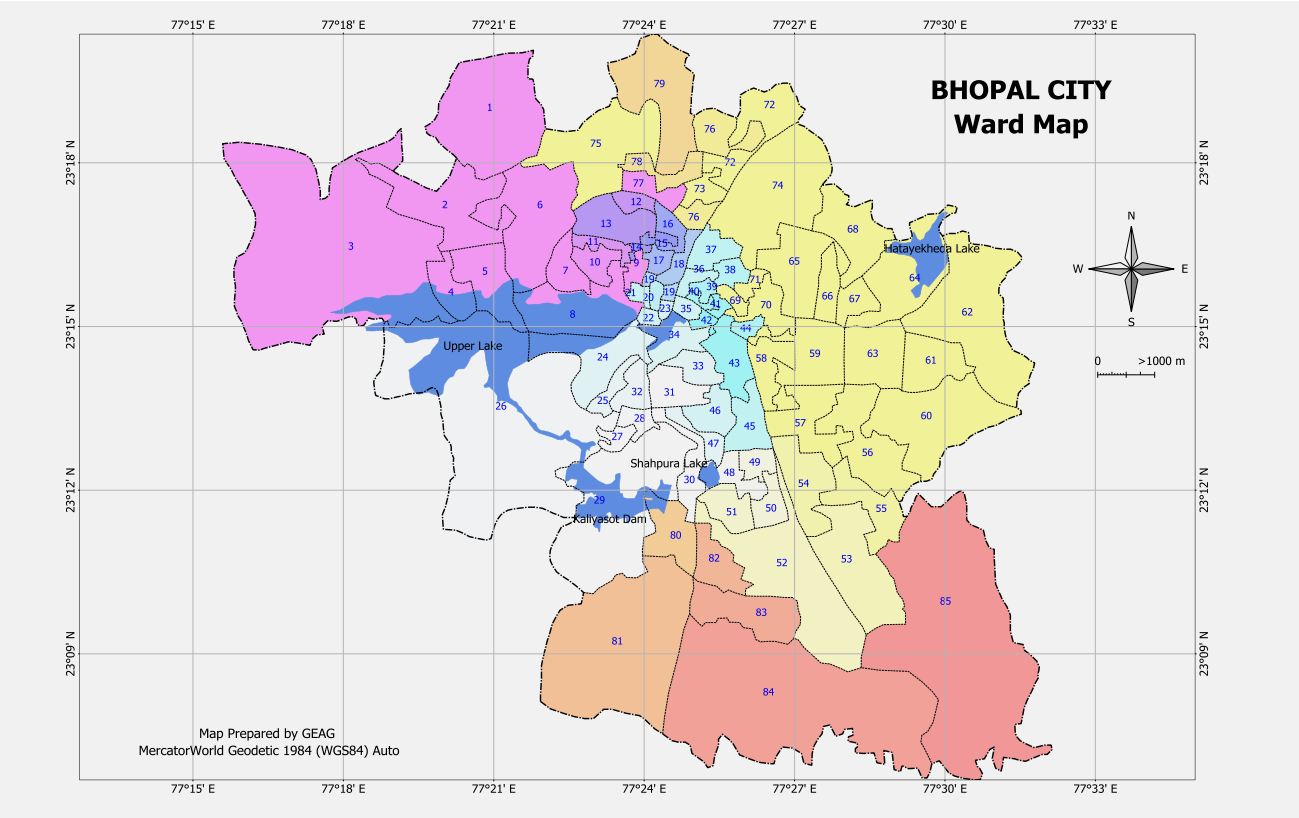
The Municipal area of Bhopal city is **413 sq km** and is divided into **19 zones** and **85 wards**

the city, the population has grown rapidly with a rate of 34.92 per cent during 1991-2001 and 28.62 per cent during 2001-2011. Percentage of the urban population to the total population of the district is 85.24 per cent and is changing very quickly, with a large floating population that comes in daily to the city in search of jobs. Hinduism is the major religion in Bhopal city with 69.20 per cent followers, while Islam is the second most popular religion with approximately 26.28 per cent Muslims. The children population in the age group (0-6) years is 2,16,088 (Census of India, 2011).

Bhopal is divided into 6 major areas and around 75 suburbs. The economy of the city is essentially divided into modern and traditional industries. Typically an administrative city, it has a large number of population engaged in various state and central government organizations. As far as total employment is concerned, Bhopal has its 39 per cent working population engaged in the informal sector. Considering the workforce participation, 30 per cent of the population, a large section, is dependent on informal employment. The pace of urbanization is fast eroding the natural ecosystem in peri-urban areas and the wetlands within the city. It is changing the micro-climate of city/region due to heat-island, increasing aerosol and is also changing the natural drainage line of the rivers.

Hinduism is the major religion in Bhopal city with **69.20%** followers, while Islam is the second most popular religion with approximately **26.28%** Muslims

Bhopal is a combination of scenic beauty, history and modern infrastructure development. The city has a clear division of old and new, historic and modern, unplanned establishment and a planned infrastructure development. The old part of the city is rich in historic and cultural values, having many monuments and heritage buildings of the royal dynasties in the past. The new part has a modern developed infrastructure, planned basic facilities accessibility and greener areas. However, the old and new parts of the city are exactly opposite to each other in their standard of living. Even the inhabitants seem diametrically contradictory to each other in every aspect, for example -compactness v/s sprawl, high density v/s low density, aged infrastructure v/s developing infrastructure.



Map 1: Ward map of Bhopal city

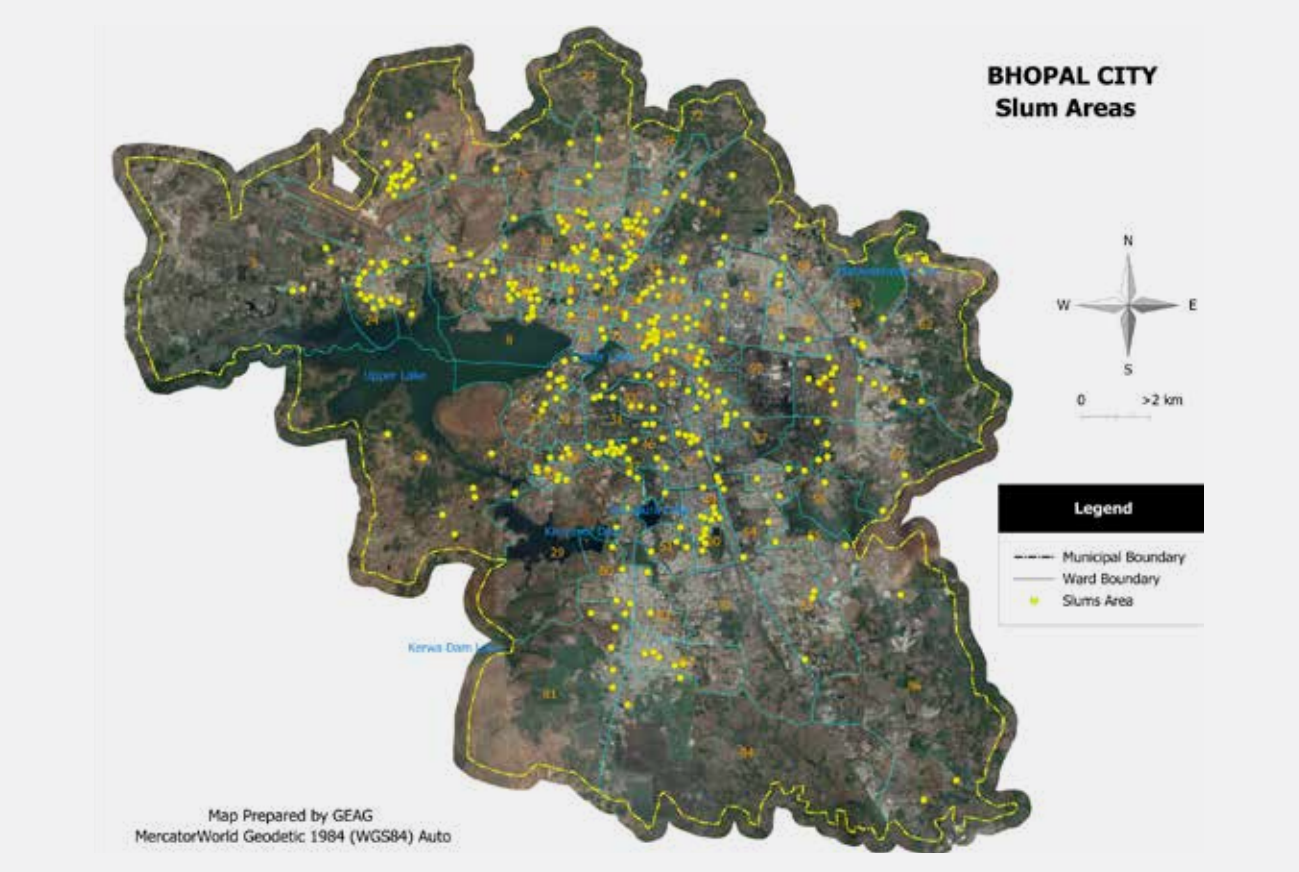
3.2 Migration

About 7 per cent of the rural population of Madhya Pradesh is engaged in the primary sector, which covers agriculture, horticulture, animal husbandry, fishery and dairy development. This sector contributes about 30 per cent to the State's net domestic product. Out of the total number of holdings, 65 per cent holding belong to farmers who occupy only 26 per cent of the cultivable land (Agriculture Census, 2000-01). Horticulture crops occupy nearly 3.25 per cent of the total cropped area of the state (XI Five Year Plan, MP). Climatic variations impact the agriculture sector tremendously. Climate change is leading to extreme events like frost, excess rain, high temperatures and shift in rainfall pattern. All this affects cropping patterns, and results in huge losses in productivity, affects soil health and is leading to heavy migration to urban areas. Bhopal, a well connected city, has become a hub for migrants who travel here for sustenance and a better way of life.

The floating population of the city is 9, 61,940 (City Sanitation Plan, 2017). Most of the migrants come to Bhopal from Bundelkhand, Chhattisgarh, Jharkhand and Nimar. People from Uttar Pradesh, Bihar and West Bengal also come to the city, searching for livelihoods. These low-skilled workers with their families live in the informal slums or create new slums. Lack of basic amenities, poverty and low literacy rates, increases the vulnerability of these individuals. These migrants are also excluded from accessing basic entitlement, education, health care, nutrition and a healthy living environment.

3.3 Slum Profile

The Census of India, 2011 registered the slum population of Bhopal city at 4,79,699 (about 26.68 per cent of total population), who reside in 388 slums (Map 2). Most of these slums spring along *nallahs* and river banks having steep slopes, rocky outcrops, or places which face a high water table. This implies a high infrastructure development cost on account of cut and fill, difficult access, rock excavation and dewatering. The positive side is that the slopes are favourable for good drainage, both storm and sewerage. Some of the slums on flatter terrain have black cotton soil, which again means a greater development cost.



Map 2: Slum location map of Bhopal city

Source: Bhopal Municipal Corporation

The current condition in the slums of Bhopal is expected to be improved as compared to the year 2005. This is mainly due to the focused efforts by BMC as well as MPUSP and BSUP. Madhya Pradesh Urban Services for the poor (Project *Utthan*) has been initiated by DFID in partnership with Government of Madhya Pradesh (GoMP) for infrastructure development, slum development and poverty reduction. The MPUSP is being implemented in Bhopal in selected 21 slums that are on municipal land. MPUSP is working with ULBs and slum communities for extending infrastructure through in-situ up-gradation in these identified slums, for improving water supply, drainage, roads, street lights, waste management, sanitation and community social assets. (Bhopal Profile, BMC).

Table 2: Government initiatives to improve housing facilities in slums

Basic Services improvement for Urban Poor	2,004 houses
Rajiv *Awas Yojana*	1,204 houses
Pradhan Mantri Awas Yojana-Housing for All	14,000 houses proposed

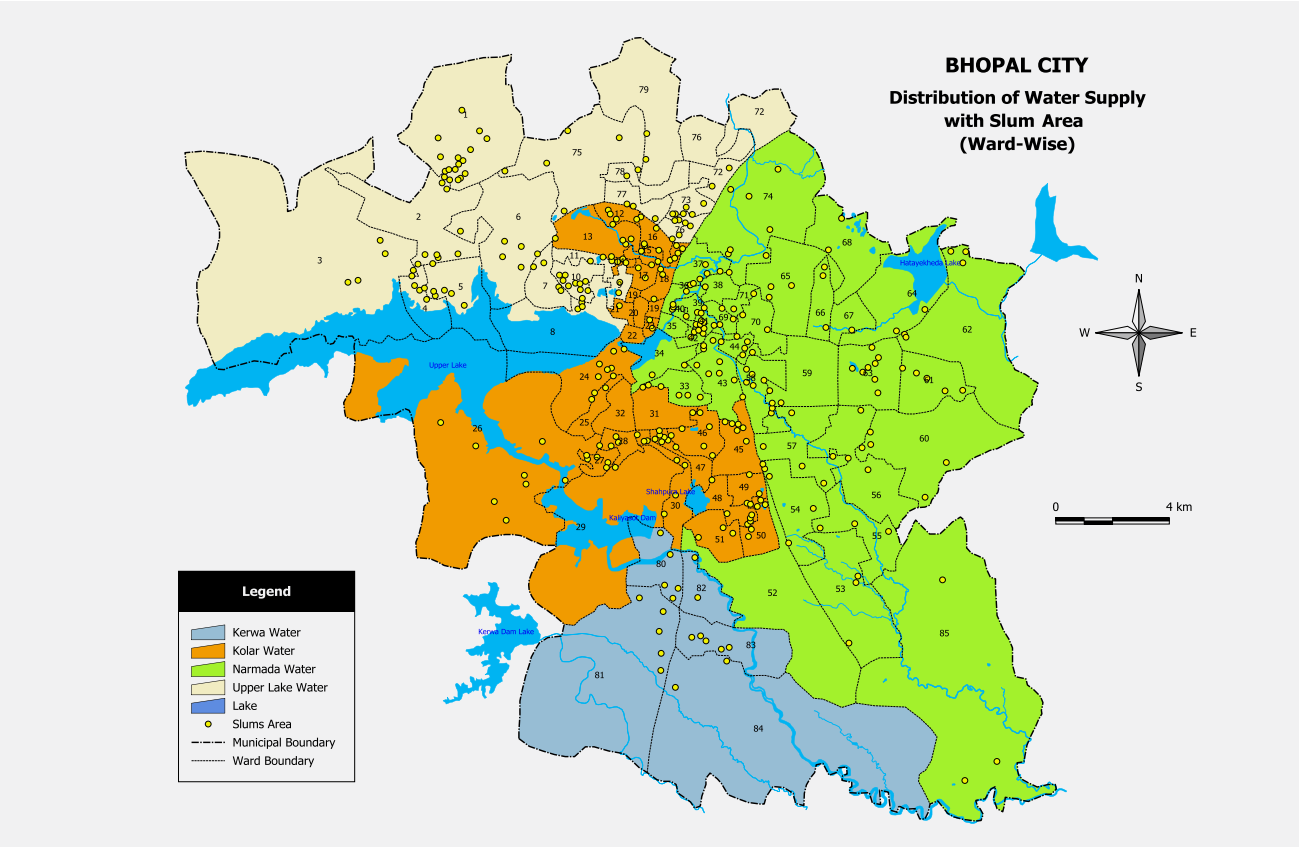
(Source: Bhopal Municipal Corporation)

3.4 Urban System Analysis

3.4.1 Water Supply System

The Upper Lake, was the oldest local water source, and is among the largest man-made lakes in central India. It was created in the 11th century, when the king Bhoj build an earthen dam across the Kolar River. The Lower Lake was constructed nearly 200 years ago, mostly from the seepage that occurred from the Upper Lake. With a steady increase in the population and the city sprawl, the increased demand in water supply was dealt by the BMC for the city. Further, an increasing water demand and lack of supply lead to the extraction of water from multiple sources, which is met through local reservoirs mainly from the Upper Lake, ground water and distant sources like Narmada River, and Kolar Dam. BMC also supplies water through tankers (Map 3).

About 95 per cent of Bhopal's water supply comes from surface water. Now, Narmada River's supply contribution is about 39 per cent, while bore wells provide about 4 per cent to the total public water supply.



Map 3: Water supply map of Bhopal city

Source: Bhopal Municipal Corporation

Table 3: Different water supply sources and their percentage contribution

S. No.	Water Source	Capacity in MLD	Water Supply Contribution %	Water Cost in Rs per KL
1.	Upper Lake	118	25	6
2.	Kolar Dam	155	32	9
3.	Narmada River	185	39	13
4.	Ground Water	20	4	

(Source: Bhopal Municipal Corporation)

The city's demand is 321 MLD, which has already increased as the city plans to supply 150 LPCD for all its citizens. The unaccounted water is about 35 to 40 per cent. The city population is projected to rise to about 3.5 million by 2033, and the expected water demand to 543 MLD. To meet this growing demand of water, the city will have to depend on a distant water source, like the Narmada River, which will further increase the cost of water (to include infrastructure for supply, operation and maintenance charges).

Presently, local supplies are affected by reduced lake catchment areas, as per a report by the Center for Science and Environment (CSE). Rapid urbanisation and encroachments are the key reasons for reduction in the catchment areas of the lakes. The Upper Lake has reduced from the initial 30 sq km to a measly 8 sq km now, and the Lower Lake from 8 sq km to 2 sq km in 2009. The total length of the lake was 38 km, but has shrunk to 5 km in 2009. Apart from local supplies, the distant source of water supply will be from River Narmada, similar to other cities near Bhopal, like Indore or Jabalpur. The irrigation and power sector will be the other major competitors for water from River Narmada. The uncertainty of rains can further lead to a huge depreciation on the water availability from River Narmada (CRS, Indore, 2011).

3.4.2 Drainage

Along with water supply, sanitation is also a necessary requirement for healthy lifestyle. The condition of sanitation and drainage system needs improvement in Bhopal, as only 30 per cent of the population has access to a proper sanitation system, while the rest 70 per cent depends upon open drains. A large amount of wastewater by a large section of the population is discharged into open drains. Drainage system in the old city is decrepit and was built to cater for about half the population that it serves today. New Bhopal, though, has a planned underground drainage system.

Open drainage system and discharge of waste in water bodies is increasing contamination and decreasing the sources of potable water. As many as 82.12 per cent of the households have a toilet facility within their premises, while the rest of the population utilizes public facilities. Still, there is about 8 per cent of household which do not have their wastewater outlet connected to the drainage, while nearly 92 per cent have them connected (CDP, Bhopal, 2006).

Open drainage in Nariyal Kheda, Bhopal

3.4.3 Sewerage

Bhopal does not have a planned and full-fledged sewerage system. A large area of the city, has no sewerage network, either internal or trunk, and the raw sewage or septic tank outflows are discharged into open drains which flow into the watercourses. Ultimately most of the sewage flows into the Upper Lake and into the *nallahs*, which eventually flow into the Patra, Halali, and Betwa Rivers.

BMC area has non-contiguous underground sewers in three different catchments, and covers about 28-30 per cent of the city population. In the remaining areas, a large section of the population discharges its wastewater into open drains. Existing Sewerage System is divided into three parts, CPA Scheme- 250km, ADB Scheme 130 km and Bhoj Wetland Scheme 86 Km. Theoretically, the sewage generated in Bhopal city is more than the treated sewage. This is either disposed in septic tanks or the people in informal housing opt for open defecation. As per the baseline data dated 24th September 2015, coverage of sewerage network and its management is 24 per cent. Coverage of latrines (individual or community covered under Swachh Bharat Mission and CM Swachhta Mission is 95 per cent (MP State Annual Action Plan for FY 2015-16 & Perspective Plan 2015-20). The city has only 8 STPs (with a total capacity of 74.01 MLD) which are also not managed properly.

Solid waste collection system in the city

3.4.4 Solid Waste Management

The city generates a total of 800 MT waste daily, within the Municipal Corporation limits. Out of the huge waste generated by the city, the civic body collects as much as 700 MT waste and transports it to the treatment plant or to the Bhanpura trenching ground.

The amount of waste treated by the civic body is a matter of concern, as only 50 MT waste is treated, which is even less than 10 per cent of the total collected waste. The BMC reports Bhopal to be the second cleanest city in India under the *Swachh Bharat* Mission 2016, under which door to door collection and segregation at source is included. At present, the municipal waste is crudely dumped at the Bhanpur village trenching ground at the city's periphery.

BMC has planned a Waste to Energy Plant in Adampur Chavni, where waste from nearby ULBs shall be collected and by utilising the mass burn technology, 21 MW energy will be generated. The municipality is also planning to install decentralized compost units all over open spaces in the city, like gardens.

4 Climate Scenario of Bhopal city

Bhopal city historically has been blessed with a moderate climatic condition, which was neither extremely hot in summer nor very cold during winter months

Bhopal has a humid subtropical climate, with mild, dry winters, a hot summer and a humid monsoon season. Summers start in late March and go on until mid-June. Bhopal city historically has been blessed with a moderate climatic condition, which was neither extremely hot in summer nor very cold during winter months. Rainy days were fairly long, consistent and evenly spread during the season. The city records an annual mean rainfall of 1027 mm with a standard deviation of 268 mm. The contribution of monsoon season rainfall is 91 per cent for the city. The mean monthly rainfall during August (346 mm) is at the highest and contributes about 33 per cent of annual rainfall, followed by July which contributes about 30 per cent. The annual mean temperature of the city is 25.04 °C, the annual mean maximum temperature of the city is 31.65 °C and the annual mean minimum temperature is 19.10 °C. Thus, climate behaviour and extremes in Bhopal are said to be fairly normal and livable.

In summer however, the average maximum temperature, soars to as high as 36.8 °C and winter average minimum is 10.5 °C. Comparing annual mean maximum and minimum with summer and winter peaks for Bhopal, a general increase and decrease of 5.15 °C and 8.6 °C in summer and winter is found. On a cursory basis, it could be summed that the city is not very hot in summer, but definitely cold during winter months.

The maximum temperature ever recorded in Bhopal was 46.0 °C on 25 May 2010 and the minimum temperature was 0.6 °C on 18 Jan 1935. Days with the

The contribution of monsoon season rainfall is **91 %** for the city. The mean monthly rainfall during August is at the highest and contributes about **33 %** of annual rainfall

maximum temperature exceeding 40 °C varies from 40 to 60 days, while the highest ever recorded rainfall in 24 hrs for Bhopal is 291.6 mm on 14 August 2006. A general climate scan of the city gives an empirical idea about climate scenario in Bhopal. But growing encounters with extreme events and experience of climate change by the people, however, draws attention and a need for deeper analysis and understanding of climate change phenomenon. It is for this purpose, an analysis of 36 years climate data is analyzed and inferences were drawn accordingly.

4.1 Climate change trends in precipitation

Rainfall in the city varies considerably both in space and time, from year to year. Analysis of the rainfall for the period from 1981 to 2016 (Figure 2 and 3), shows increasing but not significant trends in the annual rainfall. However, 0.10 mm per year increase in rainfall is observed in the pre-monsoon period i.e. in summer months, particularly in the month of June. A similar increase in rainfall trend is observed in the post-monsoon period. Pre and post-monsoon increases are however reversed by an insignificant decrease of rainfall in the monsoons. Data for the period 2001-2016, shows a decreasing trend of rainfall during rainy seasons, particularly in the month of July. Overall, a significant decline of 2.5 mm per day rain is reported during the rainy season. No specific trend in winter rainfall has been noticed for the period 1981-2016 except for a marginal decline of rainfall in December. A declining trend of rainfall is not an encouraging sign and beckons to a loss in food grain and agriculture production in the district. The decline of rainfall in December is particularly alarming for the sowing of wheat, which constitutes the main winter crop of the region. Heavy rainfall events range from 3-4 days in the monsoon season, whereas extreme rainfall days are 1-2 days.

4.2 Climate change trends in temperature

Among two important climate variables, temperature is one of the key variables usually understood by people as an indication of climate change. Temperature variation has a deep impact over the hydrological cycle and climate of any region. Analysis and interpretation of temperature variability, therefore, constitutes an important component of the study. Like rainfall, temperature trend too largely fluctuates with a marginal increase over Bhopal. Temperature data analysis for the period from 1981-2016 (Figure 4 and 5), shows an overall increasing trend for annual mean maximum temperature by 0.02 °C (per year). The rise in maximum temperature is most significant during monsoon season (0.04 °C per year) and 0.010 °C (per year) during post-monsoon season. No significant trend is found in maximum temperatures in summer and winter seasons.

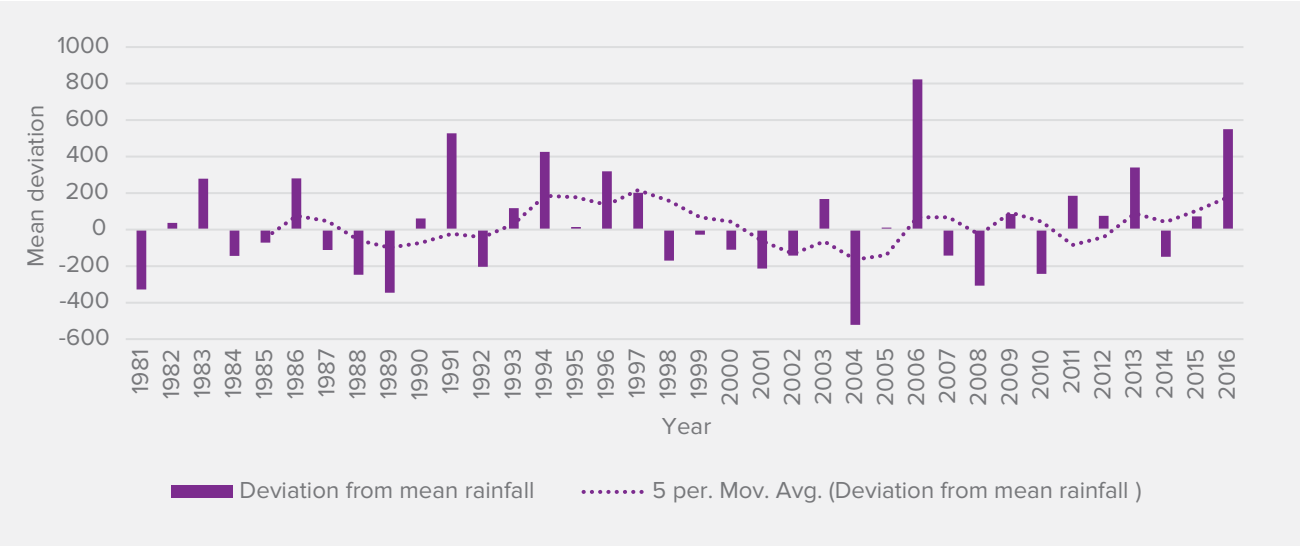


Figure 2 Deviation from mean annual rainfall, Bhopal (1981–2016)

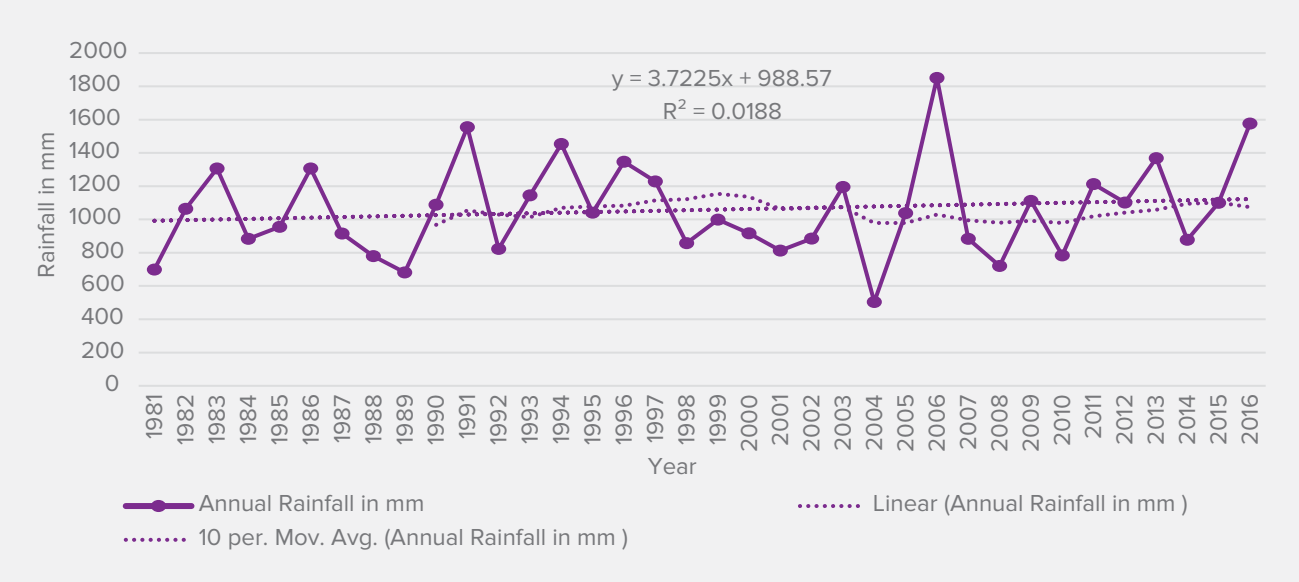


Figure 3 **Annual rainfall in mm, Bhopal (1981–2016)**

Annual mean minimum temperature shows a significant rising trend of 0.025 °C per year during the last 36 years. During the post-monsoon season, there is a significant rising trend of 0.001 °C per year. During the monsoon season, no significant trend is found. However, minimum temperature shows a significant increasing trend during winter and an insignificant decreasing trend during the summer season. This basically means that a much sharper increase in both the temperatures i.e. maximum and minimum has been observed post-1990s. It could be interpreted, that there is an overall warming of the earth and atmosphere. Increase or decrease in temperatures, however, has not been accompanied by an increase in the quantity of precipitation, except for an increase in the frequency of extreme rainfall events. It is accompanied by a reduced number of rainy days in Bhopal.

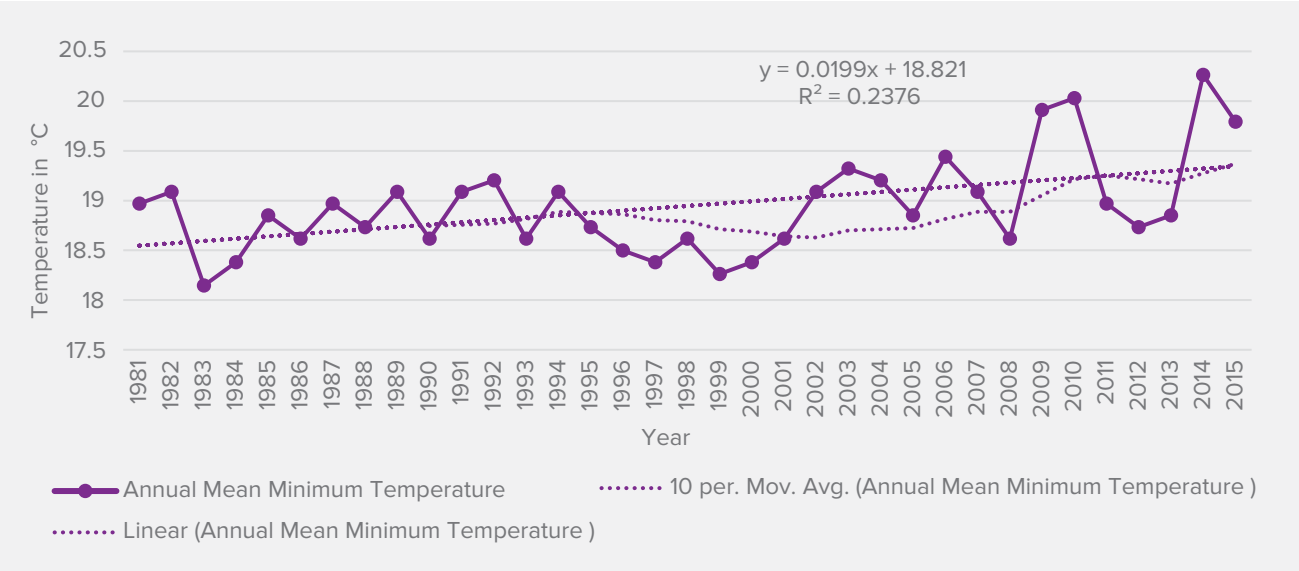


Figure 4 **Annual mean minimum temperature, Bhopal (1981–2016)**

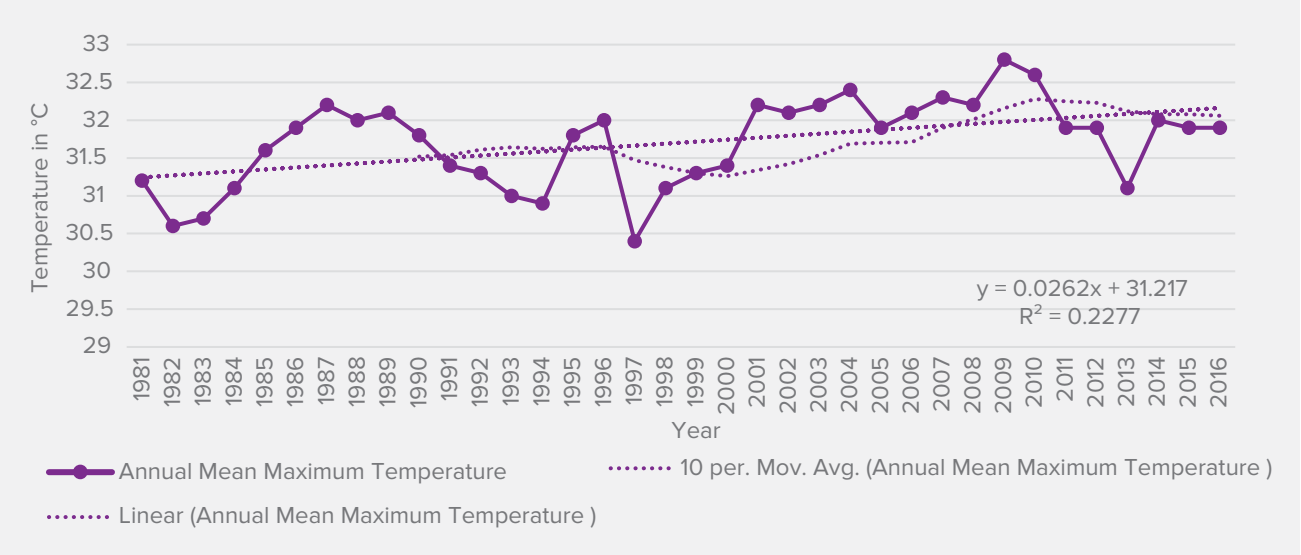


Figure 5 **Annual mean maximum temperature, Bhopal (1981–2016)**

4.3 Projected change in temperature over Bhopal

The HADCM3 simulations downscaled with PRECIS indicate an all-round warming over the Indian subcontinent associated with increasing greenhouse gas concentration. The PRECIS simulation of A1B scenario is given below:

- Annual maximum temperature is projected to increase by 1.9 °C by 2050
- Annual minimum temperature is projected to increase by 2.4 °C by 2050
- The annual mean maximum temperature in post-monsoon season is likely to rise by 2.1 °C by 2050, whereas in winter season it is projected to be changed by 2.0 °C
- Annual mean minimum temperature is projected to be changed by 2.7 °C by 2050 during post-monsoon season.
- Annual mean minimum temperature is likely to rise by 1.6 °C to 2.4 °C by 2050 during monsoon and summer season respectively.
- Hot days and warm nights might increase.

In Madhya Pradesh **42.8 % children**, less than 5 years of age, are underweight

4.4 Projected change in rainfall over Bhopal

Bhopal receives most of its rain during the monsoon season, which starts in late June. The mean annual and seasonal precipitation simulated by PRECIS indicates the following:

- As per the projected changes by 2050 under the A1B scenario, rainfall is projected to increase.
- Mean annual rainfall is projected to increase by 10-14%

A1 Emission Scenario: The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies.

(Source: https://www.ipcc.ch/ipccreports/tar/wg1/029.htm)

- Mean monsoon rainfall is projected to increase by 125-130 mm by 2050.
- Most of the increase is projected to occur in the monsoon period.
- There is a slight decline in winter rainfall towards 2050 under the A1B scenario.
- Extreme rainfall events might increase by 10-20% by 2050.

4.5 Children and Climate Change

4.5.1. Health

Madhya Pradesh is one of the top two states which have high infant mortality rates (Annual Health Survey 2010-2011). It is among the six states of India which contribute to 65 per cent malaria incidents. It is sensitive not only to malaria but also to dengue, chikungunya and cholera etc. Even bronchial asthma has become common among the children.

Directly, the overall increase in temperature and number of warmer days will increase death incidents due to greater frequency and severity of heat waves and other extreme weather events. Major nutritional health impacts are projected via crop failure caused by drought, loss of rain-dependent non-irrigated crops, and especially from high night temperatures reducing cereal yields. These impacts are projected to adversely affect a very large number of people. Indirectly, climate-related disturbances in ecological systems such as changes in the range of infective mosquitoes can lead to more incidences of vector-borne diseases. Increasing temperatures correlate with microorganisms to cause water-borne diseases like cholera, diarrhoea etc. Some other minor effects are- increased incidences of skin disorders as a result of increased temperature and humidity. Overall, climate change induced concerns are:

- Predicted increase in incidences of vector and water-borne diseases
- Re-emergence of vectors that have been eradicated
- Rising urban malaria and dengue incidences
- Heat stress-induced morbidity

4.5.2 Education

The potential impact on children has been a critical missing element from the debate about climate change and particularly so, with regard to their education and the effect climate change has on it. Children are the most vulnerable to climate change. They are already facing the impact of climate change through malnutrition, disease, poverty, inequality and increasing risk of conflict, which in turn adversely affects their education leading to larger number of dropouts, lesser enrollment and irregular attendance. Climate change may also impact school attendance and educational attainment, through its effect on children's health and nutritional status. Quite simply, children may not be fit to learn, even when they have access to schooling. Every time there is a natural disaster, it is accompanied by a host of diseases and children are the most vulnerable to these diseases, often falling sick, sometimes with fatal consequences. Even during extreme winters, children are unable to attend school as they do not have proper clothing to shield them from the harsh winter and tend to fall sick easily.

Schools may also be affected by climate change in other ways – for example, through environmental pressure on their water supply and sanitation. The lack of separate sanitation facilities for girls is often cited as one of the most significant reasons as to why parents keep girls from attending schools. Most of the schools are not equipped to deal with any kind of natural disaster as they have a poor infrastructure. Schools situated in low-lying areas get flooded immediately during the floods and as a result, they cannot operate during the course of the floods. The government is also constrained by their ability to spend on education during natural disasters, as they have more pertinent problems of ensuring the safety of the people and carrying out adequate disaster management programmes.

Sometimes, children quit school because they cannot afford supplies and school fees, or because they have nothing to eat during the school day. The provision of mid-day meals in school is considered a huge attraction for parents to get their children enrolled in schools so that they are assured at least one nutritious meal a day. A lot of parents get their children enrolled in school for this very reason.

Drought, severe flooding and other natural disasters are likely to force people to move with increasing frequency, both within and sometimes outside the country, in search of secure shelter and livelihoods. Such displacement has serious consequences on children. It fragments families and disrupts social networks; it interrupts children's education and may result in them leaving the school system altogether; it reduces continuity in health care provision and so on.

A world affected by climate change is likely to be less stable and more insecure, and the most vulnerable sections of society in such a situation are the children. Existing trends in urbanization look set to continue, and may even accelerate due to the pressure of climate change, as people abandon rural areas due to depletion of natural resources and in search of better opportunities. This constant movement gravely affects the education of the children who amidst all the poverty and migration are unable to attain proper education.

4.5.3 Nutrition

According to the National Family Health Survey 2015-16, the proportion of children under five years who are underweight is significantly high in states such as Bihar (43.9 per cent), Madhya Pradesh (42.8 per cent) and Andhra Pradesh (31.9 per cent). While large sections of the Indian population suffer from acute undernutrition, rising incomes and growing urbanization are rapidly changing the composition of the food basket — away from cereals to high-value agricultural commodities such as fish and meat.

Food security is one of the leading concerns associated with climate change, as it affects food security in complex ways. It impacts crops, livestock, forestry, fisheries and aquaculture, and can cause grave social and economic consequences in the form of reduced incomes, eroded livelihoods, trade disruption and adverse health impacts. However, it is important to note that the net impact of climate change depends not only on the extent of the climatic shock, but also on the underlying vulnerabilities. According to the Food and Agriculture Organization (2016), both biophysical and social vulnerabilities determine the net impact of climate change on food security. The impact of climate change on water availability will be particularly severe for MP, Rajasthan, Bihar and the whole of northwest India, because large parts of the country already suffer from water scarcity, and largely depend on groundwater for irrigation. According to an analysis of the climate data, the decline in precipitation and increased droughts in India has led to the drying up of wetlands and severe degradation of the existing ecosystems. About 54 per cent of India's groundwater wells are decreasing, with 16 per cent of them decreasing by more than one meter per year. Most districts with very high and high vulnerability to climate change are in Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Karnataka and Uttar Pradesh.

Wheat and rice, two crops central to nutrition in India, have been found to be particularly sensitive to climate change. Study on the effect of climate change on agriculture found that wheat growth in northern India is highly sensitive to temperatures greater than 34°C. The Intergovernmental Panel on Climate Change (IPCC) report of 2007 echoed similar concerns on wheat yield: a 0.5°C rise in winter temperature is likely to reduce wheat yield by 0.45 tons per hectare in India.

Acute water shortage conditions, together with thermal stress, will affect rice productivity even more severely. Irrigation infrastructure needs to be upgraded. Particular attention needs to be paid to Rajasthan and Madhya Pradesh. It is a food basket that is prone to climate-induced droughts. Despite the benefits of drip irrigation, it is still largely adopted for high-value horticultural crops. To enhance the area under micro and drip irrigation, the government should redirect the subsidy on electricity for drawing water for irrigation purposes, which has been a major contributor to declining groundwater levels, towards the adoption of drip irrigation techniques.

Urban India is not only an important contributor to global greenhouse gas emission, but also a victim of climate change as poor people account for the bulk of its population. As observed earlier, climate change will have an enormous impact on urban food security. Therefore, urban food security deserves serious attention.

4.5.4 Water, Sanitation and Hygiene (WASH)

Unsafe water, poor sanitation and unhygienic conditions claim many lives each year. Poor urban areas where insufficient water supply and sanitation coverage

combine with overcrowded conditions tend to maximize the possibility of faecal contamination. Open defecation in densely populated urban settlements is particularly alarming for public health. To top it all, the effects of climate change is often experienced through water. Climate-induced disasters severely affect the infrastructure and services related to drinking water, sanitation and hygiene. Floods inundate tubewells, ponds and water bodies and contaminate the natural sources of fresh water thereby forcing affected communities to use unsafe water. Toilets are generally fragile and mostly unsuitable to withstand high flood or cyclone. It leaves people with no other option but to go for open defecation. Such crisis in safe water supply and sanitation service severely disrupts hygiene practices. Because of water contamination, public health situation often deteriorates, spreading waterborne diseases like diarrhea, cholera, typhoid and hepatitis.

4.5.5 Child Protection

Children living in slums, city fringes and low-income settlements are devoid of basic amenities and so grow up in a volatile environment where safety is always in question. During extreme temperatures and rainfall, physical safety becomes problematic for these children. These slum children and those living on the streets face extreme vulnerability and deprivation of basic entitlements. Lack of proper upbringing due to various reasons makes them vulnerable to drug abuse, sexual abuse, substance abuse, trafficking, gambling, etc. Climate change and disasters cause large-scale dislocation of poor people from rural to urban areas or even within the urban areas. Eviction drives in the informal settlements and slums in the cities hamper the physical safety and protection of children, creating a traumatic situation for these children.

5 Risk and City Vulnerability

Insufficient and ageing water and sanitation infrastructure in the city is causing water contamination and lake pollution, further resulting into increased incidences of water-borne diseases

5.1 Vulnerability Risk Frame of the City

Bhopal is a rapidly growing city, which attracts people from the surrounding areas of Madhya Pradesh as well as from other nearby states. Migrant population is accumulating in existing slums and also creating informal slum pockets in different parts of the city. Lack of basic amenities like drinking water, sanitation and solid-liquid waste management is directly impacting the health of these marginalised communities. Insufficient and ageing infrastructure is contributing to water contamination and pollution of lakes, which is further resulting in an increase in the number of water-borne diseases. Encroachment near lakes and hills are degrading the micro-climate of the city.

For implementing different development plans and fulfilling the residential needs of the growing population, green areas and forest land has reduced drastically. These problems are further aggravated by climate change impacts on the city. For example, increasing events of urban flash floods and waterlogging are directly impacting the city's economy in terms of loss of assets and livelihood, affecting the marginalized population the most. Uncertainty of rains and temperature variation are compounding the vulnerability of the slum population. The resulting situation, due to the close inter-connectedness of such natural, developmental and human factors of urban system, enhance the vulnerability (current and proposed), leading to enhanced shocks and stresses of urban people, through increase in pollution, environmental degradation, unplanned

and ageing insufficient infrastructure, and lastly due to behavioral issues. These shocks and stresses (Figure 6), which are projected to grow in the future, will aggravate children's vulnerabilities, adversely impacting their health, education, water & sanitation aspects, nutrition and physical protection.

5.2 City Vulnerability

The main objective of the vulnerability assessment is to understand the different facets of risks and quantify the component of vulnerability across the study cities, and understand the natural, haphazard development and human factors as actors, to be able to formulate an adaptation framework focused on poor and vulnerable urban residents. FGDs were carried out with representatives from Gayatri Nagar, Gautam Nagar, Bhadbhada Basti, Abbas Nagar, Rajiv Nagar Basti, Nariyal Kheda, Choti Koyali and Shankaracharya Nagar.

5.3 Ecosystem Degradation

Besides the excellent location of Bhopal, the city is blessed with beautiful landscapes, and an urban fabric with historical monuments in it. The geographical location of the city helps it to be known as the "City of Lakes". There are some 14 lakes in the city. These lakes act as water recharge units as well as help in increasing the water table in the area. But most of them, including the Ramsar site, the Bhojtal, are under threat from encroachments in the catchment area. Around 80 per cent of the catchment (of Bhojtal) is peri-urban though 'officially' rural and dominated by agriculture, where intensive chemical fertilizers and pesticides are used during cultivation. The agricultural runoff from the rural catchment enters directly via streams into the lake, predominantly on the southwest side and flows from the west to the east. It affects the quality of water in the wetlands and is a long-term threat to the health

Figure 6 Climate Risk Frame of Bhopal City

of the lake. Finally, the bulk of the silt inflow takes place from the rural side of the catchment (Purohit, 2017). The sewage problem in the colonies residing along the Upper and Lower Lakes has not been addressed properly, and domestic sewage enters the Upper Lake. Another other major reason for the contamination of the lakes is the dumping of solid waste into the water bodies.

The rapid urbanization of Bhopal city has resulted in the degradation of ecosystems and their associated services. The city ecosystems are increasingly at risk to degradation and loss of natural resources, due to accelerated consumption and increased production of waste, due to the increasing urban sprawl activities. Bhopal was the 3rd greenest city of India (Smart City Proposal, Bhopal) but thanks to rapid urbanization, its tree cover fell from 66 to 22 per cent in the last 22 years. By 2018, it will remain a mere 11 per cent of the city area. Bhopal is better off than other cities in the country even today, but the concretizing trend is clear: in 1992, 66 per cent of the city was covered with vegetation, in 1977, it was 92 per cent which has fallen down to 22 per cent, and is even now constantly decreasing (Kalal, et al.,).

Bhopal city grew more towards the North West (NW) and South East (SE) zones since 1992, due to the policy of industrialization and creation of new housing colonies in NW and industrial sectors in SE post 2000 (Figure 7). Investigation exhibited that Bhopal grew radially from 1973 to 2014, demonstrating that urbanization has intensified from the city centre and reached the periphery of Bhopal. Unplanned concentrated growth or intensified developmental activities in this region has taken a toll on natural resources (disappearance of open spaces – parks and water bodies), increased traffic congestion and enhanced pollution levels. Changes in the local climate have occurred due to heat island effect and a reduced gap in maximum temperature and minimum temperature. The rising population has lead to an increased demand for houses, roads and other services, all of which lead to cutting down of trees and vanishing of open spaces.

Rapid degradation of peri-urban ecosystems is resulting in a loss of associated ecosystem services which are increasingly at a risk of degradation and loss. Natural resource consumption and waste in peri-urban areas is increasing due to rapid urbanization and increasing human activity. Water provision, storm- and waste-water regulation, along with protection from natural disasters and erosion, are the impacted services that most acutely affect the poor or vulnerable population. The poor may be disproportionately impacted by loss of ecosystem services due to lack of political power around the land-use decision making and limited alternatives for livelihoods, housing, or basic services. Vulnerability extends to urban populations that depend on the ecosystem services provided by or flowing through peri-urban areas (Mitra, 2017).

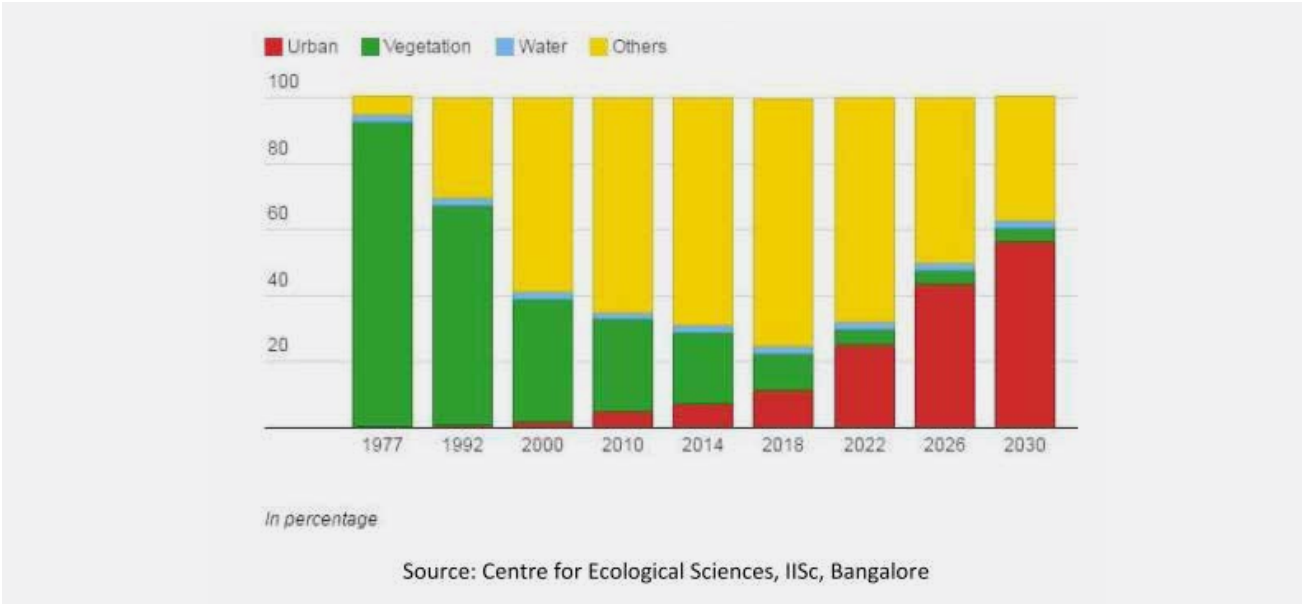


Figure 7: Land-use in Bhopal city

5.4 Heat Stress

Increasing heat stress in the city is also putting life of the citizens at stake. Conditions of excessive heat prevail between April and May when the temperature remains on the higher side with temperature above 40 °C, and the city reels under heat waves. With these excessive heat conditions, energy demand in the city too has increased as people use water intensive cooling machines to get some relief by cooling the indoors of their homes. House typology and materials used to build the house, also add to the heat effect.

Tin shed houses in Bhadbhada Basti and Jawahar Nagar, Bhopal

Those working at construction sites work in direct exposure under the sun and are hit by health issues like heat stroke, skin burns and other such problems. To save people from being affected by extreme weather conditions, the District Health Department issues health advisory every year with precautionary measures to be followed. Swiftly decreasing greenery around the slum areas is worsening the situation as it prevents the area from cooling through these natural resources.

Slums are mostly very congested and dense. They have *kuttcha* and semi *pucca* houses which are more vulnerable during rains and prone to waterlogging. Very small rooms cater to many people, and with no proper ventilation and tin sheds on roof, the ambient indoor temperature increases, and people prefer to take rest in any garden or under trees in summers. In many places there is a limited approach to enter gardens, with most of them being closed during the day. For cooling houses, fan and water coolers are used by the community, but water coolers increase humidity in the room which aggravates health issues.

Under the HFA Scheme, people are shifted to temporary shelters having tin shades. The indoor ambient temperature remains high due to the building material and this further aggravates the health risks due to heat stress.

Box 1: Rain Basera (Shelter for Urban Homeless)

Rain Basera is government scheme to provide night shelter to poor and homeless people. The Supreme Court directed all the City Corporations to establish shelters for the urban homeless. The State Government and UTs were expected to provide a shelter to the homeless with a capacity of housing 100 homeless people for every one lakh of population. It is also expected that these night shelters would provide basic amenities like bed rolls, potable drinking water, primary health care facilities and recreational facilities, among other (Jha, n,d).

Bhopal city has 15 Rain Baseras near Railway Station, Bus Stations and Hospitals. Homeless people use these shelters during extreme events. During clod waves BMC operate special drives to shift homeless people to Rain Basera.

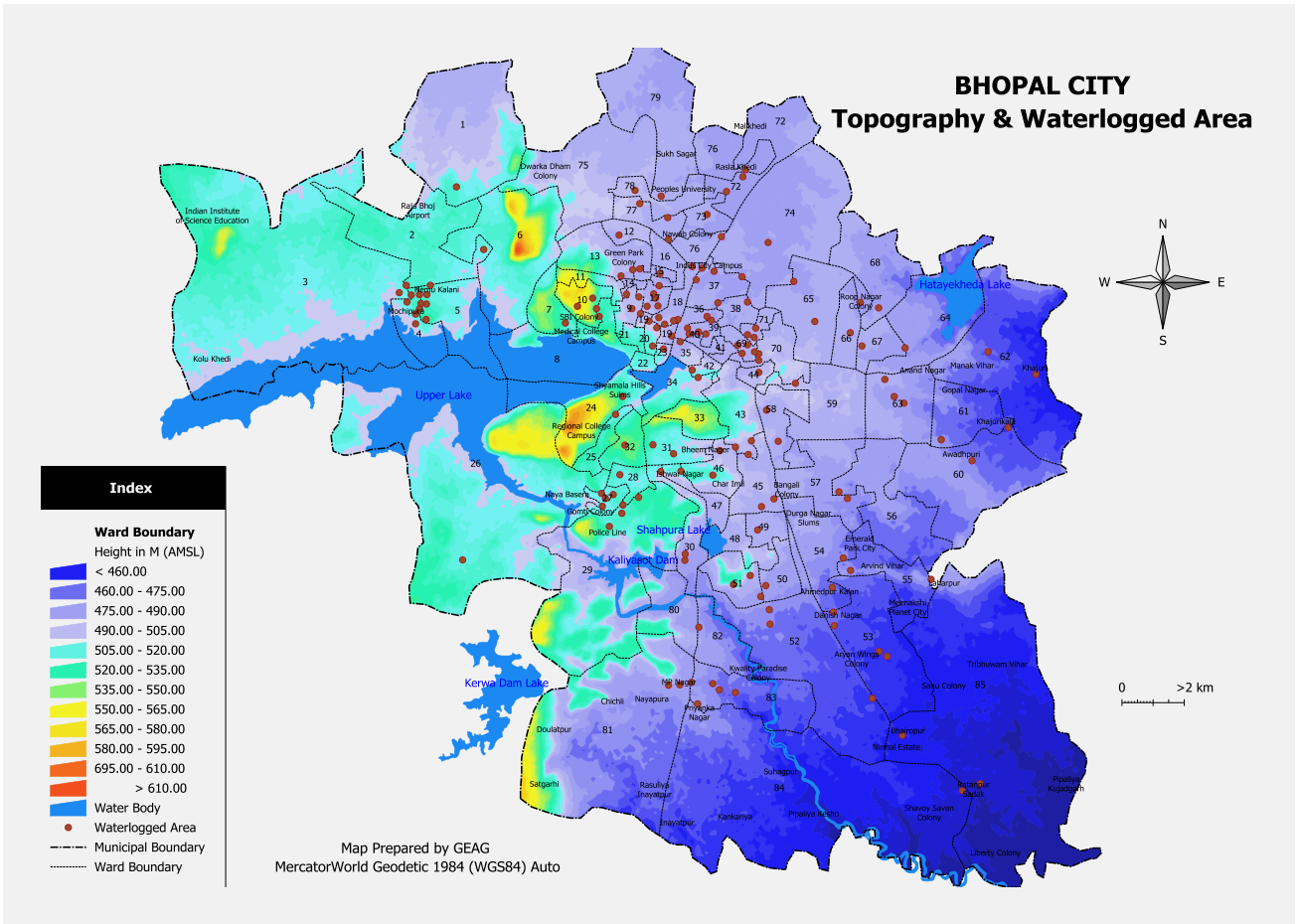
5.5 Waterlogging

Bhopal city faces waterlogging problems due to its geographical location which is a blend of hilly terrains and plains as well as due to the insufficient infrastructure and unplanned development. Waterlogging is one of the major problems the city faces during monsoon. Even a few spells of incessant rains submerges the low-lying areas of the city.

Sudden precipitation creates a flood like situation in the city. As the city has hilly terrain, rainwater flows down quickly towards the low-lying area. Inefficient and open drainage, solid waste dumping in back lines and encroachment creates a waterlogging situation in the city. Storm water drain network exists only in a limited area. Larger part of central Bhopal discharges storm runoff into the Upper Lake and Lower Lake. In New Bhopal, the drainage is managed by Katsi *nallah*, which flows for about 8 km before meeting the Shahpura Lake.

The communities and slums which are situated near *nallahs*, canal and lakes i.e. low-lying areas or near

Waterlogged area, Abbas Nagar, Bhopal



Map 4: Topography and waterlogged area of Bhopal city

streams moving away from the ridges towards the valley are more vulnerable (Map 4). The city has experienced 2 major flood events in the years 2006 and 2016. In 2016, the city received 57.6 mm rain in 6 hours. Most of the city was flooded and the low lying slums were affected to a greater extent. All the *nallahs* overflowed, and water entered the houses. In one day rain, nearly 500 houses were damaged. Affected people lost their shelter, stored food items and assets like TV, mobiles, beds, utensils and important documents like their identity cards, ration card, *aadhar* card, voter ID etc. The waterlogging continued for 3 to 5 days in some of the areas, also affecting the livelihood of people. The local administration had to declare a holiday in all the schools, leading to a loss in education for the children. Post-flood situation often leads to unhygienic situation, with waterlogging leading to water and vector-borne diseases and also to an outbreak of skin diseases.

5.6 Disease Outbreak

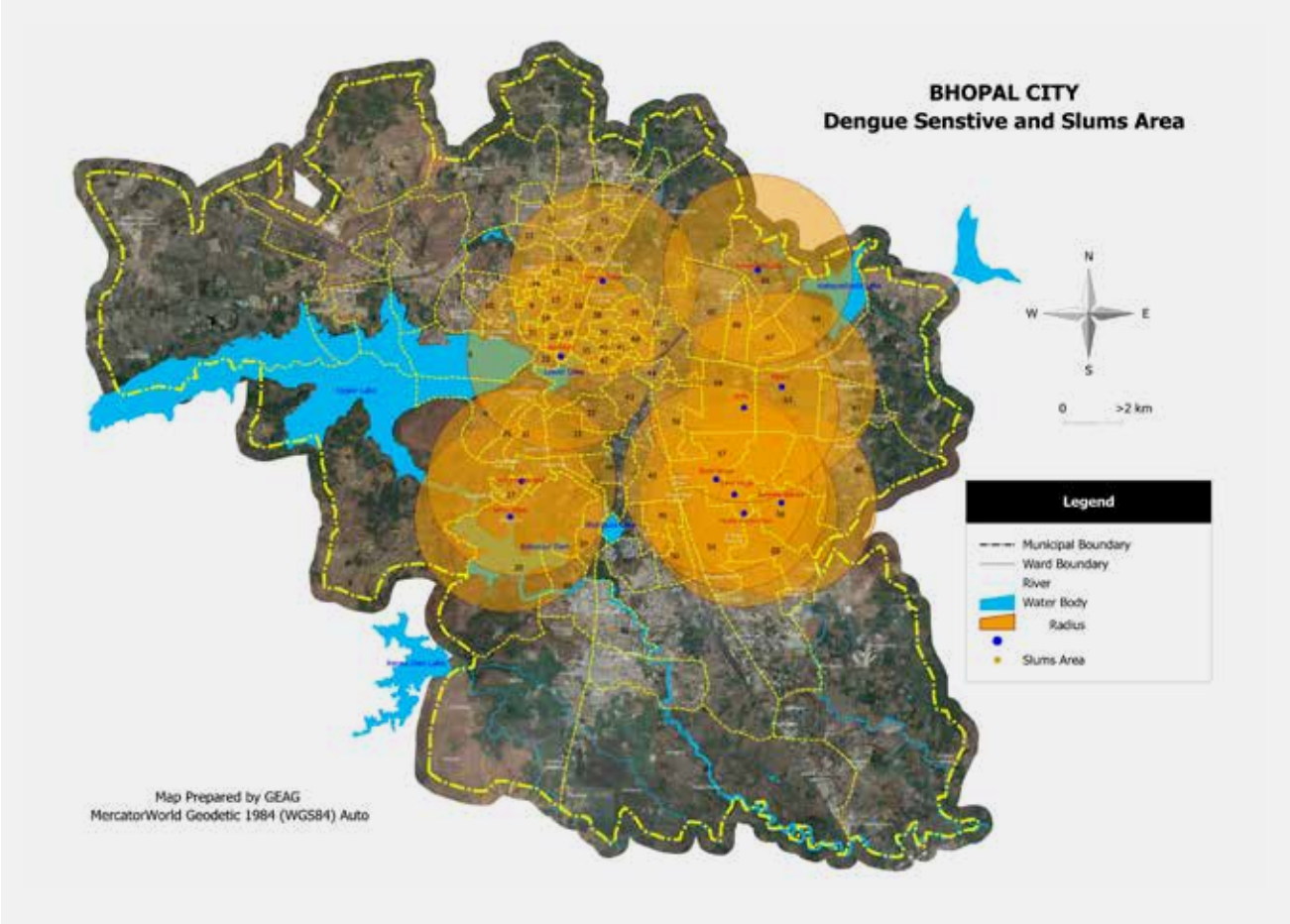
Insufficient infrastructure and lack of integrated development not only affects the routine of the people but also their health. Bhopal witness a frequent outbreak of diseases every year, mainly in the summers due to water scarcity and after monsoons, due to waterlogging. Water-borne and vector- borne diseases hit the city regularly every year and the lack of integrated development pushes the burden of diseases on the poor families.

Reasons for the outbreak of water and vector-borne diseases are waterlogging due to rains, (only 30-32 per cent of the city has a proper sewerage network), water stagnation in choked drains and over flowing drains and *nullahs*, which causes contamination of water. The lack of water supply to the residents, leads to collection of fresh water in containers for many days, providing a convenient breeding place for the mosquito larva. After rains, there is an increase in humidity and minimum temperature that leads to an extension of the disease vector viability period, which further worsens the health scenario. There is a spurt in vector-borne disease and generally an outbreak of diseases like dengue and chikungunya.

Moreover, there is a poor sewerage network in Bhopal and the poor sanitation in many areas also provides a conducive environment for mosquitoes to breed and multiply. The broken ground surface also allows accumulation of stagnant water.

In Old Bhopal and its fringe areas, residents store fresh water in containers because they lack tap water supply. As compared to the developed area of New Bhopal, these areas are hit by diseases due to the unimproved living standards which create different breeding spaces for mosquitoes like water collected in flower pots, plantation of lotus, basement of buildings and construction sites. Adding to these factors of poor infrastructure, the level of awareness about dengue among people is very limited. Also the city has a large floating population and a flow of migrants, who contribute to the spread of diseases. Despite some awareness drives by health authorities, there is a resistance among people in taking precautionary measures.

In October 2017, over 500 dengue and over 150 chikungunya cases were reported. The sudden outbreak of the diseases put the officials of the Municipal Corporation and Health Department on their toes, and they had to declare 10 zones as case sensitive. These were Saket Nagar, Shakti Nagar, BHEL, Pipaliya Pande Khan, Barkhera Pathani, Piplani, Ayodhya Bypass, Nehru



Map 5: **Possible dengue risk prone areas (3 km radius)**

Nagar, Kotra Sultanabad, Dwarka Nagar and Budhwara area in the walled city. These can be analysed in the city map above (Map 5), by overlaying the centers declared by BMC as dengue sensitive areas with the possible range area of a starved female mosquito (the flight time for it to spread the disease is said to be in an area within 3 km radius maximum).

5.7 Ageing and insufficient infrastructure

The city of Bhopal, has mainly two phases in terms of infrastructure where one is New Bhopal which is going through a phase of infrastructural development and planned constructions, while the second one is Old Bhopal, which is facing the issues of ageing infrastructure and inefficient network of water supply and drainage system catering to a huge population of the city.

The water supply and sewerage lines were laid years ago for meeting the demands of the population then, but the condition of the existing drainage system in the city is poor, and only 30 per cent of the city has access to underground sewerage system, while the rest of the city is dependent on an open drainage system.

The ageing infrastructure and poor maintenance of the available network affects the drinking water sources, for example leakages in the drainage line leads to the mixing of drainage with drinking water, which degrades the water quality and causes lack of potable water. During rainy season, the drains overflow with sewage, leading to increased vulnerability of waterlogging in residential areas and making them prone to health hazards. Schemes like Smart City and AMRUT run by the government, are working on the improvement of the infrastructure in the city.

As per the Census of India, 2011 data, the number of urban households resorting to open defecation is 46622, the number of urban households having pit latrines is 34784 and number of urban households having sanitary latrines is 193333. An annual growth rate of 2.7 per cent has been taken into consideration.

In 2014, the BMC pushed its limits from 250 sq km to 413 sq km. In New Bhopal, the Municipal Corporation has to provide basic infrastructure, which is the biggest challenge for the ULB.

5.8 Water Scarcity

Water demand of the city is fulfilled through multiple sources like Upper Lake, Narmada River and Kolar Dam. Old Bhopal gets water from Upper Lake and Kolar Dam while New Bhopal receives water from the Narmada River. The area which has recently merged into the BMC, meets its demand through ground water extraction. BMC supplies about 458 MLD water which is sufficient for the entire city @125 lpcd, but due to unequal distribution about 40 per cent population depends on ground water especially the peri- urban communities. Water scarcity is a major issue for Bhopal during summers. The city faces an acute shortage of water supply in the months between April and June, especially in the areas dependent upon groundwater, with the tankers worsening the situation if monsoons are delayed. Insensitivity towards the area's water table level while extracting water from the ground, further adds to the scarcity.

Stand Post, Gautam Nagar, Bhopal

Water storage arrangements at household level, Bhadbhada Basti, Bhopal

During mid summers, the BMC supplies water through public water tankers, where the public tankers take alternative days or sometimes a longer time, while private tankers can be availed to regularly on call and through extra payment. Slums located near lakes and canals generally use water from the reservoirs for low end use like washing clothes, utensils, flushing and bathing as well, which is not good for their health.

5.9 Water contamination

Water contamination is one of the biggest issues of Bhopal city. Open drainage, leakages in ageing old water supply lines, improper solid waste management and water supply lines laid next to drainage lines are the main cause of water contamination which increases the health risks of the urban poor in the city. Another reason for water contamination in Bhopal is the unhygienic and filthy surrounding around ground water sources like wells, bore wells, tube wells, stand posts and also near other drinking water connections.

Ground water sources have high Total Dissolved Solids and some of the areas like Bhadbhada Basti have even reported red colored water, which points towards excessive iron contamination in the water. In the industrial areas, especially near Union Carbide industry (Box 2), the ground water contamination is high.

The water supply by BMC through tankers is mainly to those areas where there is no access to groundwater or tap water, and the quality of water is not maintained. Communities have also reported yellow colored water supply in summer, which happens due to absence of regular cleaning of tankers, and consequent contamination.

Box 2: Bhopal Gas Tragedy

Bhopal Gas Tragedy (December, 1984) is one on the world's worst industrial disaster. Union Carbide India Limited (UCIL), Bhopal produced three pesticides namely sevin (Carbaryl), temik (aldicarb) and sevidol, which is a formulation of carbaryl and gammahexachlorocyclohexane (y-HCH).

In the intervening night of Dec 2 and 3, 1984, methyl isocyanate (MIC) gas leaked and over 5,00,000 people were exposed to this gas. Even after 33 years of the tragedy, victims still have health issues like infection, weakened eye sight, infection in lungs and kidneys. The immune system of the new generation is also very weak, and the children living near this area suffer from water-borne and pulmonary diseases like bronchitis.

The industry dumped its toxic waste and products at a certain area inside the plant and outside in the solar evaporation pond (SEP). The UCIL plant was closed after the gas leakage disaster, but the hazard toxic waste of the plant is still present in the premises and SEP. Over the years, this waste has been continuous source of soil and ground water contamination.

Communities living near the plant are vulnerable because of this toxic waste. During rains, water overflows from SEP, and the toxic waste too flows with water leading to the contamination of water bodies and ground water sources as well. The Supreme Court had ordered to seal all bore well and hand pumps of the area after which Municipal Corporation arranged piped water supply in the area (affected wards are Ward No. 13 to 18 and 72 to 79). However, the situation at the ground has not changed to the satisfaction of the local people and the scientific community at large.

5.10 Open Defecation

Bhopal was declared open defecation free in September, 2016 under Swachh Bharat Mission, but it is still an issue in the slum areas, due to the density and migration of labors. The floating population of the city is 9.6 lakh and only around 46,622 urban households restored to open defecation (Census of India, 2011). BMC has constructed latrines at household level. It has also installed mobile toilets in those areas where there is no space within the household, where the major challenge today is the supply of the basic requirement of water and cleaning of toilets. Another challenge for the BMC is the maintenance of the post building, toilet blocks for the communities. And this issue of dirty toilets and unwillingness to use them leads to open defecation by the slum residents.

During summers, due to lack of water availability, open defecation increases, leading to an increase in the breeding areas for insect spreading diseases, whereas during rainy season this becomes a threat to the drinking water sources in the area, leading to greater health and hygiene issues. Also, migrants entering the city from their varied cultural background, prefer open defecation, and add to this existing problem.

5.11 Solid Waste Management

Bhopal City generates approximately 800 tones of solid waste, and BMC is able to manage 700 tones in 24 hours. Some of the areas have door to door collection. But in slums, the waste is irregularly collected, either once or twice a week. Where communities throw solid waste on the main arterial roads, or near lakes or *nallahs*, during rains this garbage with a large plastic content, choke the drainage lines, leading to waterlogging. Solid waste has an increased weight during the wet season, making the surroundings more messy and unhygienic, further developing health issues among the inhabitants of the city.

Box 3: Good Practices in the Sanitation sector

Bhopal city has about 185 Sulabh complexes in different parts of the city. BMC makes arrangement for water and other basic services. For monitoring of the service quality and cleanliness of the Sulabh Complex, BSNL has installed a digital machine in each complex. There are three buttons, green represents clean, yellow signifies okay and red means dirty. The SBM team does a data analysis on a weekly basis.

5.12 Impact of city's vulnerabilities on the urban poor children

After studying the city level vulnerabilities above, we understand that the key vulnerable communities are the slum residents or the urban poor, whose children are more sensitive and easily prone to climate change impact on the built environment in which they stay. This study has focused on five main domains of children's development, which guide the overall growth, and development in children. These domains of children's development are – Health; Education; Water, Sanitation and Hygiene (WASH), Nutrition and Child Protection. The vulnerabilities were assessed along these domains.

Solid waste dumping at Shahjahani Park, Bhopal

5.12.1 Health

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease," believes the World Health Organisation. Health is always a concern in India as the government spends a large share of its budget in providing better health facilities for the residents, especially for the young ones.

Lack of necessary facilities like treated water supply or inefficient sewage system are the main challenges in Bhopal which are putting the life of the urban poor children at stake. Consumption of contaminated water due to the mixing of water supply line with the sewage or by the leakages, the burden of diseases in slum children has been increasing. Water-borne diseases like jaundice, typhoid, and diarrhoea have become a routine issue for them. Vector-borne diseases like malaria, dengue, and chikungunya too have spread their tentacles, mainly in the post-monsoon season, and affected the health of the children living in slum areas. The major cause for the spread of these diseases is waterlogging on roads or pits during excessive rains, flooding caused water stagnancy and also a rise in the minimum temperature which creates a favourable condition for mosquito breeding. The city also faces water scarcity which forces the residents to store fresh water in containers, providing a breeding ground to the vectors.

In summers, children living in urban poor settlements suffer from heat stroke, low blood pressure and skin disorders. Water-borne diseases too remain on the higher side, as these children consume Ice-Popsicles

(*Barf ka Gola*) and flavored ice packed in a plastic cover, popular as Pepsi amongst them, to beat the heat. But, the quality of ice used in these products is poor as the vendors purchase their ice from those facilities who have already used it for cooling other products, or is of low quality, as cheap ice helps keep the product cost low and margins high. The sudden attack of water-borne, vector-borne and viral diseases, put an additional strain on the children's health affecting their education, preventing them from attending schools. The most vulnerable are the rag pickers, as these children are exposed to even more unhealthy and unsanitary conditions.

Urbanisation pressure leads to compact development, and open spaces for playing have also reduced drastically. This adds to the health and growth issues, and if the children play on roads, they are prone to accident risks from vehicles. There is a prevalence of acute respiratory infection among children due to the open cooking system in houses without any proper ventilation.

A lack of coordination between Municipal Corporation and Health Department is also a reason for the dismal conditions in slums and low-lying areas. Lack of health facilities and scarcity of human resource has also come to fore as health facilities are still far away from the reach of the children in these vulnerable groups.

The Integrated Child Development Services (ICDS) provides pre-school education, food and primary health care education for children under 6 years of age and their mothers. This facilitates the children in getting health benefits through immunization schemes in the city among the children aged 12-23 months. But, this is not reached by everyone as only 62.7 per cent were benefitted (NFHS-4, 2015-16) (BCG, measles, and 3 doses each of polio and DPT), which means that all children have not gained from this campaign.

Climate change has coupled with these factors and is causing health degradation. Conditions will only worsen if immediate steps are not taken into consideration.

5.12.2 Education

Bhopal is one of the leading cities in terms of education in the state, having a large number of private and government institutions. However, the economic condition of the urban poor does not allow them to send their children to private schools and hence they prefer government schools, the main attraction for them being the Mid-Day Meal Scheme which releases them from the worries of arranging food for their children in the afternoon.

Climate change affects children's education, as they fail to access the provided facilities, either due to excessive rain or drought. Not only climate change, but the poor infrastructure facilities are also affecting their education.

Health related issues like water and vector-borne diseases, heat stroke etc. are also the reasons for a temporary dropout from schools, while because of insufficient infrastructure like limited table, chair, fan and electricity in schools, and compactness of their residential spaces, they are unable to cater to the needs of education in the indoor spaces. The outdoor ambience provides no facility to cope with the situation, and leads to absenteeism as district administration declare holidays during such extreme events of rain, cold and heat waves.

During monsoon, especially at the time of extreme rains, the probability of old school buildings collapsing increases due to lack of maintenance leading to seepage. Waterlogging in low lying areas interrupt the access to schools. Due to a distance between schools and community, lack of public transport system in the fringe areas, particularly during extreme climate, may prevent a child from going to school. Loss of stationary or books due to flooding, waterlogging or other weather impacts can further affect the school returning capability of a child.

When tackling water scarcity as an issue, slum children are involved in water arrangement, especially in those areas where water supply is done through tankers or stand posts. Timing of the tankers for supply of water is not fixed. All parents work for their livelihood throughout the day and hence, the children are generally made responsible for collecting water from these sources. During the process of water collection, the small children are often bullied and fall prey to conflicts and quarrels which further aggravates their struggles.

The compulsion of a *Samagra* ID is also a reason for the negative impacts on the education of migrant children. Migrants fail to get these identities through the civic

bodies, as they do not have a permanent residence, and hence fail to get admission in schools. Parents in slum areas too are concerned about the distance between the working sites and schools, and do not allow the children to attend school as they cannot keep an eye on their activities, and are worried for their safety.

The poor vicinities having high Muslim population, especially in Old Bhopal, have a lack of awareness among parents towards education. The children in these areas start earning at an early age, which increases the school dropout rate in Old Bhopal. Social reasons too affect the education of children. Parents involve the girl child in the looking after and upbringing of their siblings, which restricts their education and increase the cases of school dropouts.

5.12.3 Nutrition

The Census figures state that the population of children under five years of age in MP is 91,42,292 and the NFHS-4 reported that 42.8 per cent of the children i.e. 39,12,900 are underweight, 42 per cent of children i.e. 38,39,762 are stunted and 9.2 per cent of children i.e. 8,41,090 are severely malnourished and wasted. In Bhopal Urban the condition of children too is a matter of concern, as children under the age of 5 years who are stunted (height-for-age) is 47.9 per cent, children who are wasted (weight-for-height) is 17.8 per cent, children who are severely wasted (weight-for-height) is 7.7 per cent and the children under who are underweight (weight-for-age) is 37.7 per cent. Children of the age 6-59 months who are anemic (<11.0g/dl) is 78.1 per cent.

Children involved in water collection at Abbas Nagar, Bhopal

Children in slums are vulnerable to nutritional inadequacies, as they do not get proper nourishment in their diet as compared to the required supplements for healthy children. The intake of nutrition in urban poor children is worse and most of these children suffer from malnutrition. Reasons for the poor condition of the children and risk of food insecurity include extreme climatic conditions, high price, non-availability and access to food.

Insufficient sanitation infrastructure in slum areas is the reason for open defecation. In addition to this, child's disposal can spread diseases, especially diarrhoea by direct contact with the stool or animal transmission. Majority of the children deaths are attributable to the disadvantages of inefficient supply of water, leading to infections and illness like diarrhoea and pneumonia. Frequent occurrences of these diseases are often responsible for malnutrition. Similarly, open drainage leads to malaria which contributes to anemia among children. The burden of diseases always remains high in these areas, and children are more vulnerable due to which they do not get appropriate economic stability or even clean environment to eat nutritional food. When it comes to the climatic conditions, waterlogging in low-lying areas during rains ruins the stored food, and they do not even get a proper diet during that time due to limited food supply.

Earning is the biggest challenge for migrants and those living in slum areas, due to which they remain busy in work and do not have time to worry about the nourishment and growth of their children, because of which they take low quality food products from the market to fulfill their bodily needs only. The food produced these days is available after spraying a number of pesticides, leading to its low nutritional and nourishment value. Another reason is that the mother's involvement in other activities also disturbs the food intake of her children.

Migration of farmers to the cities also leads to malnutrition, as they cannot get a multi-grain diet in the city which they easily get in the rural areas. Dependency on a single grain and its high price restricts the reach of the migrated people from accessing the nutritional food. Imbalanced diet of pregnant women in slums leads to the birth of malnourished babies.

Migrants also face the issue of inflation as they do not have ration cards or below poverty line cards, due to which they do not get benefit from the low cost food provided by the government through various schemes and the ICDS facilities. Laborers and children involved in labor consume *gutkha* and tobacco products which keep them further away from healthy food and put an adverse effect on their immunity.

5.12.3 WASH

Slum children are badly hit by the inadequate basic services like safe drinking water, sanitation facility, garbage collection, drainage system, which are the key reasons for the manifestation of water-borne and skin diseases. Although, BMC provides treated water to the slum areas, it gets contaminated due to various reasons, such as leakages in water supply line, filthy conditions in the surrounding of water sources like borewells, tap water and stand posts, while the open drainage system contaminates groundwater and also natural water sources.

Unavailability of safe drinking water increases the prevalence of water-borne diseases in children, where limited water availability prevents them from a hygienic routine like bath or brushing their teeth regularly, pushing the flush after toilet usage, especially where water scarcity is a major concern. They even avoid washing hands before eating food or after using the toilets. Those living near to the canals or *nullahs* take a dip in the contaminated filthy water, which is resulting in all kinds of skin diseases.

Lack of electricity in community toilets, unhygienic conditions and lack of water doesn't motivate children to use toilets; they prefer open defecation, which in turn poses health risks. During rainy season, the community toilets are choked, resulting in avoidance of its use, as well as contamination of water, and both of these factors increases health related risks.

Such conditions are not only prevalent in the households, but also in the schools located in these areas. Under the Swachh Bharat Mission, the government has

Box 4: Good hygiene practices at school level

To improve hygiene practice in girls during menstruation period, ICDS has installed a Sanitary Napkin Vending unit in girl's schools. This machine provides 2 Napkins for Rs. 5. But disposal of these napkins in schools is another challenge for the school authority, and this too leads to greater health risk for the children.

established toilet facilities in almost every school, but cleaning of these toilets is the biggest challenge for them. Secondly, its accessibility to the children is limited and it is also reported that new toilets are used by teachers only. Post puberty, female students try to avoid going to school during their menstruation period, due to lack of services and sanitation infrastructure at the schools, where disposal of the used sanitary napkins is also a concern. In an effort to teach washing etiquettes, schools have arranged training and learning sessions for the children with the 'How to Wash Hands' campaign, but they failed to provide soap and water to them. All of these issues culminate in increasing the health hazards of children going to school.

5.12.5 Child Protection

Child protection is a major concern all across the country and Madhya Pradesh is one of the most vulnerable states with the third highest number of cases of crime against children after Uttar Pradesh and Maharashtra. The National Crime Records Bureau (NCRB, 2016) reports that the total number of crime cases reported against children were 13,746, which was 12.9 per cent of the total number of cases reported across the country. Overall crime against children have also show an increasing trend over the past 3 years with the significant increase of 13.6 % (106958) in 2016 over (94172) in 2015. As many as 132 cases of a child's murder were reported in the state, 14 cases of infanticide and 4,882 of rape were reported in which 2,479 children were the victims (between 6 to 18 years).

During 2016, a total of 1,11,569 children (41,175 males and 70,394 females) were reported missing in which 12,068 children were from Madhya Pradesh. In 2016, the state has recorded the third highest number of minors kidnapped in the age group of 16-18 years in the country. As many as 911 males and 2323 females were kidnapped in the state. Similarly, the state stood third in the country in kidnapping minors in the age group of 12-16 after Uttar Pradesh and Maharashtra. The data revealed that while maximum number of the cases of abduction of adults and children were for marriage and unlawful activities, adoption also came out as one of the reasons (NCRB 2016).

Conditions are no better in Bhopal, as children, especially in the slum areas suffer from the problem of labour and harassment during their daily chores. Child labour is a common scenario in urban poor. Cases of child harassment were reported from poor children as they travel to fetch water from remote sources. Children are involved in rag picking, selling news papers, furniture polishing, working in hotels, factories, garages or as domestic help. Begging on streets, selling toys on traffic signals and other odd jobs too put the life of children at stake, and restricts their physical and mental development.

As the number of migrants is high in Bhopal due to a better connectivity with other cities, the number of migrant children too is high, and they face abuse at their work place or in their neighborhood, as they stay alone for most of the time. Other issues adding to this are the climatic changes, through drought and delay in rainfalls affecting the surrounding villages, leading to the reduced crop production, which brings about losses and consequently increases migration to the city in search of jobs at construction sites, at the traffic junctions selling things or other such odd jobs. Children in slum areas are vulnerable to exposure to drugs in their surrounding and also fall prey easily to substance abuse, smoking or tobacco consumption.

Addiction of intoxicants, leads to sexual abuse of the children as they get easily exploited under the influence of alcohol or drugs. Girl children are in worse conditions in slum areas when it comes to safety, and early child marriage is an easy, prevalent solution to ensure their safety, leading to the maximum number of dropouts from school. Issues related to protection, heterogeneous, unfriendly, mobile and volatile neighborhood, high level of violence including sexual violence, particularly against children living on the streets are on the rise. Cases of forced begging, child trafficking for labor and sexual exploitation are witnessed. The reason behind such poor condition of children is mainly the lack of their participation in decision making, increasing issues of violence in schools and discrimination against children in various forms.

6 Resilience Directions

There is a need to build the capacity of the local government and institutions through special programmes focusing on "Urban Resilience Building" while addressing the specific vulnerabilities of urban poor children.

Urban resilience is the capacity of cities to function, so its inhabitants —particularly the poor and vulnerable, including women and children—survive and thrive inspite of the constant stresses or shocks they encounter. Building Urban Climate Change Resilience (UCCR) entails climate change adaptation, mitigation actions, and disaster risk reduction while recognizing the complexity of rapid urbanisation, and it is certain that climate change increases the pressure on cities. Building urban resilience against climate change requires looking at a city holistically: understanding the systems that make up the city and their inter dependencies as it is often a cross sectorial issue that needs a multi-agency and multi-departmental approach in addressing them and by analysing the risks they face in the future.

One of the main limiting factors responsible for the present situation in the existing urban scenario, is that the coordination structure usually works is silos. This can be improved by strengthening the underlying fabric of a city and better understanding the potential shocks and stresses it may face, and only then a city can improve its flight to development along with the well-being of its citizens.

Hence to build Bhopal into a child friendly and resilient city in terms of Health, Education, Nutrition, WASH and Child Protection aspects, and to absorb the increasing impacts of climate change and disasters, there is an urgent need to improve the overall growth and development in children, leading to a better quality of life for them, and help make this child friendly resilient city in an integrated way.

Table 4: Children focused city resilience strategic directions for Bhopal

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/Programmes	Institutions
Health	• Heat Stress, Dehydration ,Low blood pressure and Headache in summers • Vector -borne diseases (Malaria, Dengue especially in post-monsoon season • Water -borne diseases (Jaundice, Diarrhoea)	• Reduced green cover in and around the city • Air pollution due to industries and vehicles • Improper housing (lack of ventilation and very small rooms) • Limited sewage and drainage lines • Choking of existing drains • No separate storm water lines • Water contamination due to leakages • Ground water contamination • Unavailability of safe drinking water to poor settlements • Improper solid waste management in slums • Solid waste dumping in back lines resulting in chocking of drainage • Limited fogging • Improper cleaning of water storage containers • Urban sprawl and limited basic amenities • High migration and settlements in slum areas • Contamination of lakes and water bodies through wastewater flowing into them • High dependency on tanker water supply • Improper maintenance of public toilets • Open defecation • Limited health facilities • Limited knowledge on vector -borne and water- borne disease	• Promote green and cool roof technologies at school, anganwadi and individual HH level • Conserve green area, lakes and open space in and around the city • Massive tree plantation with support from communities • Develop and maintain parks with community participation • Motivate architects and engineers to innovate heat resilience technologies for low cost housing • Awareness on wearing right clothing as per weather condition • Incorporate heat resilience and low cost housing technologies in housing guidelines • Issue health directives during peak temperature period • Change school timings during extreme temperature • Manage implementation and financial resources for these action by linking them to Govt. scheme like *Ujjawala* • Integrated real time diseases surveillance system • Need assessment of human resource in the health department • Pre-monsoon cleaning drive for *nallahs*, back lines, lakes, and open spaces/ plots etc. to avoid choking and waterlogging • Post- monsoon fogging on mosquito breeding sites like open space, construction sites, and basement of commercial places etc. • Proper management of MSW • Organize clean drives and campaigns at community and school level • Awareness campaigns on vector-borne diseases • IEC and knowledge material distribution among school children • Establish high quality lab, equipped with modern testing instruments, trained personnel and financial allocation for water testing • Water quality monitoring at house hold and community level • Low cost water purification technology at house hold level • Rain water harvesting at household level, government buildings and public places • Conserve traditional water sources like lakes, wells and step wells • Installation of decentralized waste water treatment plants	• City Master Plan Guidelines • City Development Plan • PMAY Scheme Guidelines • Development Authority and Housing Board Guidelines • Smart City Guidelines • AMRUT Program GoI • Swachh Bharat Mission (Urban) • CM Urban Water Supply Scheme (CMUWSS), MP • CM Urban Infrastructure Development Scheme (CMUIDS), MP • SDMA • DMI Curriculum • National Health Mission (Urban) • Integrated Disease Surveillance System Guidelines • National Wetland Conservation Program	• Bhopal Municipal Corporation • Forest Department • EPCO • Bhopal Development Authority • Town and Country Planning Department • CREDAI • Pollution Control Board • District Health Department • Public Health Engineering Department • Ground Water Board • Home Guard • Smart City Department • Government Hospitals and health centers • AIIMS • Private Hospitals • Malaria Department • National Health Mission • ICDS • District Administration • Residents Welfare Association • NGOs • CBOs • Institute of Town Planers, India • Concerned Technical Institutes • SPA • MANIT • Media

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/Programmes	Institutions
Education	• Absenteeism due to water scarcity • Absentee-ism due to diseases • Absenteeism due to extreme events of rain • Absentee-ism due to involvement of children as labourers to support lost livelihood of families • Possibility of accidents due to poor school infra-structure	• Limited access to piped water supply • Involvement of children in fetching water • Irregular health check-ups • Improper sanitation facilities • Limited access to WASH facilities for students • Improper cleaning of toilets • Ageing school infrastructure • Filthy school surroundings • Distance between school and communities • Limited public transport system • Disrupted livelihoods of parents due to extreme climate events • Increased burden of household chores on girl child • Lack of proper housing facilities for migrant communities and daily wagers at construction sites	• Installation of water storage facilities at community level • Increase sensitivity among communities and keep children away from conflicts • Identify and conserve traditional water sources • Provide safe and adequate tap water supply at premises • Rainwater harvesting • Water tanker registration and its monitoring • Regular health check-up in schools • Promoting resilient school buildings • Health camps pre and post monsoon • Cleaning of schools (mosquito free schools campaign) • Promoting good sanitation and hygiene practices among children through their course curriculum • Implementing school safety plan • Awareness among school children on climate change and disasters; and essentials of self-safety • Trainings for risk related to climate change hazards • Develop IEC materials related to climate change impact on day to day life • Special facilities at schools for migrant children (enrolment, counseling and other essentials) • Change in building regulations to include flood resistant/ enabling design • Ensure Public transport system for fringe areas and issue student passes • Develop community resource centre to ensure basic education and skill based training • Creating additional employment opportunities and ensuring basic support system like insurance facilities (life, health assets, pension, and micro-credit). • Enforcement of labour laws	• Sarva Shiksha Abhiyan • School Chalein Hum Mission, MP • School Safety Policy • Swachh Bharat Mission GoI • National Curriculum Framework for Teachers Training (NCFTE),2010	• State Education Department • District Education Department • Private School • Municipal Corporation • Sarva Shiksha Abhiyan • NGOs • Teachers • Local Public Representa-tives • Health Department • ICDS • State Disaster Management Authority (SDMA) • Disaster Management Institute (DMI)
WASH	• Water-borne diseases • Skin Infections • Open Defecation	• Poor quality and quantity of drinking water • Insufficient WASH infrastructure • Contaminated water due to sewage and drainage mixing • Filthy conditions near water resources • Ground water contamination • Solid and industrial waste dumping in lakes • Rationing of water due to less availability compromises basic hygiene and cleanliness	• Decentralized drinking water system • Mapping and conservation of traditional water sources and promote conjunctive use of water • Rainwater harvesting • Ensure safe drinking water availability at school level • Water quality monitoring • Monitoring of packaging water, particularly water pouches • The household coverage of toilets should reach 100 % • Develop STPs and ETPs and promote using recycled water for low end use • Awareness among children on good hygiene practices • Ensure water availability in community toilets • Enforcement of rules on private builders for preparing sanitation plan • Preparing guidelines for resilient WASH infrastructure design at household, institutions and community level • Proper maintenance of existing infrastructure against leakages and damage	• Swachh Bharat Mission (Urban) Guidelines • Smart City Guidelines • CGWB Guidelines	• Municipal Corporation • Education Department • Public Health Engineering Department • NGOs (UNICEF, Sulabh International, Rotary Club, Lions Club, and Local NGOs etc.) • Swachh Bharat Mission • Ground Water Board • Pollution Control Board

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/Programmes	Institutions
Nutrition	• Diminishing food security • Malnutrition • Birth Deficiencies • Anemia • Underweight children	• Unhygienic environment and food intake habits • Non-accessibility to good quality food products • Limited accessibility to Anganwadis and health centers • Non entitlement in PDS shops • Using of tobacco/ gutkha in the absence of any counselling for parents and children • Non-availability of safe drinking water	• Promote organic urban farming • Promote resilient agricultural practices in peri-urban areas • Awareness building on seasonal and local fruit consumption • Promotion of traditional food consumption • Increase employment opportunities for informal sector in city • Awareness on ill effects of tobacco consumption • Control use of pesticides in agriculture • Strict enforcement of no tobacco sale to children • Linkages with ICDS services (Monitoring of mother and child, proper immunization, mid-day meal) • Tracking the status of migrants • Prepare food chart of existing food pattern and provide information to improve food cooking habits • Awareness about food borne diseases among children and parents • Awareness about open defecation and its consequence leading to malnutrition, diarrhoea and other gastro-intestinal diseases • Ensure availability of multi-grain food items in PDS shops • Low cost supplements	• National Food Security Mission • National Horticulture Mission • National Health Mission • Sabla Scheme (Adult Girl) • Kishori Shakti Yojna (KSY) for Adolescent Girls (MP)	• Municipal Corporation • Development Authority • Agriculture Department • Agriculture College • District Administrative • PDS Shops • ICDS • Health Department • Social Justice Department • Education Department • Forest Department • NGOs
Child Protection	• Children in low-income settlement are at a high risk (Heat stress, water fetching and related conflicts, and floods) • Climate change induced migration • Child labour • Child abduction • Drug Abuse	• No safe play areas • Increasing crime against children • Child harassment during water fetching • Child labour- rag pickers, evening news paper selling, furniture polishing, garage, hotels, factories, domestic, mechanic and seasonal work • Lack of identity for migrant children • Loss of livelihoods of parents due to climate change impacts (higher unemployment) • Domestic violence due to unemployment • Lack of education and awareness among parents about child safety issues • Lack of strict enforcement of laws relating to child safety and protection	• Creation of local safe play areas • Awareness among parents and children on child safety and protection issues • Develop children's knowledge groups at community and school level • Awareness camping for not to use tobacco as well as other drugs • Making children aware of safety measures during floods, waterlogging, heat and cold waves • Safeguarding the poor children with improved access to health centres at their locality • Strict enforcement of laws for child protection against violence and drug abuse • Establish "*Nasha Mukti Kendra*" (rehabilitation center) especially for children • Special shelter houses for migrant population • Counseling of children to reduce mental stress and sense of separation from families • Creating special identity proof for migrant population so that they can get the benefit of education, ration and other basic services • Registration of migrant initiated by BMC with the help of builders and Real Estate developers • Ensure *Aadhar* entitlement of poor children	• Integrated Child Protection Scheme • National Plan of Action for Children • School Safety Policy • Shelter for Urban Homeless • Beloved Lakshmi Yojana • National Livelihood Mission	• Police Department • Labour Department • Social Welfare Department • Education Department • Municipal Corporation • Private Crèche • ICDS • Child Line • NGOs • Public Transport Department (Railway and Roadway) • Media

7 Conclusion

Climate induced upheavals like flood, heat stress, vector and water-borne diseases increase the existing vulnerabilities of urban poor children. For making Child Friendly and Climate Resilient Bhopal City , it is important to implement the resilience directions identified here.

Those urban children are the most vulnerable, who are living in slums. Insufficient infrastructure and sanitation facilities, inadequate safe drinking water, increase the vulnerability of children. Climate induced upheavals like flood, heat stress, vector and water-borne diseases increase their existing vulnerabilities.

National Urban Development Mission projects such as Smart City, AMRUT, Housing for All and Swachh Bharat Mission (Clean India), will improve lives of citizens and the children will also be benefited by them. The Smart Cities Mission and Housing for All, statement and framework, recognize children as stakeholders and have provision of play grounds and park developments, but accessibility for the slum children is a major issue. AMURT and Housing for All missions will provide housing facilities to slums residents and improve sanitation facilities, which further will reduce their disease burden and improve their living standards. The mission also focus on enhancing the amenity value of cities by creating and upgrading green spaces, parks and recreation centers, especially for children. The Swachh Bharat Mission (Clean India) aims at making the country open defecation free by 2019. Under this mission, the sanitation facilities will improve at household levels, as well as at schools, which will enhance children's health and development. For making climate resilient cities for children, it is important to instill these resilience options/directions. Awareness among the parents and children can reduce vulnerabilities of children. Habits related

Washing hands can reduce the disease burden by as much as **50%**

to sanitation, such as washing hands can reduce the disease burden by as much as 50 per cent.

Existing policies and legislative frameworks only focus on child rights and social aspects like health, education, child security and present living conditions but there is a requirement to introduce and address the climate induced vulnerabilities of children. Separate data sheets of the affected children should be maintained to address their vulnerabilities.

Interdepartmental coordination with State Disaster Management and Climate Change, Health, Education Departments and ULBs are required. The SDM directives are laid out during extreme rains, but it needs the involvement of the other concerned agencies as well. BMC budget must focus on children vulnerabilities. Maintenance of school facilities, water and sanitation will help improve the health of the school going children. Need is to ensure the involvement of policy makers to maintain these life changing facilities in schools.

Lack of knowledge and awareness increases vulnerabilities. Development of IEC and awareness campaign is required to reduce vulnerability. To understand climate change and its impacts, there is a requirement to include climate change as a subject in the school curriculum. To strengthen the capacity of children, it is important to ensure capacity building programs and trainings to build leadership qualities amongst them, so that their interest and involvement in social activities will increase.

A deeper understanding of the comprehensive research studies related to issues of children and the challenges faced, impacts of climate change on different sectors, development of strategies and an effective, multi-pronged implementation plan is recommended to make Bhopal city more resilient.

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Key Stakeholders in Bhopal

Government Agencies

- SDMA
- DMI
- EPCO
- UADD
- PCB
- Rajya Shiksha Kendra
- State PHED Laboratory
- BMC
- IDSP, Bhopal
- ICDS, Bhopal

NGOs

- UNICEF, Bhopal
- Nutrition International
- Child Line (Aarambh)
- Jan Sanwad
- Swabhiman
- Bachpan
- MHT, Bhopal
- CASA
- Aide et Action
- Aawaj
- Sarthak
- Vidhya Bharti
- Aanand Niketan

Academic Institutions

- SPA
- MANIT
- Govt. Hamidiya Arts and Commerce College
- Govt. High Secondary School, Jahangirabad, Bhopal
- Govt. School, Narela Shankare, Bhopal

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