

The image is a full-page background photograph with a blue color overlay. In the foreground, three children are visible: a boy on the left looking down, a girl in the center looking directly at the camera with her hands near her face, and a girl on the right looking down. They are wearing simple clothing and some have henna on their hands. The background is a blurred view of a slum area with small, makeshift buildings and other people in the distance.

# **Children Focused City Resilience Action Strategy for Patna Urban**

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**Children  
Focused City  
Resilience Action  
Strategy for Patna Urban**

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## Children Focused City Resilience Action Strategy for Patna Urban

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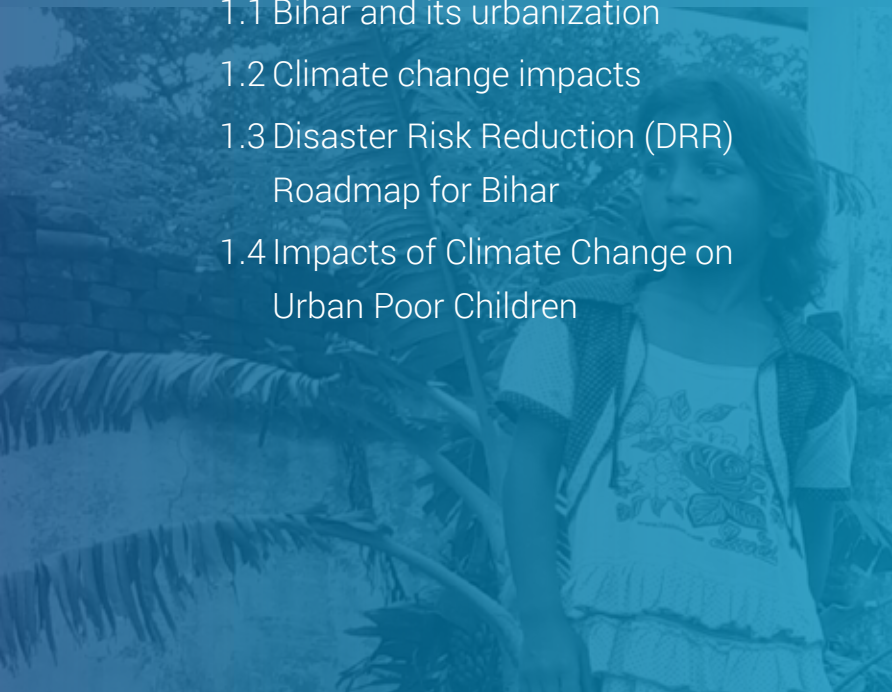
# Abbreviations

<b>ACCCRN</b>	Asian Cities Climate Change Resilience Network
<b>AIIMS</b>	All India Institute of Medical Sciences
<b>BIS</b>	Bureau of Indian Standards
<b>BSAPCC</b>	Bihar State Action Plan on Climate Change
<b>CAA</b>	Constitutional Amendment Act
<b>CBOs</b>	Community Based Organizations
<b>CC</b>	Climate Change
<b>CD</b>	Community Development
<b>CDP</b>	City Development Plan
<b>CNG</b>	Compressed Natural Gas
<b>CPHEEO</b>	Central Public Health and Environmental Engineering Organization
<b>CRF</b>	Climate Resilience Framework
<b>CSOs</b>	Civil Society Organizations
<b>DDMA</b>	District Disaster Management Authority
<b>DMD</b>	District Disaster Management Department
<b>DPR</b>	Detailed Project Report
<b>DRR</b>	Disaster Risk Reduction
<b>FMIS</b>	Financial Management Information System
<b>GDP</b>	Gross Domestic Product
<b>GoB</b>	Government of Bihar
<b>GoI</b>	Government of India
<b>ICDS</b>	Integrated Child Development Services
<b>IHHL</b>	Individual Household Latrine
<b>ISET</b>	Institute for Social and Environmental Transition
<b>LED</b>	Light-Emitting Diode
<b>LPCD</b>	Litre per Capita per Day
<b>MGNREGA</b>	Mahatma Gandhi National Rural Employment Guarantee Act
<b>MLD</b>	Million Litre per Day
<b>NAPCC</b>	National Action Plan on Climate Change
<b>NLCP</b>	National Lake Conservation Plan
<b>OHT</b>	Over Head Tank
<b>PHED</b>	Public Health Engineering Department
<b>PMC</b>	Patna Municipal Corporation
<b>RTO</b>	Regional Transport Office
<b>SAPCC</b>	State Action Plan on Climate Change
<b>SFDRR</b>	Sendai Framework for Disaster Risk Reduction
<b>SPCB</b>	State Pollution Control Board
<b>SPUR</b>	Support Programme for Urban Reform
<b>STP</b>	Sewage Treatment Plant
<b>SWM</b>	Solid Waste Management
<b>UCCR</b>	Urban Climate Change Resilience
<b>UNICEF</b>	United Nations Children's Fund
<b>WHO</b>	World Health Organization
<b>WQI</b>	Water Quality Index

## **In this section**

### 1. INTRODUCTION

- 1.1 Bihar and its urbanization
- 1.2 Climate change impacts
- 1.3 Disaster Risk Reduction (DRR)  
Roadmap for Bihar
- 1.4 Impacts of Climate Change on  
Urban Poor Children



# 1. Introduction

In today's increasingly global and interconnected world, over half of the world's population (54 per cent) lives in urban areas. The coming decades will bring further profound changes to the size and spatial distribution of the global population. The current urbanization and overall growth of the world's population is likely to add 2.5 billion people to the urban population by 2050, with nearly 90 per cent of the increase concentrated in Asia and Africa. At the same time, the proportion of the world's population living in urban areas is likely to increase, reaching 66 per cent by 2050 (UN World Urbanization Prospects, 2014).

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.

At a time when the idea of 'SMART City' dominates policy discourse, India is facing a very real urbanization challenge. The socio-spatial hierarchy in the country's ever-expanding cities is growing deeper, even as inequalities of income, access and opportunities remain unaddressed. Marginalization and ghettoization remains appallingly commonplace in Indian cities, particularly in the secondary cities where rural-to-urban distress migrants end up in large numbers. Inequality in urban India is rising much faster than in rural India. The consequences are large. According to a 2014 research paper presented at a Population Association of America Conference, "poor health and inequality in urban India reduces human capital attainment and productivity, increases social fragmentation and threatens sustainable development."

The economic dimensions of India's urbanization challenge are large, but the social and cultural factors resulting from the sudden urban demographic bulge also present a daunting challenge. Nevertheless, it is

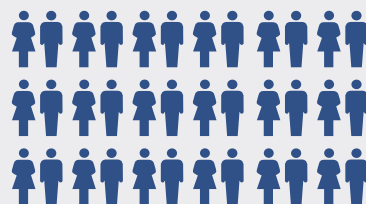


RURAL

Approximately  
**404 million people**



URBAN



will migrate to urban areas in India between 2014 and 2050





**Bihar covers  
an area of  
94,163 sq km**

believed that much of the socio-economic upheavals look potentially surmountable through poverty alleviation and job creation.

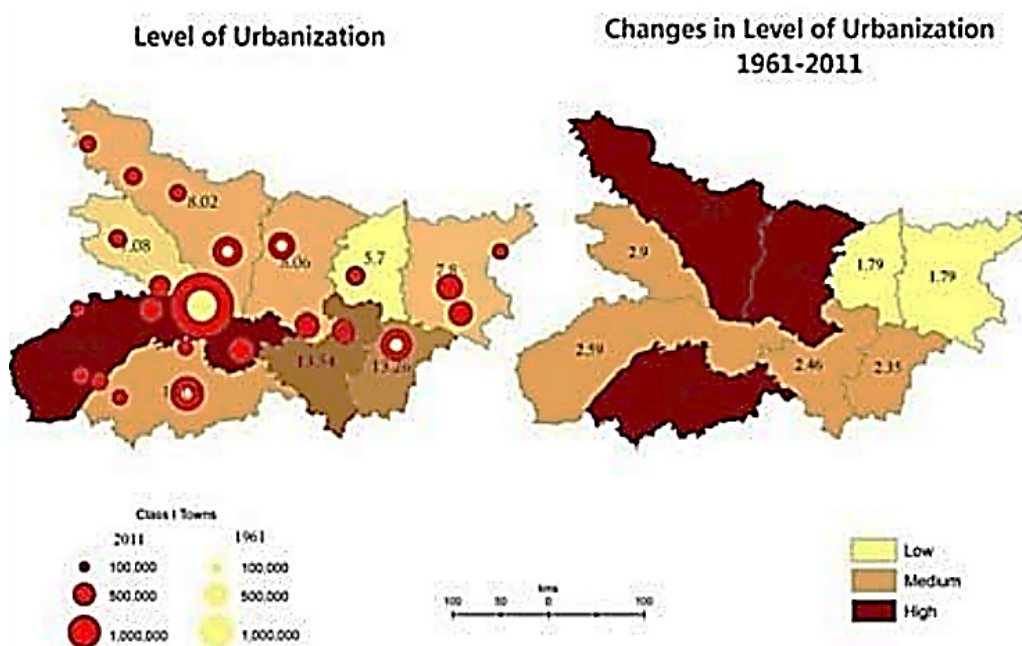
Asia is arguably among the regions of the world which are most vulnerable to climate change. Climate change and climatic variability have affected and will continue to affect all sectors, from national and economic security to human health, food production, infrastructure, water availability and ecosystems. Rapidly developing second and third tier cities are already facing a daily struggle to deliver infrastructure and services, given their limited institutional capacities and constrained finances. Population growth and the demographic shift from rural to urban areas are challenging the ability of urban governments/systems and other actors to provide for the basic needs of people. It is in particular the urban poor, living in informal settlements that are often built on marginal or dangerous land, who are the most impacted by climate change, and of these the most vulnerable are the women, children and the elderly.

Further, the impacts of climate-induced disasters are also increasing globally and even nationally. The impact of climate-related disasters has exacerbated in cities due to the interactions of climate change with urban infrastructure systems, growing urban populations and economic activities. As the majority of the world's population is currently living in cities, and this share is projected to increase in the coming decades, cities need to focus more on climate-related disasters such as heat waves, floods, and droughts.

## 1.1 BIHAR AND ITS URBANIZATION

Bihar is on a fast-track growth and development trajectory, and in the current years, it has acquired substantial attention throughout the nation and even abroad, for its remarkable performance in the development sector. For a state which had suffered stagnation for long, and which had almost resigned to its unending backwardness, this was a decisive moment, heralding new expectations and aspirations. These changes were possible because of the state government's firm commitment to an agenda of development, which is both speedy and comprehensive.

Approximately 2.97 per cent of India, Bihar covers an area of 94,163 sq km. As per the final population Census of India (2011), the State has a population of 103.8 million (males: 54.18 million and females: 49.62 million). The rural and urban population encompasses 88.70 per cent and 11.30 per cent, indicating a



(Source: Census of India)

**MAP 1: DISTRICT WISE LEVEL OF URBANIZATION IN BIHAR (1961-2011)**

high population density at 1102 persons per sq km compared to a national figure of 382 persons per sq km (Provisional Census, 2011). In terms of population, Bihar is the third largest state (having 8.58 per cent population of India) behind Uttar Pradesh and Maharashtra (Census of India, 2011). The Sex Ratio in the State is 916 as compared to 940 for the country, and the child sex ratio is 933 as compared to the national average of 944.

**TABLE 1: PATNA URBANIZATION AND URBAN POPULATION GROWTH RATE**

District level Urbanization and Urban Population Growth Rate		
District	Decadal Population Growth 2001–2011	Level of Urbanization (2011)
Patna	23.73 %	>20%

(Source: Census of India, 2011)

The population in Bihar has been growing rapidly during the decade 2001–2011 at 25.42 per cent, compared to India as a whole at 17.64 per cent. The population nearly doubled in thirty years from 1981 to 2011.

**TABLE 2: BIHAR DECADEAL POPULATION GROWTH RATE**

	Decadal population Growth Rate								
	Percentage Decadal Growth Rate			Sex – Ratio(Females/1000 Males)			Population Density per sq km.		
	1981–91	1991–01	2001–11	1991	2001	2011	199	2001	2011
INDIA	23.87	21.54	17.64	927	933	940	267	324	368
BIHAR	23.38	28.62	25.07	907	921	916	685	881	1102

(Source: Census of India, 2011)

Although Bihar continues to be the second lowest urbanized state for three successive decades (separating out Jharkhand from 1991 Census), its percentage decadal growth of urban population is at 35.11 against 31.80 at the national level. From a population of not more than a million residing in urban areas in 1911, urban Bihar today is home to nearly twelve million people. The absolute urban population of the State at 1.17 Crores is above the urban population of all the eight North Eastern States together. There are in all 141 urban institutions, 11 Corporations, 43 Municipal Councils and 86 Municipal Panchayats in the state (2015).<sup>i</sup>

## 1.2 CLIMATE CHANGE IMPACTS

The concentration of urban population in a few large cities has led to a huge pressure on public infrastructure systems like water supply, sewerage and drainage, solid waste management (SWM), parks and open spaces,



transport, etc. In a few cities, the problems of traffic congestion, pollution, poverty, slums, crime and social conflict are assuming alarming proportions. High rate of urbanization and population density has also put destabilizing level of pressure on the natural resource-base of city which provides resilience and sustainability to human activities. Climate change is likely to aggravate the existing stresses that these settlements already face.

The vulnerability of men, women and children varies with the economic, social, and institutional conditions. The deprived and the marginalized have a much lesser capacity to adapt to change in climate by adopting mechanisms such as air-conditioning or heating. The traditional coping mechanisms of these vulnerable groups are over stretched due to other stresses related to climate change. Climate change upsets the homes, livelihoods, and well-being of the urban poor. Limited understanding of differential impacts of disasters and climate change on different population groups and

groupings (men, women, children, elderly, poor etc.) impedes respective duty bearers to take appropriate action for risk reduction within their service delivery systems. When disasters occur, homes may be damaged or destroyed, and people may be incapable of travelling to work, causing them to lose their source of income to fulfill their food and other basic needs and more than often also the access to health and other facilities is also challenged. Similarly boys and girls lose their school days. Poor people often live in informal settlements that are already at risk, and which become even more vulnerable to climate change. Drains and culverts near their homes are invariably blocked with solid waste. The residents, the slum dwellers often lack secure tenure, appropriate shelter, water, sanitation, electricity and other services, and access to specific life-skills and knowledge to deal with difficult and changing conditions (not only due to climate change). Most have no insurance.

Available evidence indicates that there is a high possibility of increase in the rate and intensity of climate associated natural hazards due to climate change, and therefore increase in potential risk due to climate change related natural disasters in India; And Bihar is no exception to this. It is highly vulnerable to hydro-meteorological natural disasters, with North Bihar in general being highly flood-prone, and South Bihar being notably drought prone. Due to the absence of climate models and low community awareness, the State is potentially more sensitive and vulnerable to climate change and its impact (Singh, et al., 2014).

Bihar is one of the most disaster prone states of the country. Floods, droughts, earthquakes, heat/cold waves, river erosions, fire incidence etc. are several forms of disasters predominant in the state. Among natural disasters, flood is the most common and a regular annual phenomenon, causing massive loss to life and property. Other than floods, the seismic vulnerability of the state to earthquakes is another perpetual danger. Increasing population pressure, high density of buildings and their poor construction quality, settlement in vulnerable areas and inadequate or no investment on mitigation and preparedness measures, has further increased the vulnerability of the populace to these natural hazards. In addition to widespread damage to life and property, these disasters over the years have also adversely affected the economic development in the State.

### 1.3 DISASTER RISK REDUCTION (DRR) ROADMAP FOR BIHAR

Bihar, one of the most populous states of India, is prone to climate-induced disaster risks and natural hazards including floods, drought, cyclonic storms, fire, hailstorms, lightning, heat waves and cold waves. Taking inspiration from the Sendai Framework for Disaster Risk Reduction (SFDRR), signed in Sendai, Japan in 2015 which is an international comprehensive framework for Disaster Risk Reduction (DRR) for 15 years (2015–2030), the Government of Bihar decided to develop a DRR Roadmap (2015–2030) for the state of Bihar.

The Government of Bihar has duly recognized the importance of Resilient Cities in urban areas in the DRR Roadmap. It defines 'Resilient Cities' as a ***“dynamic and proactive social unit wherein all individuals, households and the community as a whole, is capable to assess the disaster and climate change induced risks and access the early warning systems; and address disasters including climate change induced disasters through risk informed development planning which includes preparedness, response and mitigation actions. Further, it also includes the component of preserving ecosystems through environmental impact assessment and recovering from disasters through building back better.”***

The roadmap identifies children as vulnerable groups and acknowledges that the vulnerable groups also have the capacities which must be considered while designing and implementing DRR actions. Inclusive DRR being a guiding principle of the roadmap also takes into the different vulnerabilities faced by children in disasters. One of the most important guiding principles of the plan focussing on children is ***“investing in children and young population which will reduce the risks in present and future”***. It also emphasises on school safety programmes for disaster risk reduction.

### 1.4 IMPACTS OF CLIMATE CHANGE ON URBAN POOR CHILDREN

Climate change has the potential to undermine human development across many countries, including India, and may even lead to a reversal of current developmental progress. This will have a huge impact on the future course of human development. Though no one will be immune to the effects of climate change,



children will be particularly vulnerable. The types of climate risks confronting children are diverse, ranging from direct physical impacts such as cyclones, storm surges, and extreme temperatures, to impacts on their education, psychological stress and nutritional challenges. Higher temperatures are linked to increased rates of malnutrition, cholera, diarrhea disease and vector-borne diseases like dengue and malaria. And children's underdeveloped immune systems put them at a far greater risk of contracting these diseases and succumbing to their complications. Even moderate climate change impacts can have a profound long-term consequence on children's overall development, threatening the achievement of the Sustainable Development Goals.

Globally, there are 2.2 billion people under the age of 18 (2011)<sup>ii</sup>. Of these, 637 million are under 5 years and over 1.2 billion are between 10 and 19 years old. An estimated 61 million children of primary school age and 71 million children of lower secondary school age are out of schools, of which 53 per cent are girls. In conflict affected, poor countries, 28 million children of primary school age are out of school, which are a 42 per cent of the world's total number of primary school age children<sup>iii</sup>. In the late 1990s, the number of children affected by disasters was estimated at 66.5 million per year; climate change impacts project this increase to as many as 175 million per year in the current decade (2010–2020)<sup>iv</sup>. Trends specify that many of the world's poorest countries and communities will face the double threat of climate change and violent conflict<sup>v</sup>. An estimated 46 developing and transition countries are considered to be at high risk to climate change, deteriorating existing problems and increasing possibility of conflict; a further 56 countries face a lower but still marked risk of climate-exacerbated conflict<sup>vi</sup>. Children and youth represent approximately one third of the world's population. Their vulnerability, experience and ability are crucial and relevant components in the overall adaptation and mitigation capacity of a particular country or region.

Today, over half a billion children live in tremendously high flood occurrence zones; nearly 160 million live in high or extremely high drought severity zones. While climate change will eventually influence every child, these children are in harm's way even now, and face some of the immediate risks described above. The dangers of climate change are more pronounced for children than for adults. Children are more vulnerable to vector-borne diseases as compared to adults. They

face greater dangers from under nutrition and diarrheal diseases. In 2015, malaria was accountable for 438,000 deaths, of which more than two-thirds were children under 5 years of age. Children are also more vulnerable to under nutrition. Diarrhea diseases are a major cause of under-five mortality, and are estimated to be the cause of 530,000 deaths in 2015 alone.<sup>vii</sup> The population of Patna is projected to be 60.25 lakh by 2031 out of which the estimated urban population will be 48.77 lakh. The total number of workers that year is likely to be 16.09 lakh, considering a 33 per cent of the urban population (Patna Master Plan, 2031). The projected figure has been based on the trend using share and shift method. It has been projected for the region as a whole, as well as for the community development blocks (CD blocks) and villages. It has also been validated by the provisional figures released by Census of India. The proposed Patna Plan area would have 1,144.92 sq km and its spread will be across 13 CD blocks in Patna district. Six units out of 564 administrative units come under urban centres. The city and its suburban areas are facing critical problems due to high population growth and demand for housing, water supply, drainage, etc. It has created chaotic conditions due to unplanned development and traffic congestion (University, 2016)<sup>viii</sup>. Therefore, assessment of children's vulnerability in urban areas in Bihar is necessary to understand the factors of – fast growing Patna, increasing in-migration, basic services hindered and low development. Children, a vulnerable population, need addressal, and resilience planning is required for the city of Patna, especially for the children and may be eventual adjustment of the existing urban development plans and local area plans of areas that are at-risk of waterlogging etc..



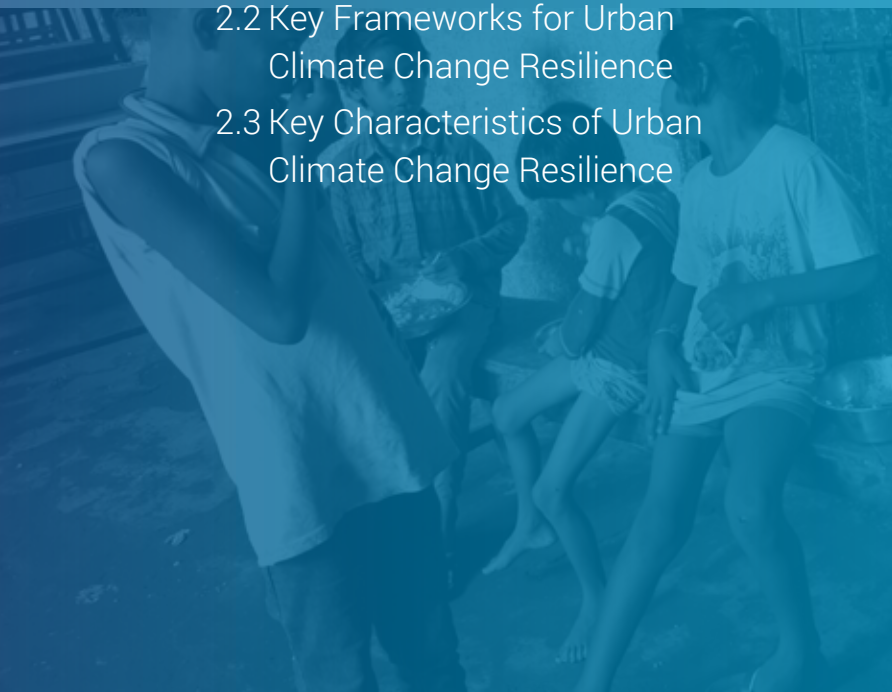
## **In this section**

### 2. Resilience Concepts

#### 2.1 Urban Climate Change Resilience

#### 2.2 Key Frameworks for Urban Climate Change Resilience

#### 2.3 Key Characteristics of Urban Climate Change Resilience



## 2. Resilience Concepts

This section of the document outlines the theoretical and analytical concepts that frame the basic idea of urban climate change resilience (UCCR). It also talks in brief of the guiding principles and key characteristics of urban climate change resilience.

### 2.1 URBAN CLIMATE CHANGE RESILIENCE

In the context of work on climate change, development, and natural hazards, resilience is generally understood to mean the ability of systems to “absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.”<sup>ix</sup> There are numerous definitions of urban resilience. Some argue that “a resilient city is one that can adapt to changing conditions and withstand shocks while still providing essential services to its residents.”<sup>x</sup> Others argue that a vision for resilience includes ideas of taking advantage of opportunities and bouncing back better.” For example,<sup>xi</sup> “Urban resilience is the capacity of cities to function, so that the people living and working in cities—particularly the poor and vulnerable—survive and thrive no matter what stresses or shocks they encounter.”<sup>xii</sup>

These definitions of urban resilience further branch out into an understanding of UCCR, which adds specificity to the nature of shocks and stresses and includes those

that have hydro meteorological origins. UCCR embraces climate change adaptation, climate change mitigation, and disaster risk management, while recognizing the complexity of rapidly growing urban areas and uncertainty associated with climate change.<sup>xiii</sup>

This approach of understanding UCCR concept also emphasizes on considering the cities as dynamic systems, which are capable of evolving and adapting to the threats posed by climate change shocks and stresses. Systems thinking approach also helps in working across sectoral silos and engaging with multiple and evolving risks, simultaneously.<sup>xiv</sup> This is important because climate change is increasing the frequency and intensity with which climate shocks and stresses occur, rendering historical records alone less effective in predicting the future. Importantly, the resilience of a city depends on the overall performance and capacity of its systems, not solely on its ability to manage disaster risk, reduce greenhouse gas emissions, or adapt to the impacts of climate change. In fact, UCCR describes a city that is resilient on three levels:

- The city's systems survive climate-related shocks and stresses.
- The people and organizations are able to accommodate climate-related shocks and stresses into their daily decisions.



Globally, over **half a billion children** live in tremendously high flood occurrence zones; nearly

**160 million** live in high or extremely high drought severity zones.



- The city's institutional structures continue to support the capacity of people and organizations to fulfil their aims.

## 2.2 KEY FRAMEWORKS FOR URBAN CLIMATE CHANGE RESILIENCE

There are a number of frameworks which have been formulated on UCCR, and these have emanated from the experiences of different organisations across the globe. Though these frameworks have been developed in different contexts, there is a high degree of convergence that can be seen which is mainly because the concept of urban climate change resilience engages a wide range of issues. Each of these frameworks commonly highlights that integration of technological advancements and infrastructural growth along with engagement with organisational, social, institutional and financial issues, is essential to make cities resilient.

### 2.2.1 City Resilience Framework, Arup<sup>1</sup>

Arup's City Resilience Framework developed with the support of The Rockefeller Foundation is designed to enable cities to measure and monitor the multiple factors that contribute to their resilience. The City Resilience Index, as it is called, presents a view of what a resilient city looks like and represents an outcome-oriented framework, with 12 outcomes across 4 different categories (health and well-being, economy and society, infrastructure and environment, and leadership and strategy) and 7 additional qualities of resilience (integrated, inclusive, resourceful, flexible, redundant, robust, and reflective), resulting in 52 indicators. Therefore, in this framework, "resilience" implies an enhancement to city systems' capacity to function in the face of multiple hazards.

### 2.2.2 Urban Climate Change Resilience Framework, Institute for Social and Environmental Transition – International

The Climate Resilience Framework (CRF) developed by ISET-International is a conceptual planning approach to building resilience to climate change, which results from dynamic interaction between three elements:

- Systems: infrastructure, ecosystems, water and food supply, energy, transport, shelter, and communications
- Agents: individuals, households, private and public sector organizations
- Institutions: laws, policies, social and cultural rules or conventions that structure human behaviour and exchanges in social and economic interactions, including rights and entitlements, decision-making processes (particularly in relation to urban development), and access to information and knowledge

It operationalized these concepts through structured and iterative-shared learning approaches that allow local planners to define these factors in their own context, in order to develop practical strategies for local action.

### 2.2.3 City Resilience Framework, Asian Cities Climate Change Resilience Network (ACCCRN)

The framework developed for the Asian Cities Climate Change Resilience Network, pioneered by The Rockefeller Foundation, views the city as a sum of interconnected parts that share dynamic relationships and argues that urban systems, vulnerable groups, and climate change combine to determine the resilience of a city. This means that anyone designing or deploying actions to build resilience should consider three main aspects – how does city work, direct and indirect impacts of climate change on cities and who is least able to respond to climate related shocks and stresses.

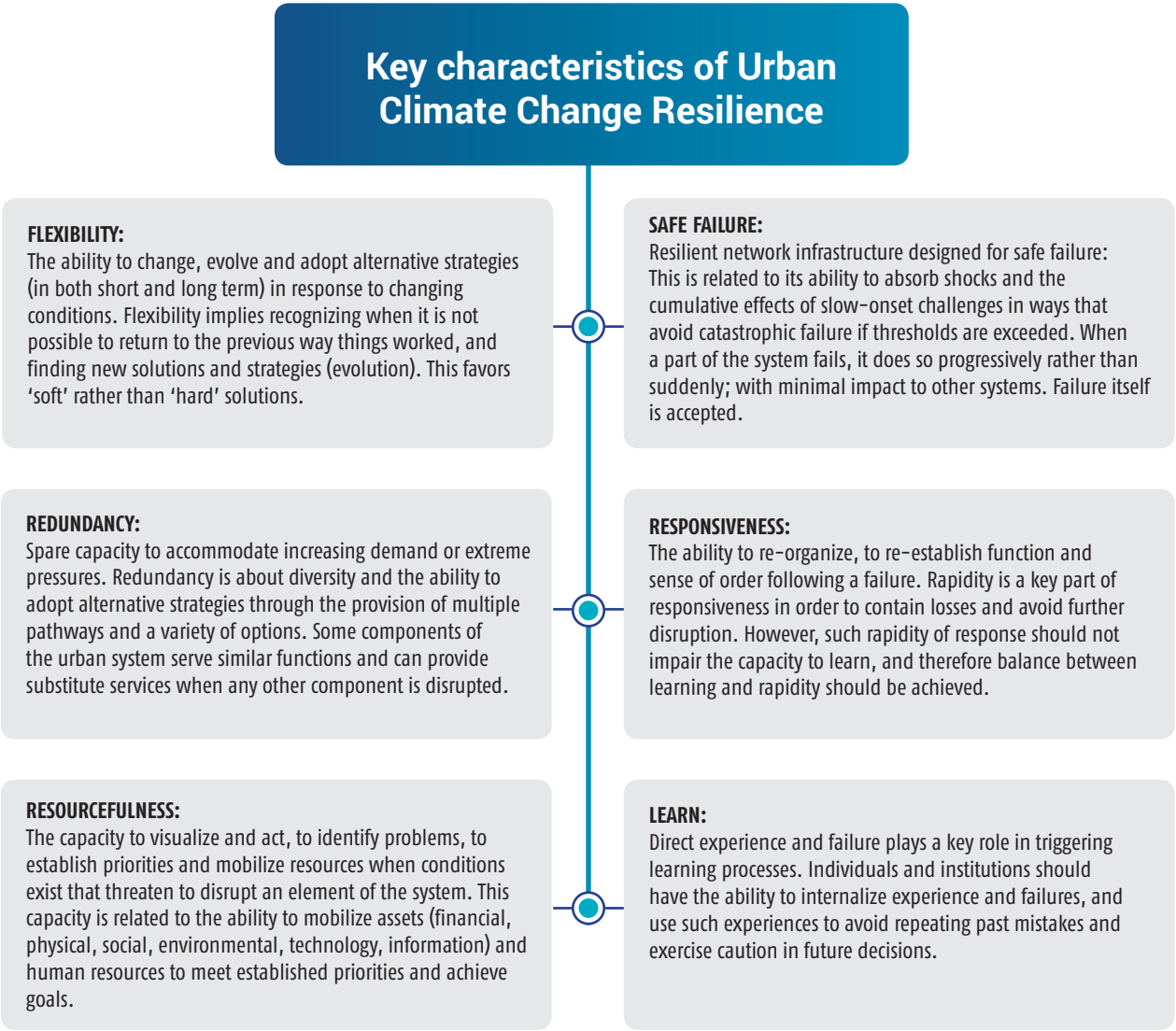
## 2.3 KEY CHARACTERISTICS OF URBAN CLIMATE CHANGE RESILIENCE

Urban resilience to climate change demands that key actors develop and demonstrate a set of core capacities and that city systems exhibit a number of essential characteristics. These characteristics (See Table 3) of resilience can be used to group and conceptualize a set of systemic behaviors that avoid catastrophic outcomes or system breakdown, and enable recovery and stability after dramatic and unexpected events or gradual impacts that force change over time. Each of the characteristics is applicable to the infrastructure, institutional and knowledge networks that comprise any urban system.

<sup>1</sup> (<https://www.arup.com>)



TABLE 3: KEY CHARACTERISTICS OF URBAN CLIMATE CHANGE RESILIENCE



## **In this section**

### 3. Methodology for Developing City Resilience Strategy

3.1 Literature review of secondary data and information

3.2 Policy review

3.3 Stakeholder Workshop

3.4 Field Visits and Community Consultations



### 3. Methodology for Developing City Resilience Strategy

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The methodological framework followed a set of key steps which aimed at understanding the existing and future risk profile of the city based on the shocks and stressors which the city faces and its' vulnerability, specifically on children and vulnerable groups, determined by the local factors of the city and to prepare a resilience strategy/options for the same. The focus of the assessment is to facilitate adaptation initiatives and mainstream them into the city development paradigm to make the city more resilient and prepared towards risks. This assessment was done through the following steps:

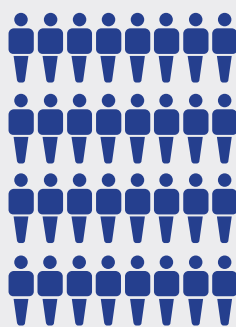
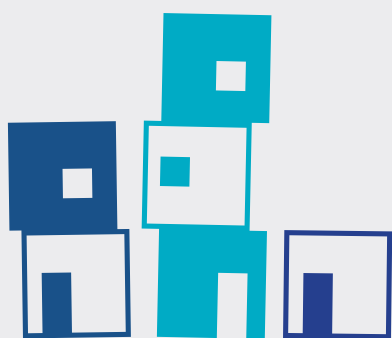
#### 3.1 LITERATURE REVIEW OF SECONDARY DATA AND INFORMATION

Refer the resilience frameworks, which were used to develop the methodology and approach of the CRS. The first step was to assess the current literature linking urbanization, climate change, urban poverty and the status of urban poor children in Patna urban area in such conditions. This drew heavily upon recent commissioned researches into these areas like previously conducted vulnerability assessments of infrastructures and systems in the city, City

Development Plan, Bihar State Action Plan on Climate Change (BSAPCC), Bihar DRR Roadmap, Bihar State Policy for Children 2017, Status of Slums, etc. In addition, climate data projections for Patna urban area was also done based on the historical data, to predict the future probable impacts of climate change. Review of existing policies and governance framework of the city was carried out to identify channels for integrating adaptation and disaster risk reduction measures. Secondary data and information were also collected.

#### 3.2 POLICY REVIEW

In India, the primary tool for climate change (CC) planning is the State Action Plan on Climate Change (SAPCC). Most of the states, including Bihar, have now prepared approved SAPCCs, which describe the climate change projections and risks for the state, and list the priority actions that the state government proposes to undertake to adapt to climate change and to contribute to reducing global greenhouse gas emissions. Government of India has launched a plan with certain laid down missions, called the National Action Plan on Climate Change (NAPCC) in the year 2008. The NAPCC provides an accurate focus on the needed interventions. The NAPCC consists of many



Total households in the slum areas of Patna are  
**13,696**  
with a total population of  
**77,034**

targets on climate change problems and addresses the urgent and important issues of the country through a directional shift within the development pathway. It has given a direction of measures on climate change related adaptation and mitigation, which at the same time advance development. The Missions form the core of the plan, representing multi-pronged, long termed, and integrated ways for achieving goals within the context of climate change. Presently, NAPCC is enforced through 8 National Missions. These missions outline the priorities for mitigation and adaptation to combat climate change in India. The broad policy initiatives of the government's measures are to be supplemented by actions of the State Governments, Non-governmental Organizations (NGOs), initiatives of the private sector and other stakeholders. As a part of this plan, 32 States and Union Territories have already implemented the SAPCC in trying to address climate change issues in their respective development methods.



The basic principles of NAPCC are:

- Protection of the poor and vulnerable sections of society
- Achieve national growth and enhance ecological sustainability
- Demand side management
- Better technology while considering mitigation or adaptation
- Market mechanism through sustainable development
- Inclusivity of civil society and local government institutions

The action plan outlines a number of steps and climate change-related objectives. The NAPCC encompasses a range of measures and focuses on eight missions,

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining the Himalayan Ecosystem
6. Green India Mission
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change

### 3.3 STAKEHOLDER WORKSHOP

A two-day Participatory Stakeholder Workshop was held in Patna which was designed to connect interdisciplinary teams from various sectors like the government, academicians, practitioners, media and civil society organisations with city-based and technical expertise, to map children's vulnerabilities and propose resilience strategy that address the current and future risks of the city. The aim was to invite stakeholders concerned with the five priority areas – WASH, Health, Nutrition, Education, and Child Protection.

The workshop aimed to achieve the following outcomes:

1. Understanding the city: Changes and trends, Mapping habitation patterns, Major Assets and its status-change
2. Climate Change and its impact: Identifying major Shocks and Stressors because of climate change and induced disasters



3. Causes of such Stress/Shocks (Underlying Factors) according to drivers (Physical, Environmental, Social, Economic)
4. Linking Drivers with Assets and causes to understand what solution (cause) can be thought of and which asset will be needed for this
5. Understanding Vulnerability of Children in the city due to direct/indirect impact of climate change
6. Identifying Resilience Options
7. Short, Medium, Long terms Interventions and related rules/guidelines/programmes that can help
8. Stakeholder Engagement and Roles

### 3.4 FIELD VISITS AND COMMUNITY CONSULTATIONS

The workshop was followed by field visits to identified vulnerable wards in Patna urban area, low-income settlements and slums to understand the vulnerabilities of children in the face of climate change. The vulnerabilities identified in the stakeholder workshop were further deliberated and vetted by the community groups.

Shared Learning Dialogues (SLDs) and Focussed Group Discussions (FGDs) were conducted with the communities to source information on their key vulnerabilities and identify resilience options. SLDs and key informant interviews with government departments were also undertaken.

Causal Loop Diagram (CLD) tool was one of the most important tools used in this process, which aided in visualizing how different variables in a system are inter-related. The diagram consists of a set of nodes and edges. 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 decreases, the other node also decreases. Similarly, if the node in which the link starts increases, 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 increases, the other node decreases and vice versa. Several linked causes to a particular problem related to children was analysed through this tool. The CLD tool helped in doing a causal analysis of the vulnerabilities of community groups, especially the children.

## In this section

### 4. Patna - An Overview

#### 4.1 Demography



## 4. Patna - An Overview

Patna, the most prominent town and capital of Bihar is located in the plains of the southern side of river Ganges. Historically, the city was known as Patliputra in 600 BC, and evolved to its current form through a long journey of socio-cultural and economic development. Patna is also known as a sacred Buddhist and Sikh pilgrimage centre. The major industrial areas in the city are towards northern and southeast part, with the railway units located in Hajipur and Sonepur areas.

Patna (and Bihar) is a part of the Indo-Gangetic region, a region rich in food production with good soil fertility and water availability, served through a network of rivers. With growing frustration because of deceleration in agriculture production growth and reduced farming outputs due to increased input costs, decreasing land holding size and recurrent impacts of disasters and climate change, a large population solely dependent on primary production activities are adversely affected, and are shifting to urban areas in search of livelihoods. Secondary cities like Patna are favored destination for such rural-urban migration because of vicinity from source areas and socio-cultural comfort. This makes the city of Patna the 5<sup>th</sup> fastest growing city in India.

**TABLE 4: GENERAL PROFILE OF PATNA**

Area (sq km)	99.45
Number of wards	72

Relief	Plains
Climate	Sub-Tropical
Rainfall (mm)	1100 mm
Population (2011)	1684222
Projected Population 2030	4443678
Population Density (per sq km)	15650
Literacy Rate (2011)	83.4
Household Size (Census, 2011)	5.7
Sex Ratio (2011)	885

(Source: City Business Plan, 2012)

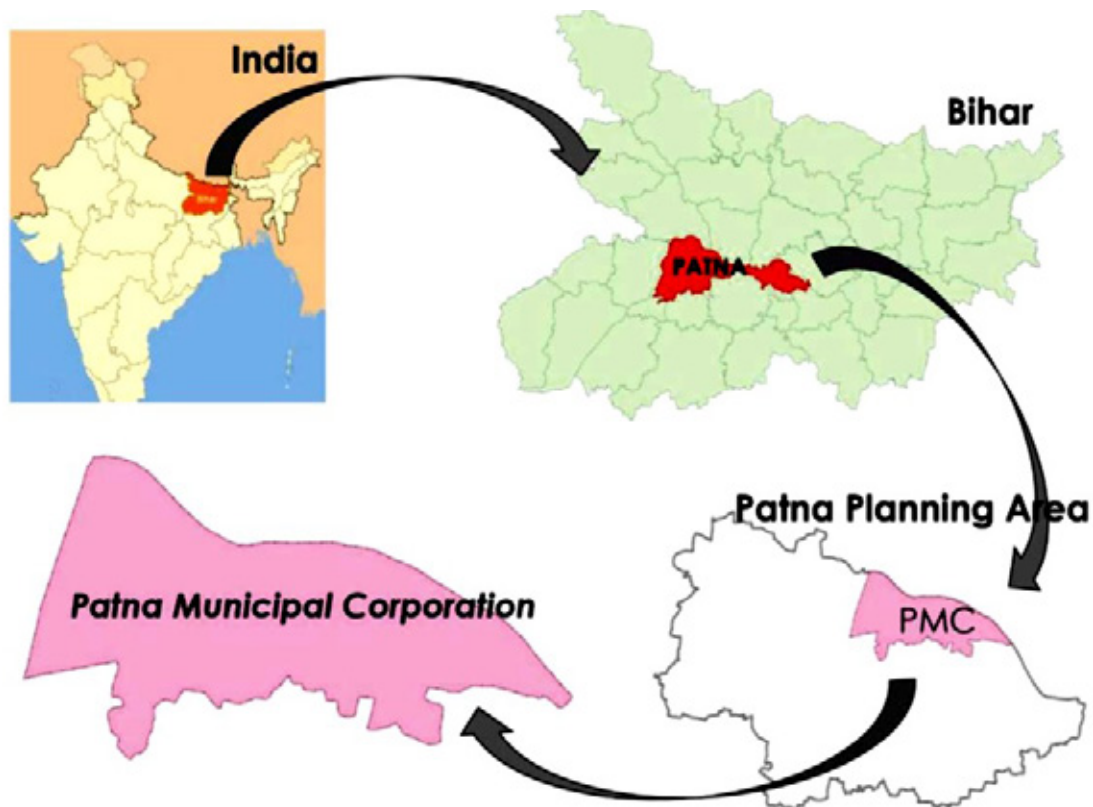
Patna is located between 85° 2' to 85° 16' E longitude and 25°34' to 25°39' N latitude. The Patna Municipal Corporation has an area of 99.45 sq km and the city is approximately 35 kilometers in length from Danapur in the west, to Malsalami in the east. It is around 18 to 20 km wide from Kankar Bagh in the south to the river Ganga in the north, with rivers Sone, Ganga and Punpun in the vicinity.

The topography of the district is very much affected by the floods of the river Ganges. The district (and city) forming a part of the flood plains of the Ganga has a monotonously flat relief. With a saucer shaped topography and a slope in the southern direction of the city (Map 3), this area without adequate drainage provisions is acutely prone to waterlogging. Organized settlements and developmental activities in the flood plains of the rivers have added to the problem.



The total number of children in the **age group of 0-6** living in the slums of Patna is **11, 322**





(Source: Master Plan, 2031)

**MAP 2: LOCATION MAP: PATNA MUNICIPAL CORPORATION**



**The population in Patna Metro Region is 20.5 lakh.**

The Municipal area is divided in 72 wards (Map 2 and 4) with the addition of three new designated wards, viz 22 A, B and C, and the total number of wards in the city is 75. The resilient development of the city will be incomplete without the adjoining peri-urban areas. There is also a strong rural-urban connect as far as flow of goods and services are considered and peri-urban areas play a major role in this transition. Patna is a metropolis and has a designated regional development area that covers 234.70 sq km and includes outgrowths within Patna district – the Patna Urban Agglomeration (Danapur, Khagaul and Phulwarisharif), Saran and Vaishali districts.

As per the provisions of sections 16, 17 and 18 of Bihar Regional Developmental Authorities Act, it is statutory to develop Master Plans of urban centers. The various Master Plans developed from time to time are:

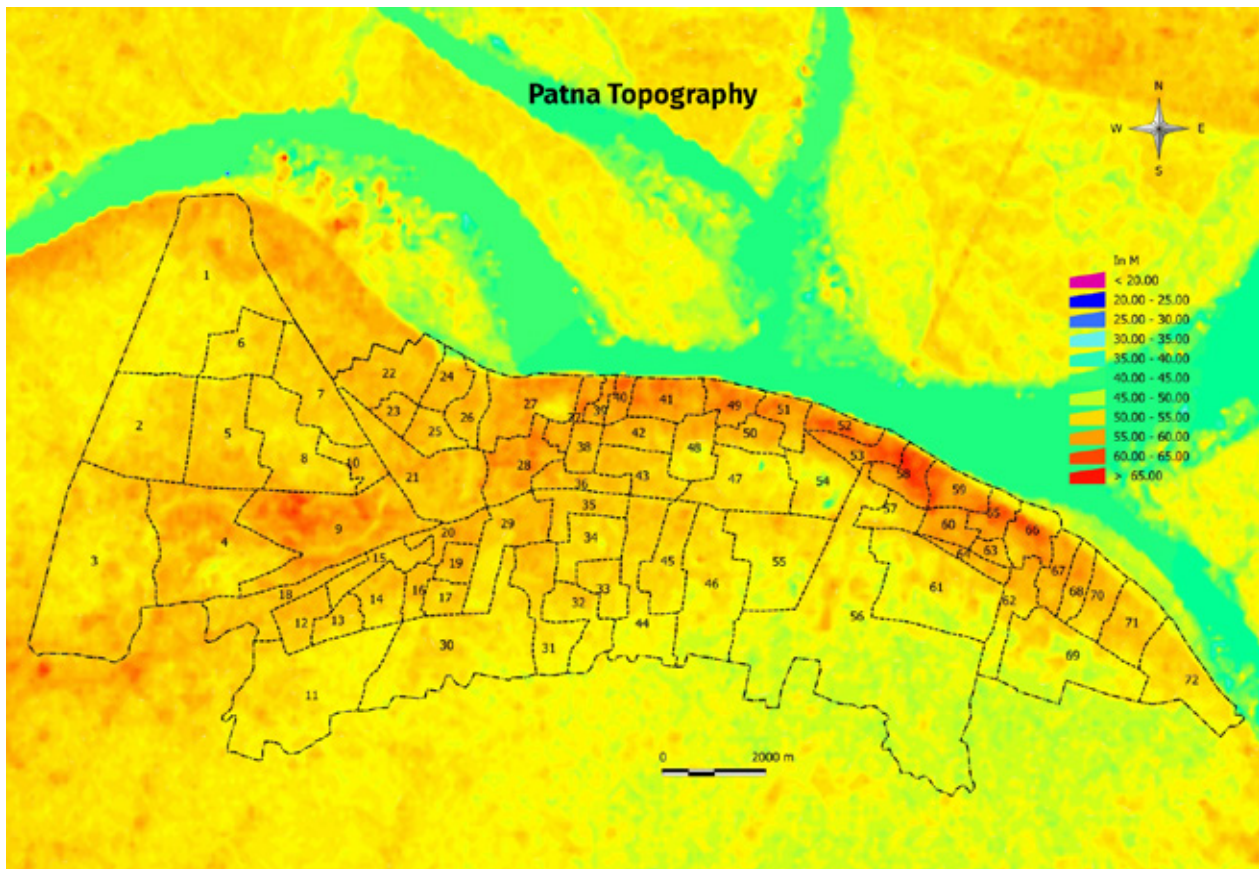
1962- 1981: Broad Brush Master Plan

1982-2001: Developed by PRDA

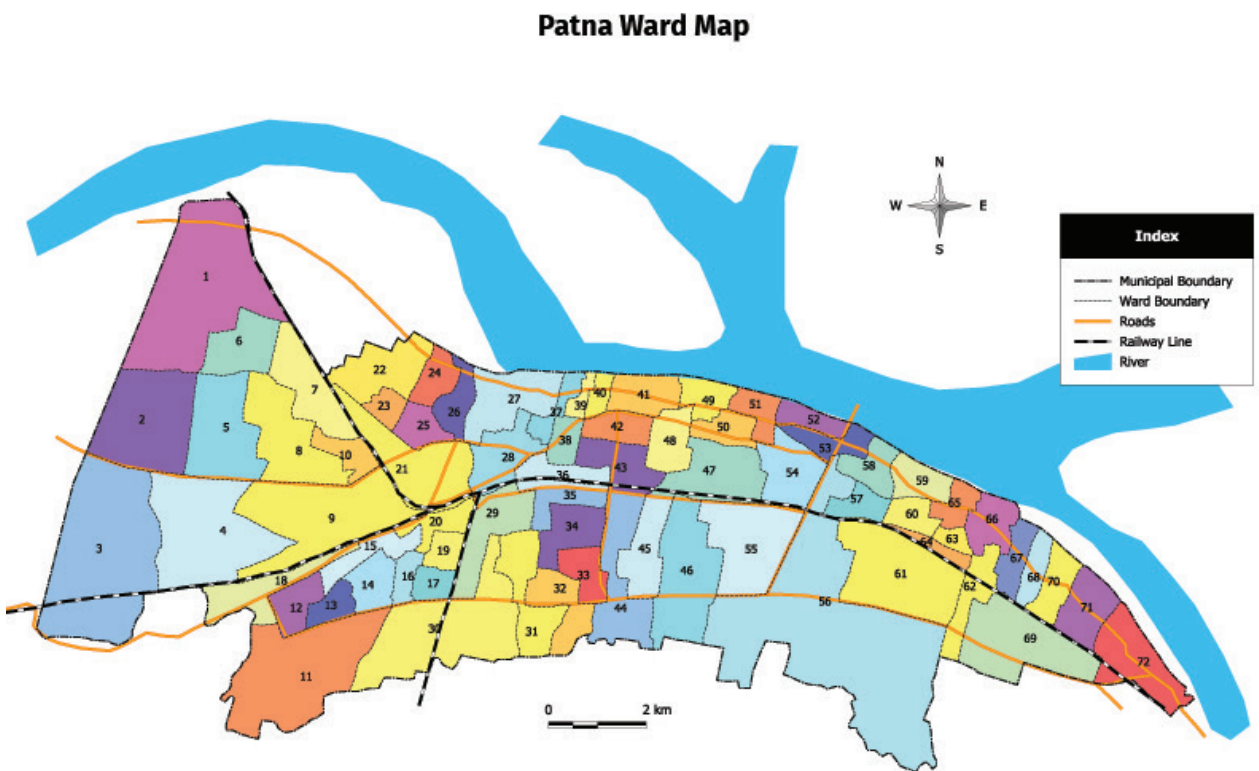
2001-2021: Not approved and notified

2010- 2031: Draft Plan developed

Patna is emerging as a trade and business center since the past ten-fifteen years and witnessing rapid migration from the hinterland and other parts of the state. It has resulted in the rapid urbanization in adjacent areas of PMC, and these have become outgrowths of Patna itself. In the absence of planning interventions since 1981, rapid growth has led to haphazard development in the city and resulted in deterioration of open spaces and forest areas (Now only 2.34 sq m per capita), uncontrolled and unregulated construction activities, growth of brick kilns in and along the riverbed of Ganga, development of slum and unregulated construction within the core city.<sup>xv</sup>

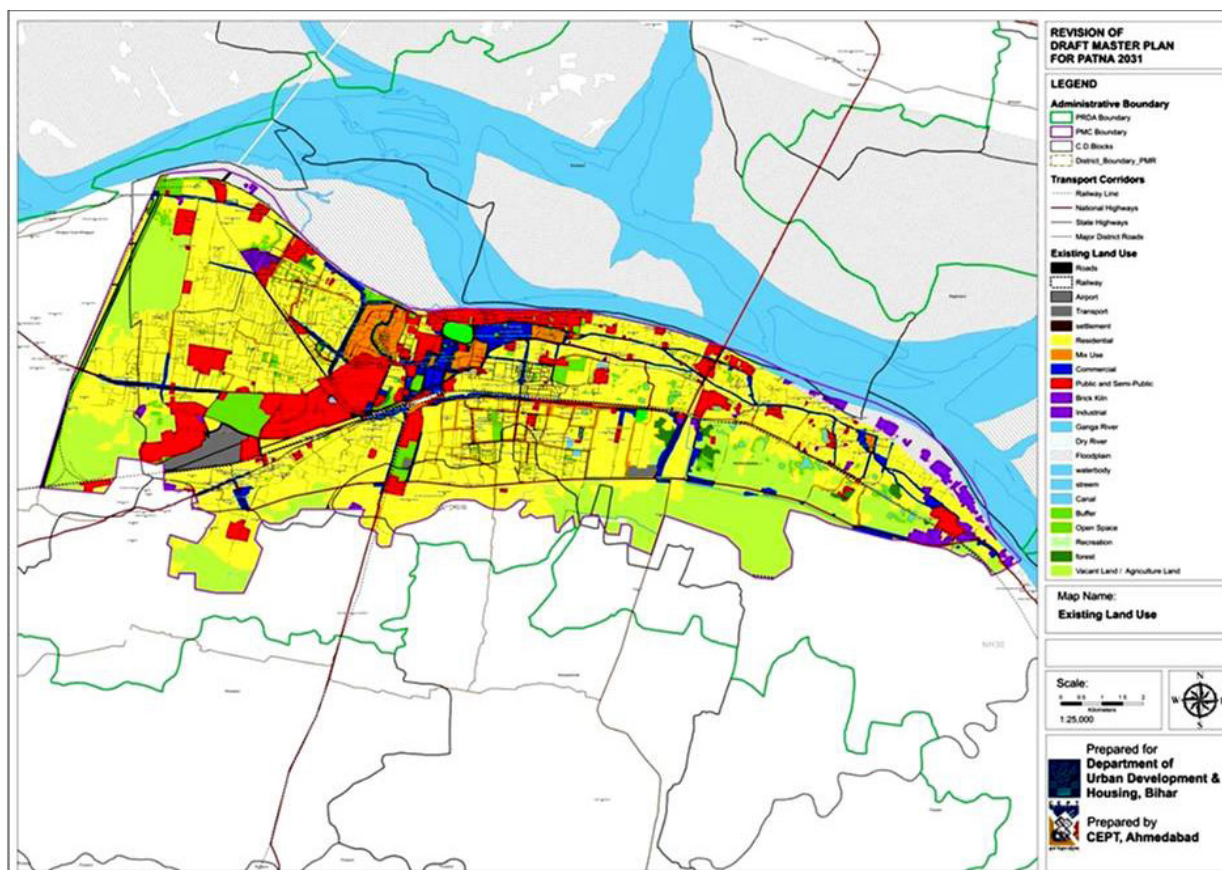


MAP 3: TOPOGRAPHY MAP OF PATNA



MAP 4: WARD MAP OF PATNA





(Source: Master Plan for Patna-2031)

**MAP 5: LAND USE MAP OF PATNA**

Although a Master Plan (Map 5) has been prepared, this could not be notified due to some reasons and the consultant was unable to use the land use map prepared under it. Even though it was not mandatory under the assignment, the consultant nevertheless prepared the existing land map based on field observations. The actual area that comes under various land use in the PMC cannot be calculated under this assignment; therefore an approximate land use has been calculated. It is estimated that the majority of the developed land is under residential usage (approximately 60.34 %), followed by agriculture related (approximately 17.10 %), transportation (approximately 8.19 %), public & semi-public (approximately 6.21 %), industrial (approximately 2.61 %) and commercial (approximately 2.04 %). The most stunning land use deficiency is under recreational (existing 1.45 % and required 18-20 %) as there are very less recreational places in the city (City Development Plan, 2010-2030, Patna).

#### 4.1 DEMOGRAPHY:

According to Census 2011, the total population of Patna is 16.8 lakh, whereas the population in Patna

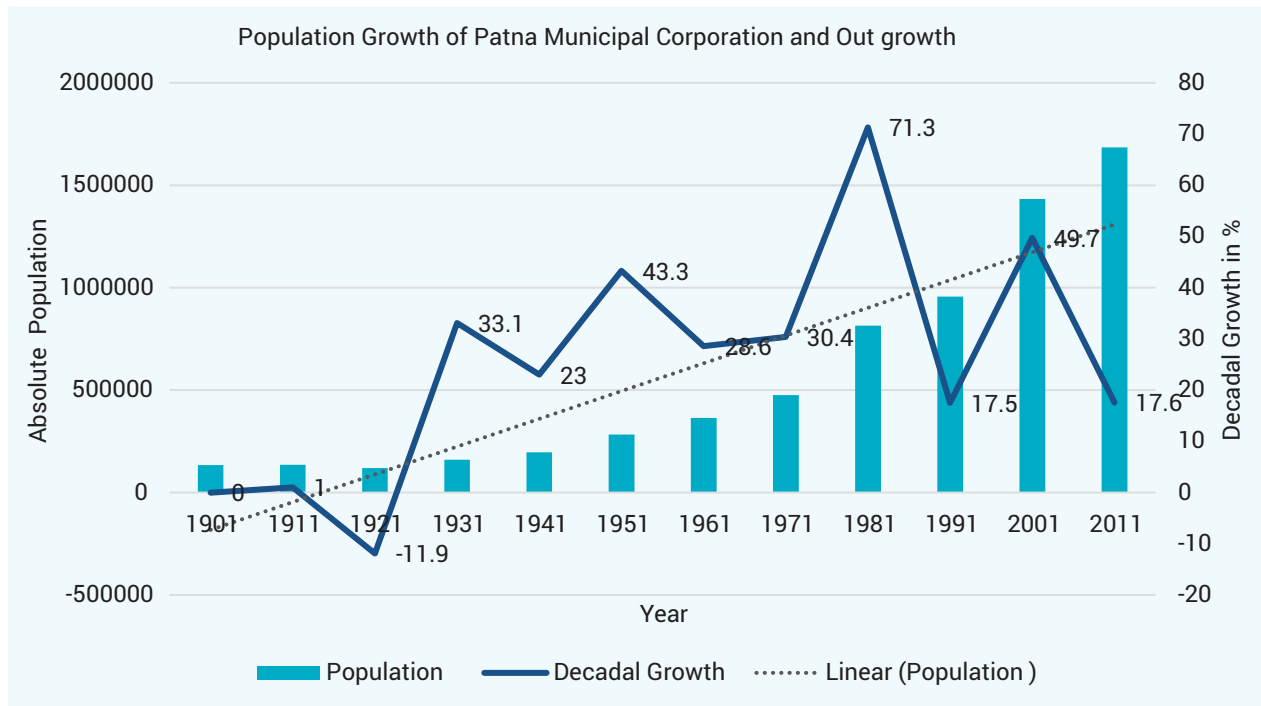
Metro Region is 20.5 lakh. The total number of children 0-6 years in Patna is 203,041 (254,465 in Patna Metropolitan area). The population growth of city of Patna has been uneven in the period 1951-2011. The growth registered an increasing trend in the period 1961 to 1981, from 28.6 % to 71.3 %. It reduced to 17.5 % during 1981 to 1991, rising again to 49.7% during 1991 to 2001 and dropping again during 2001 to 2011 to 17.6 % (Figure 1). It is projected that by the year 2030, the population of the city will reach 4.44 million.

Over the last six decades, the city's population has increased manifold. The reason behind such a growth is the strong rural-urban connection in terms of flow of goods and services, and peri-urban areas are playing a major role in this transition. Patna is a metropolis and has a designated regional development area that covers 234.70 sq km and includes outgrowths within Patna district – the Patna Urban Agglomeration (Danapur, Khagaul and Phulwarisharif), Saran and Vaishali districts

There are large numbers of slums in Patna with a higher concentration in the central part of the city. According to census 2011, the total households in the slum areas

are 13,696 with a total population of 77,034. The total number of children in the age group of 0-6 living in the slums of Patna is 11,322. SPUR has recorded 108 slums with 16,277 households in December 2010. These slums have poor infrastructure with hand pumps and public stand posts as the main drinking water

supply sources; very few households (HHs) have toilets and there is an acute lack of public toilets.



**FIGURE 1: POPULATION GROWTH OF PATNA MUNICIPAL CORPORATION AND OUT GROWTH**

## **In this section**

### 5. Climate Change Impacts and Urban Poor Children

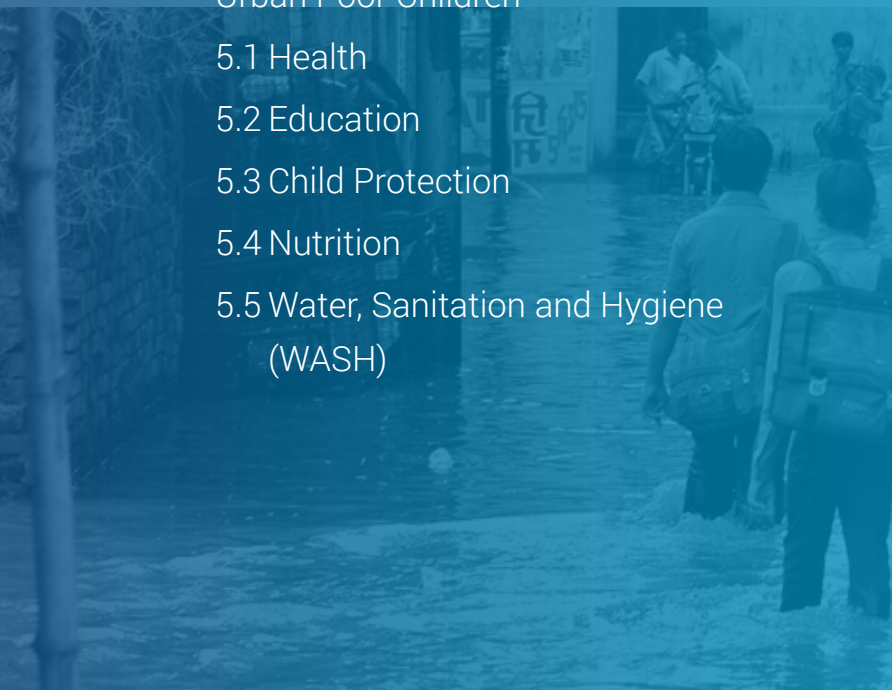
5.1 Health

5.2 Education

5.3 Child Protection

5.4 Nutrition

5.5 Water, Sanitation and Hygiene  
(WASH)



## 5. Climate Change Impacts and Urban Poor Children

Children are particularly vulnerable to the effects of climate change. More specifically, urban children living in poverty face multiple deprivations rendering them vulnerable in the fast urbanizing cities. They are frequently exposed to physical hazards, such as polluted water; open sewer systems; inadequate public transport; lack of local safe play areas or cultural facilities; toxic local environments; and overcrowding. The dangers severely restrict children's independent mobility, and opportunities for play and recreation while increasing their exposure to hazards, violence and unintentional injuries. The cumulative effect of such risks severely undermines the adaptive capacities of children to climate change. Understanding these risks is important, as policies that lessen pressure on resources, manage environmental threats and increase the welfare of the poorest members of society can simultaneously advance sustainable development goals, enhance adaptive capacity and reduce vulnerability to climate change and other risks. Thus, it has become important for the emerging secondary cities to undertake a rapid assessment of their vulnerability, in order to understand risks, build their capacity to plan for adaptation, and to then develop infrastructure systems which will not lead to cascading failures of other elements or related systems and key service deliveries.



In Patna, in order to understand the different vulnerabilities among urban poor children in the context of climate change, this vulnerability assessment looked at 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.

### 5.1 HEALTH

Children's health is primarily determined by the socio-economic and physical conditions of the environment in which they live and are nurtured. Climate change

## Five Key Domains of children's development



**Health**



**Education**



**Water Sanitation  
and Hygiene (WASH)**



**Nutrition**



**Child  
Protection**



alters the frequency, timing, intensity, and duration of weather events. In such situations, these children reside in the fragile fringes of the city and slums with poor basic facilities that get aggravated in times of extreme weather events, and their living environment becomes even more precarious. Climate change affects the growth and survival of disease-causing organisms related to water- and food-borne illnesses. These increase when outdoor temperature increases. Immediately following storms or floods the incidence of water and food borne illnesses, such as gastroenteritis and infectious diarrhea too escalates. High disease load in slums eventually manifests as under nutrition and stunting amongst young children. Extreme weather can result in the breakdown of sanitation and sewer systems, or inadequate means to cook food, increasing the likelihood of water- and food-borne illness. Children are especially susceptible to water- and food-borne illness due to their still developing immune systems. Health is closely inter-linked with livelihoods, income, nutrition, and water and sanitation facilities. During this assessment, these aspects were closely studied in order to understand the issues of health amongst children living in different situations.

## 5.2 EDUCATION

Proper schooling and education is closely linked with the elusive triangle of its access, equity and quality for these urban poor children. In the wake of changing weather patterns, this is influenced by declining livelihood opportunities, migration, inaccessibility to schools, health, and disruption of social sector services (schools, anganwadis, health centres, water supply, sanitation system and social protection systems like PDS) etc. Climate induced disasters hit the poor communities who are then forced to discontinue their children's schooling. Displacement due to rural-urban migration\* leads to problem of identification, which also adversely impacts education and other child rights.

### \* Are there more environmental migrants in cities:

"Water scarcity affects more than 40 per cent of the global population and is projected to rise. Over 1.7 billion people are currently living in river basins where water use exceeds re-charge. Floods and other water-related disasters account for 70 per cent of all deaths related to natural disasters."

Source: United Nations Department of Economic and Social Affairs

## 5.3 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.

## 5.4 NUTRITION

Though urban children are considered to have better nutritional status, several researches have evidenced that urban malnutrition is on the rise. Children, in their growth period are vulnerable and need proper food and nutrition for their overall development. Repeated incidences of acute diarrheal disease during childhood due to lack of appropriate sanitation and safe drinking water and hygiene in slums is one of the drivers of undernutrition, which is closely linked to exposure of slums to waterlogging and floods. Nutritional inadequacies results in the hampering of the development of their body. If this nutritional inadequacy persists for a longer period, it results in their improper growth manifested in the form of low weight, stunted height, low IQ, etc. Child malnutrition is the single biggest contributor to under-five mortality due to greater susceptibility to infections and slow recovery from illness. Droughts that lead to food shortages are likely to lead to malnutrition, affecting the health and development of urban poor children.

## 5.5 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 tube-wells, 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 water-borne diseases like diarrhea, cholera, typhoid and hepatitis.

## In this section

### 6. Child-Centered Urban Climate Resilience Framework



## 6. Child-Centered Urban Climate Resilience Framework

The Child-Centered Urban Climate Resilience Framework (Figure 2), adapted from the internationally acclaimed Climate Resilience Framework developed by ISET-International, is an integrated approach for understanding vulnerabilities of urban poor children, one on part, due to climate change impacts around their five key development parameters – Health, Education, Child Protection, Nutrition and Water, Sanitation and Hygiene (WASH). On the other hand, it focuses on the critical roles of Systems, Agents and Institutions across these five development parameters and the manner in which, with their own resilient characteristics, they can contribute in building urban climate change resilience for children. It also incorporates the concept of shared learning as part of an iterative process in which analysis feeds into planning, planning into actions, action into learning, learning into further cycles of analysis, and so on. This iterative, shared action-learning cycle fosters building and maintaining resilience over time, in the face of rapidly evolving contexts and high levels of uncertainty.

To explain, the left circle helps in assessing vulnerabilities due to climate change exposure on five key development parameters – Health, Education, Child Protection, WASH and Nutrition. In addition, the causes of vulnerabilities across these five thematic areas are inter-linked and inter-dependent on each other. The right circle helps in understanding the key resilience mechanisms at three levels – Agents, Systems and Institutions, across the five development parameters of children. The Framework also suggests the key characteristics of Agents (Responsible, Ability to Learn, and Resourcefulness), Systems (Flexibility, Diversity, Modularity, Redundancy, Safe Failure) and Institutions (Decision-making, Information Access). It further guides that for resilience planning, it is important to **identify actions** across key thematic sectors, **prioritize actions**, **design** resilience options/solutions, **implement** and **monitor** them around a set of key indicators.

This framework guides efforts to build urban resilience that support children, youth, girls and boys. It integrates child and human rights into resilient urban development, enabling children to become agents of resilience.

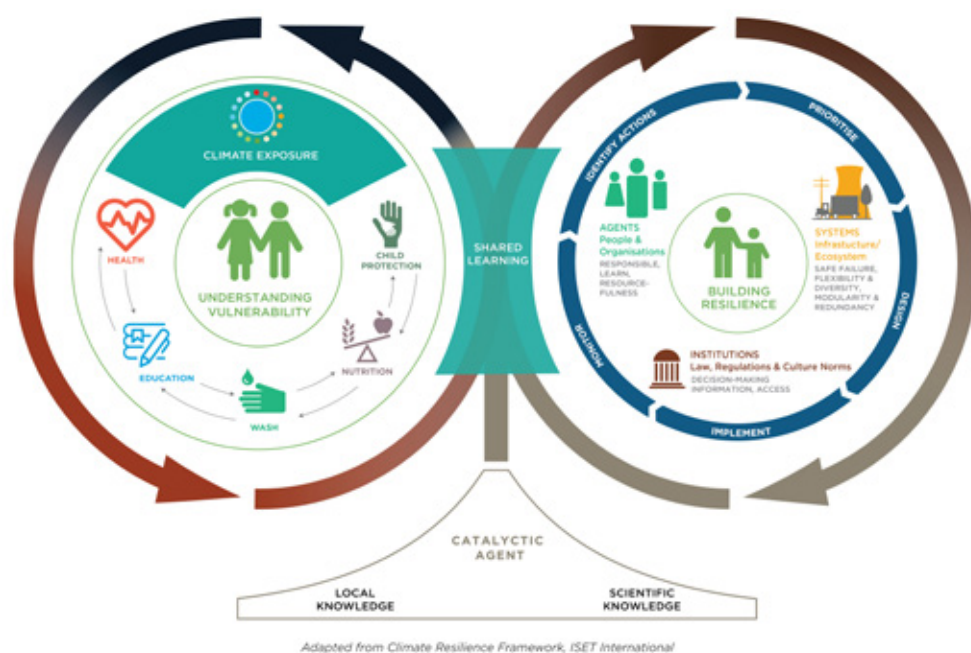
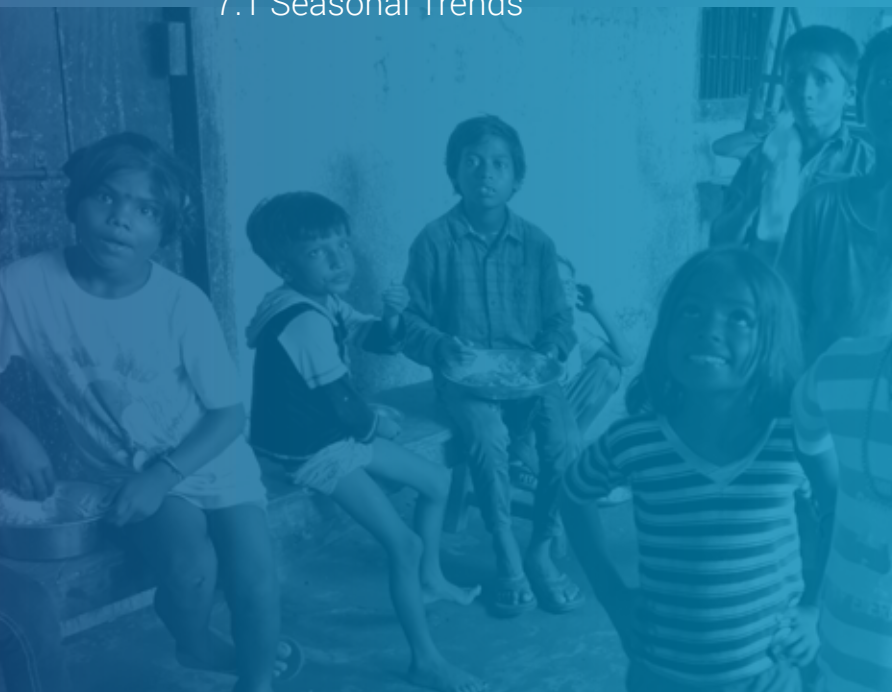


FIGURE 2: CHILD- CENTERED URBAN CLIMATE RESILIENCE FRAMEWORK

## **In this section**

### 7. Climate Scenario

#### 7.1 Seasonal Trends





## 7. Climate Scenario

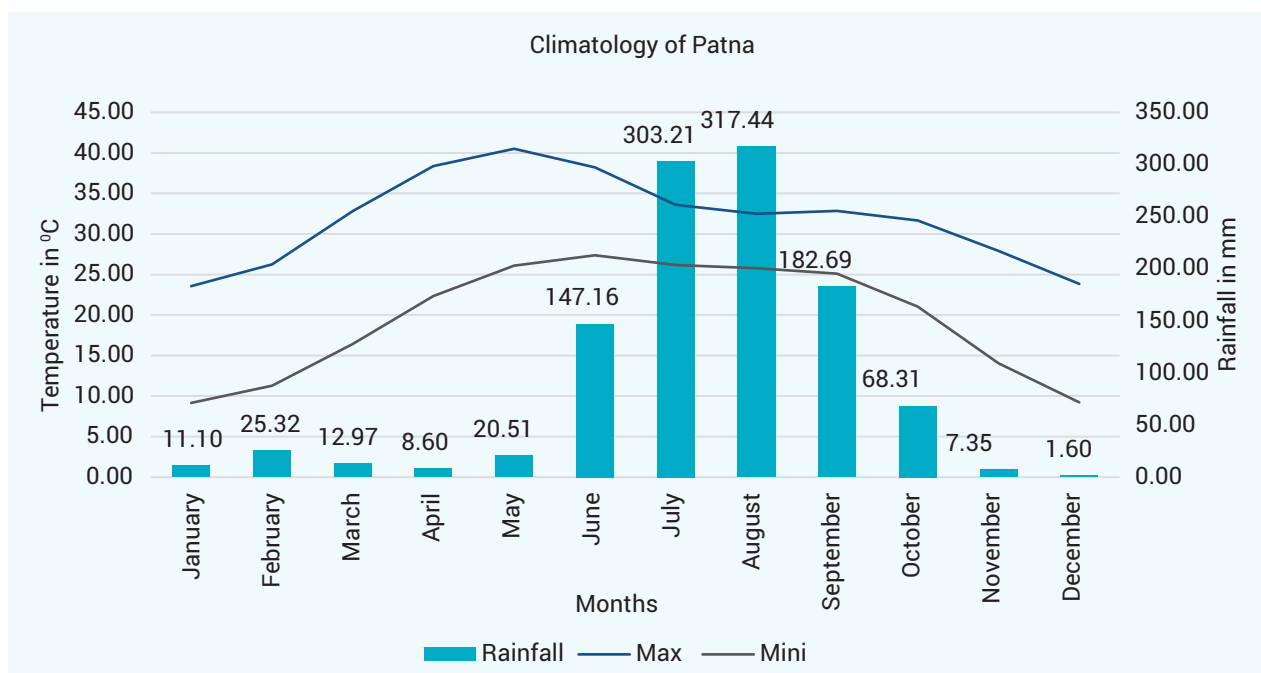
The city of Patna has become hotter and more humid during the last 115 years (1901-2015) which is forcing people to stay indoors to protect themselves from heat waves and clammy, sticky weather. Today, the climate of the city is recognized as humid subtropical, with extreme hot summer from late March to early June, with the monsoon season from mid- June to late September, and chilly winter nights and foggy/sunny days from November to February. Annually, the city on an average, receives rainfall of 1100 mm in 80 days. The monsoon season (June– Sept) accounts for more than 80 per cent of its annual rainfall. The month of August receives the highest rainfall, about 28 per cent contribution, followed by July, which contributes 26 per cent (Fig 3). The highest ever-recorded rainfall in 24 hours was 273.5 mm on 20<sup>th</sup> September 1967.

The annual mean temperature of Patna is 25.55°C. Annual mean maximum temperature of the city is 31.30°C and annual mean minimum temperature is 19.80°C. Highest temperature during the last 115 years ever recorded was 46.6°C on 9<sup>th</sup> June 1966, while the lowest ever was 1.1°C on 9<sup>th</sup> January 2013. In summers, the average maximum temperature however



**Highest temperature during the last 115 years ever recorded in Patna was 46.6°C on 9<sup>th</sup> June 1966**

soars to as high as to 37.2°C and winter average minimum drops to 10.6°C. Days with maximum temperature exceeding 40°C varies from 35 to 57 days. The early or late onset of monsoon and large spatial and temporal variability of monsoon rainfall causes floods, and affects the city. Thus, the climatic variations and increasing extreme events have been recognized by the people and draw enough attention to itself. This, however, needs deeper analysis and understanding of the climate change phenomenon. It is for this purpose, that the critical analysis of three seasons has been carried out, to comprehend issues of climate change in Patna and its emerging impact. For each of the three seasons, 115 years data was analyzed and inferences drawn accordingly.



**FIGURE 3: CLIMATOLOGY OF PATNA**

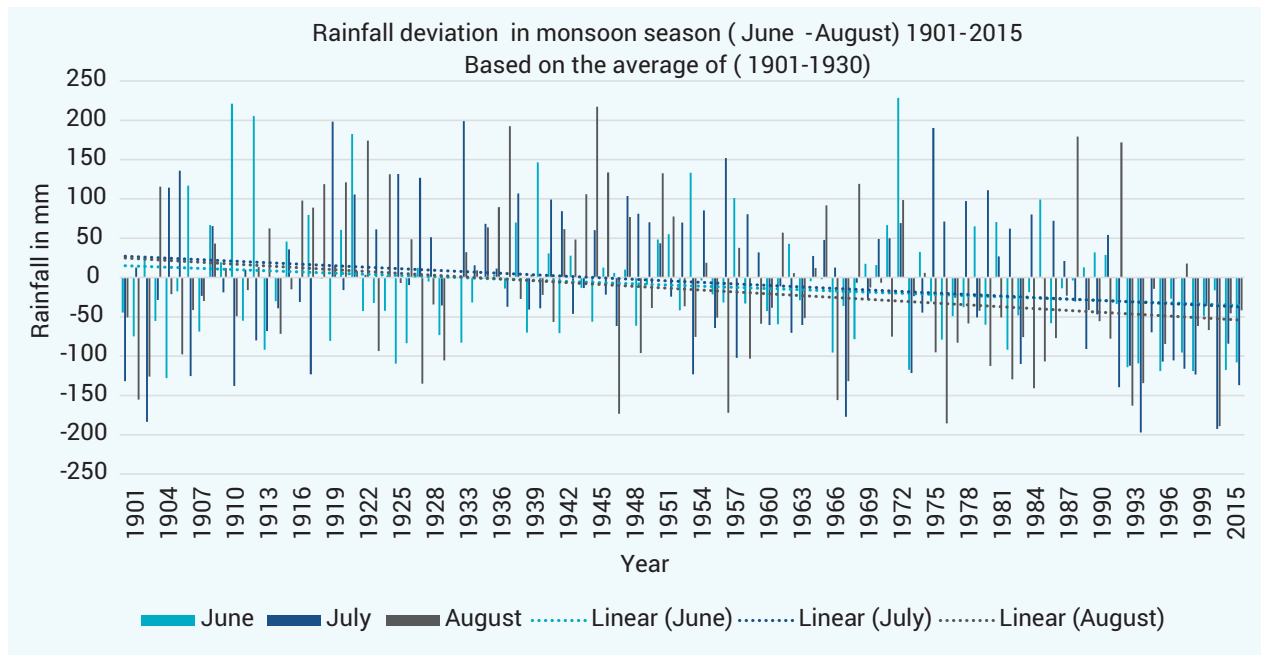


## 7.1 SEASONAL TRENDS

### 7.1.1 Rainfall

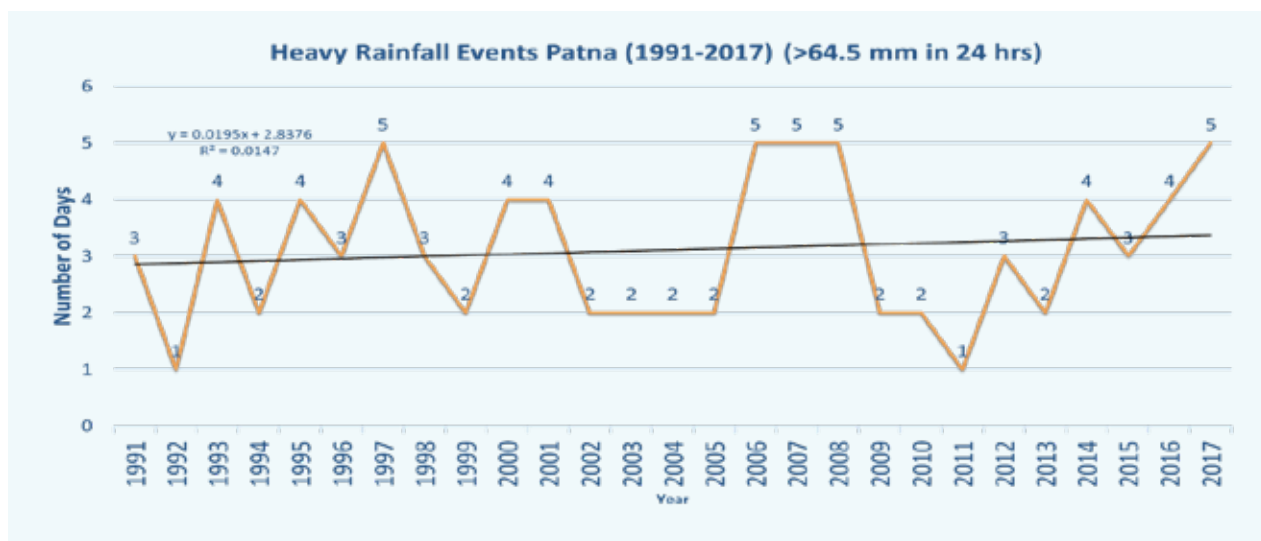
The rainfall pattern in the city has changed considerably over the last fifteen decades. This has been due to impact of climate change. But such changes are more conspicuous since the 1980s. During the last 30 years (1985-2015), there has been an absolute negative trend in the annual rainfall amount. It is decreasing at the rate of 3 mm per year, seasonality of the rainfall is showing marked variations, and the pre and post

monsoon seasons have no significant trend. Major change (negative) is being noticed during the monsoon season (June to August) (Fig 4) which is a matter of concern for the agricultural activities being carried out in and around the villages of the city. Apart from this, historic data also shows variation in the rainfall events. The number of rainfall events with more than 20 mm in a day during monsoon season is decreasing, while the frequency of light rain (0.1-7.5 mm) is increasing. It is also observed that, inter annual variability is more in moderate rain (35.6-64.4 mm) frequency. The analysis of frequency of heavy rainfall events (greater than 64.5



(Source: Based on climatology data provided by IMD)

FIGURE 4: RAINFALL DEVIATION IN MONSOON SEASON (JUNE-AUGUST) 1901-2015



(Source: Based on climatology data provided by IMD)

FIGURE 5: FREQUENCY OF HEAVY RAINFALL EVENTS ABOVE 64.5 MM (1991-2017) IN PATNA

mm in 24 hours) (from 1991 to 2017) indicates an increasing trend (Fig 5).

As the above graph indicates, heavy rainfall events (above 64.5 mm) in Patna are increasing (the return period analysis of such event has been calculated based on past occurrences). The table below depicts the probability (in percentage) of the return periods of the heavy rainfall events over Patna.

**TABLE 5: HEAVY RAINFALL RETURN PERIODS OF PATNA**

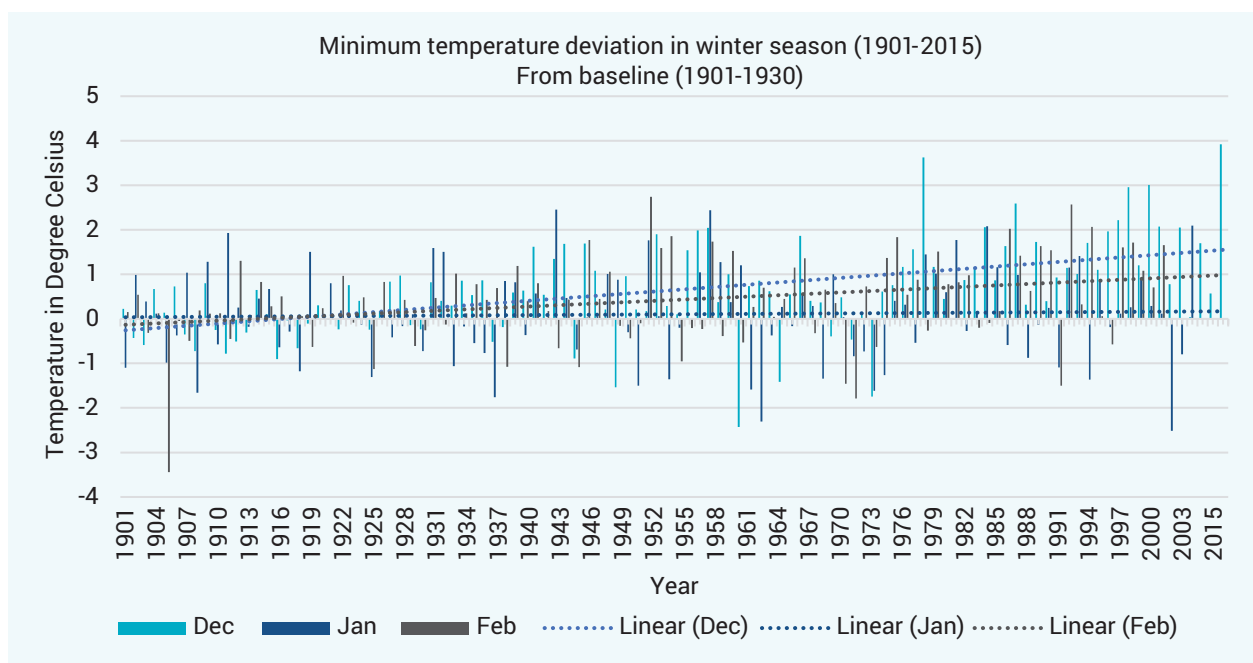
Heavy Rainfall Return Periods of Patna			
Sl. No.	Return Period ( year)	Probability in %	Rainfall in mm
1	1.05	95.2	71
2	1.11	90.1	76
3	1.25	80	84
4	2	50	105
5	5	20	138
6	10	10	162
7	25	4	196
8	50	2	224
9	100	1	254
10	200	0.5	286

(Source : Computation based on past rainfall data ,1981-2016)

From the table 5, it can be concluded that there is a high probability (95 percentile) of 71 mm of rainfall in 24 hours every year. The chances of heavy rainfall event, which is more than 105 mm in 24 hours, are also predicted to increase. Such events will occur in every two years interval. Thus, it can be concluded that though the total amount of rainfall over the city in the last few decades has decreased, the intensity of rainfall in shorter periods will increase.

## 7.1.2 Temperature

In terms of temperature, the city's scenario has undergone a marked change in the last 115 years (1901-2015) and its variations have made a deep impact over the hydrological cycle. The analysis and interpretation of temperature variability (during 115 years) therefore constitutes an important component of the study to assess its impacts on the day-to-day concern of the people in general, and children, in particular. Temperature trends (both minimum and maximum) show an increasing trend. However, the gradient of rise in temperature is more conspicuous during the winter season. Winter seasons are becoming warmer. The striking feature is that the minimum and maximum temperature during the winter season (Dec-Feb) is increasing. Fig-7 and Fig-8 below clearly manifest that the minimum and maximum temperature



**FIGURE 6: MINIMUM TEMPERATURE DEVIATION IN WINTER SEASON (1901-2015)**

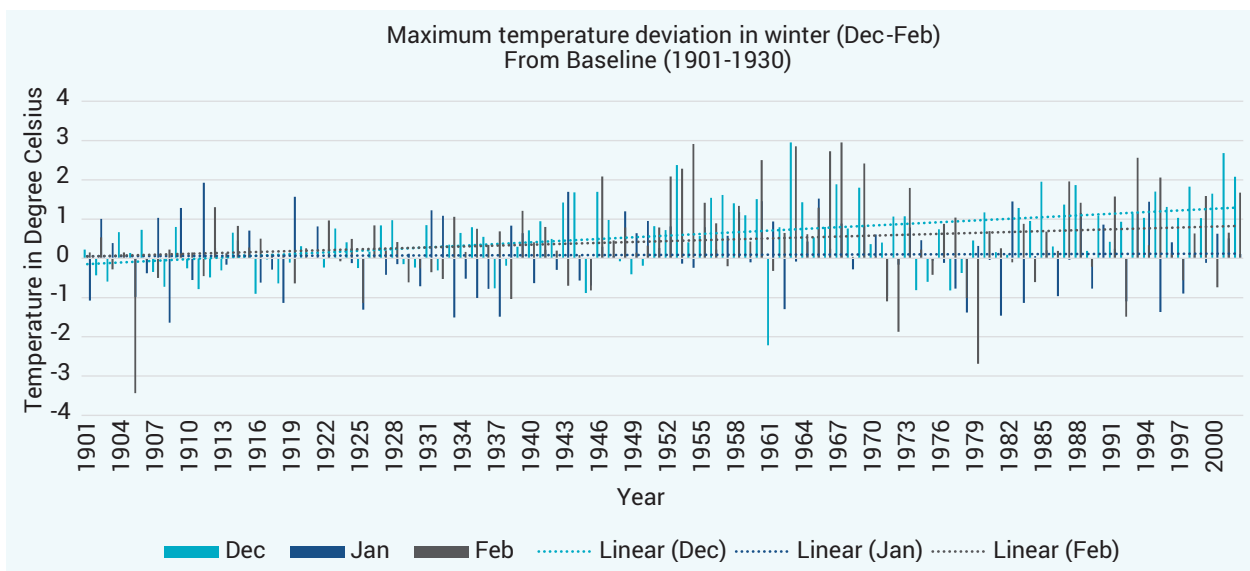


FIGURE 7: MAXIMUM TEMPERATURE DEVIATION IN WINTER (DEC-FEB)

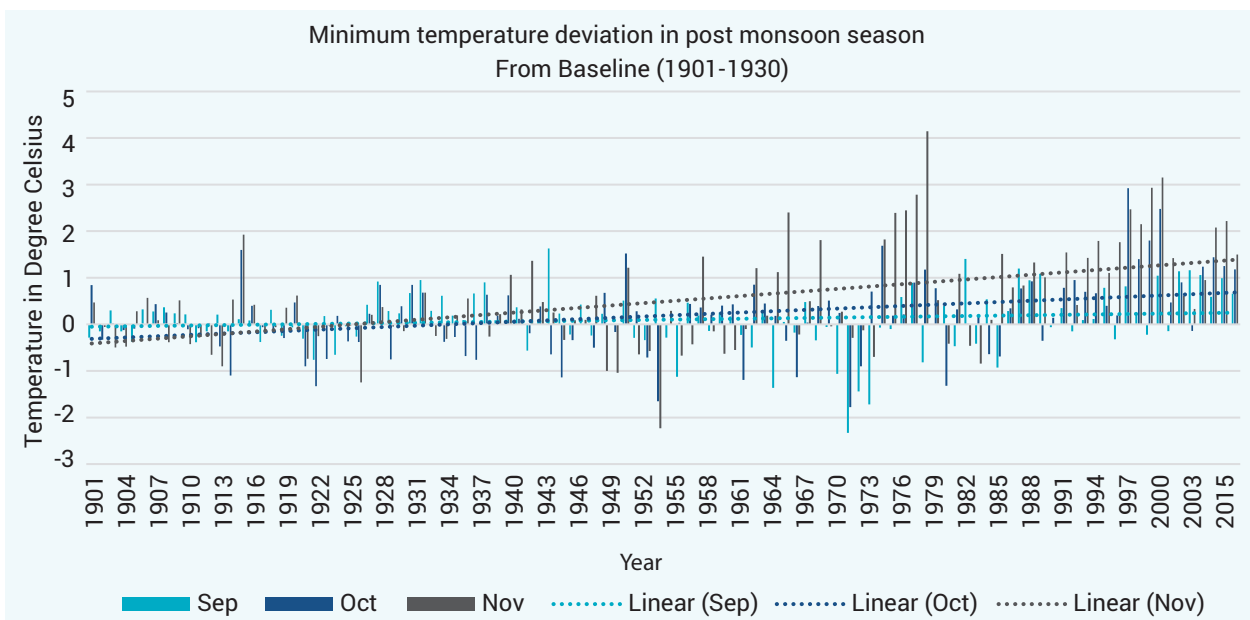


FIGURE 8: MINIMUM TEMPERATURE DEVIATION IN POST MONSOON SEASON

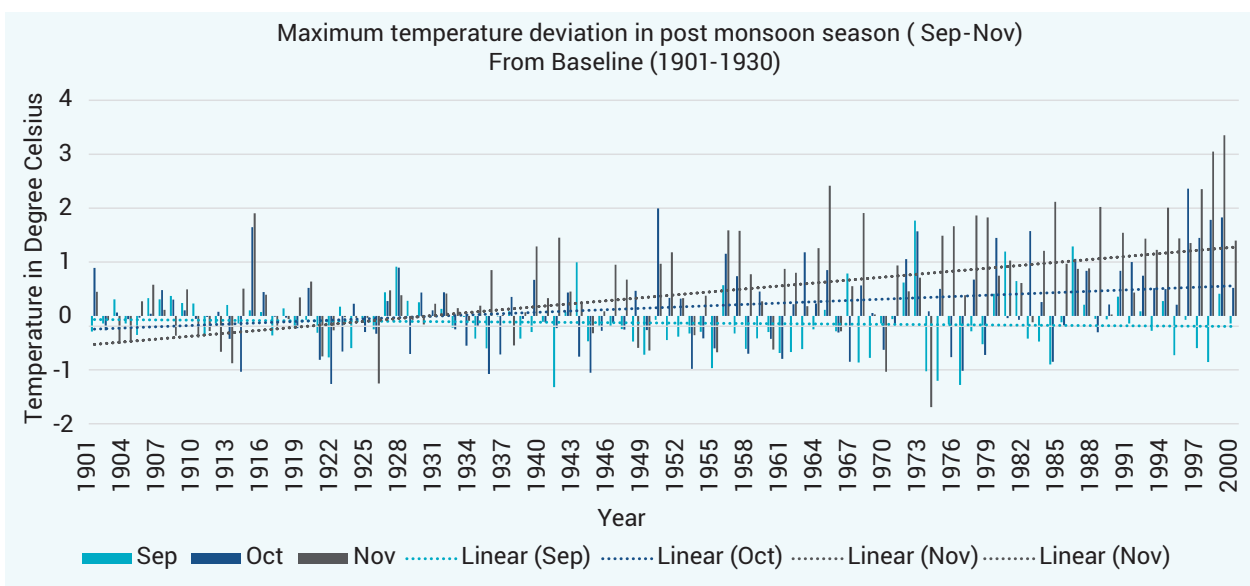


FIGURE 9: MAXIMUM TEMPERATURE DEVIATION IN POST MONSOON SEASON (SEP-NOV)

of December, January and February during last 115 years has increased significantly from base line (1901-1930). The trend of rise in temperature in December and February is more conspicuous and has increased sharply.

Another marked change in minimum and maximum temperature was noted during the post monsoon season. Fig-8 and Fig-9 show that the months of October and November are becoming warmer.

### 7.1.3 Extreme temperature events

The analysis of extreme temperature events especially during summer (April- June) in the last 16 years

becomes more interesting. Due to climate change, the hot season has extended to March. Though, mean maximum and minimum temperature during the summer season has not increased significantly, but the number of days above 40°C in the city has increased significantly. The analysis of day wise data of Maximum temperature of day and night during the summer months (March- June) of the city for the last 30 years (1998-2017) shows that the number of hot days and warm nights (5 degree above from normal) events has increased (Fig 10 and 11) over the last 30 years. The years 1992, 1995, 2005, 2010, 2012 and 2014 have recorded the highest number of days above 40-degree temperature.

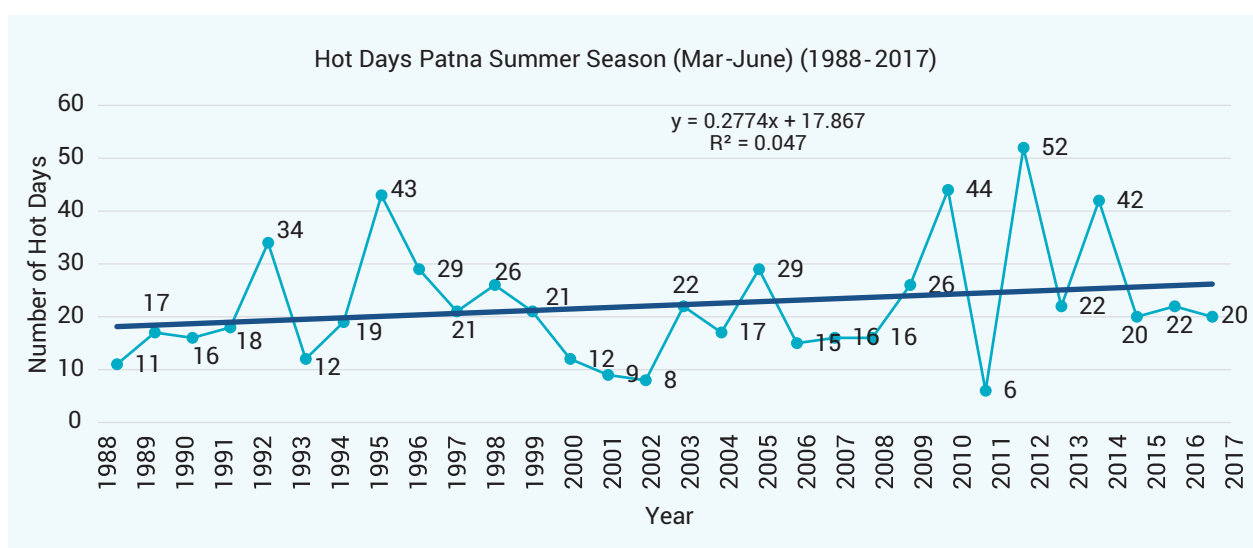


FIGURE 10: HOT DAYS PATNA (1988-2017)

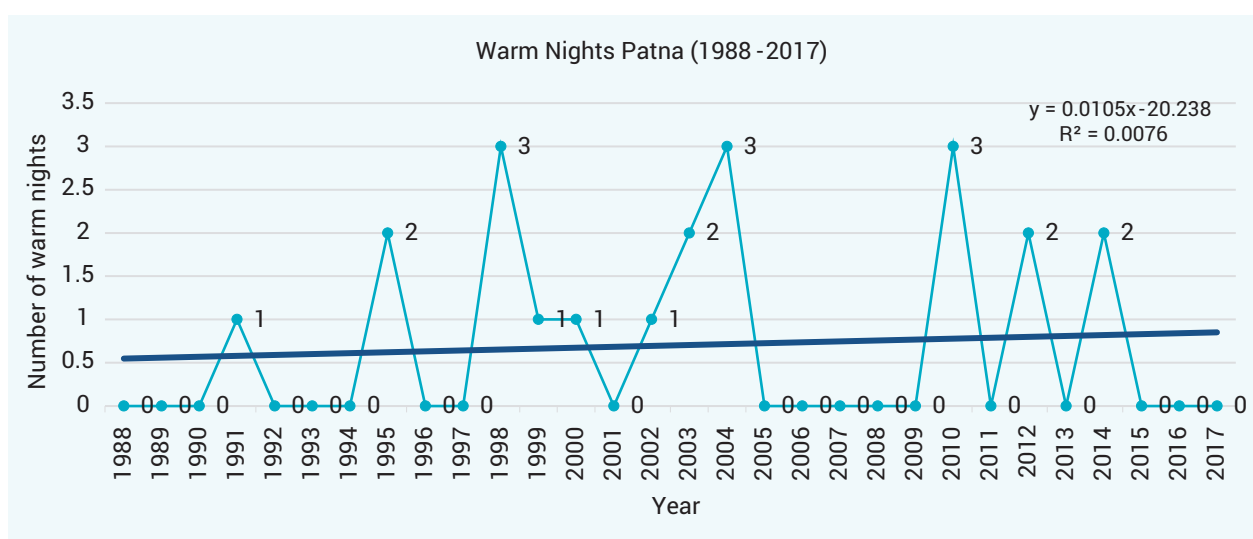


FIGURE 11: WARM NIGHTS PATNA (1988-2017)



### 7.1.4 Key Inferences

From the climate data analysis, the following inferences on seasonal trend in temperature and rainfall are drawn based on the historical climate data:

- The mean maximum temperature has increased in monsoon and post-monsoon season over the city, which is influencing the humidity content in the air.
- The mean minimum temperature in winter and post monsoon season has increased. This is creating a conducive environment for breeding of mosquitoes giving rise to vector-borne diseases, especially in children.
- The number of days above 40°C in the city is increasing which is influencing child health and causing heat stroke in school going children and for those working in the open.
- The absolute rainfall amount is decreasing while frequency of light rainfall (less than 7.5 mm) is increasing which has a direct effect on the input cost of food production and horticulture, especially on vegetables and banana cultivation in peri-urban areas.

Thus, the above inference indicates that city is already experiencing the impact of climate change, which is affecting the daily lives of the people. The increase in temperature and events of erratic rainfall are adversely influencing the health and overall development of urban poor children.

### 7.1.5 Projected Change in Temperature and Rainfall over Patna

The future projections of temperature and rainfall (based on the downscaled data of PRECIS) indicate an all-round warming over the region due to increasing concentration of greenhouse gases. The PRECIS simulation of the region gives the following indications:

- Annual maximum temperature is projected to increase by 1.82°C by 2050
- Annual minimum temperature is projected to increase by 1.95°C by 2050
- Annual mean maximum temperature in post monsoon season is likely to rise by 1.75°C by 2050, where as in winter season, this will rise by 1.85°C



- Annual mean minimum temperature during post monsoon season is projected to increase by  $2.85^{\circ}\text{C}$  by 2050
- Hot days and warm nights may increase
- Mean annual rainfall is projected to increase by about 8-12 %
- Mean monsoon rainfall will increase by 70-90 mm by 2050
- Most of the increase will occur in the monsoon period.
- Extreme rainfall events may increase by 10-25 % by 2050



## **In this section**

- 8. Vulnerability Risk Framework
  - 8.1 Rainfall Variability
  - 8.2 Temperature Extremes
  - 8.3 Humidity
  - 8.4 Natural/Topographical
  - 8.5 Behavioral/Social
  - 8.6 Basic services
  - 8.7 Major Shocks and Stresses



## 8. Vulnerability Risk Framework

Disaster and Climate Change variability risks is recognized as a consequence of interaction between hazard and the characteristics that make people and places vulnerable.

It has been observed that climate risk in Patna results from the complex interaction between development processes that generate conditions of exposure and vulnerability. Patna is experiencing unplanned infrastructural development and the ill effects of climate change are further exacerbating vulnerabilities, with grave consequences, especially for children. The impact of such hazards also depends on the natural systems of the city, like vicinity of the city to rivers, topography, low slope gradient and high ground water table. The role of communities and their behavioral dimensions too play an important role. Lack of awareness, low level of civic discipline and social

discrimination are some of the factors which enhance the vulnerability of the city as well as its people.

Lack of adequate planning and effective enforcement of rules and regulations increases the vulnerability of the city, which needs proper awareness. The current actions, existing plans, policies and procedures are not at par to be able to tackle the impact of climate change. All these need to be adapted and plans to be adjusted to factor the current context. Climate change impacts have the potential to affect all the city departments and service deliveries. This is why it is imperative that the city government take an undivided interest in planning to adapt to climate change. At the same time, a strong political will can only strengthen the planning and implementation processes.

Based on inferences gathered from the interaction with children, community members and stakeholder

### CLIMATE RISK FRAME OF PATNA

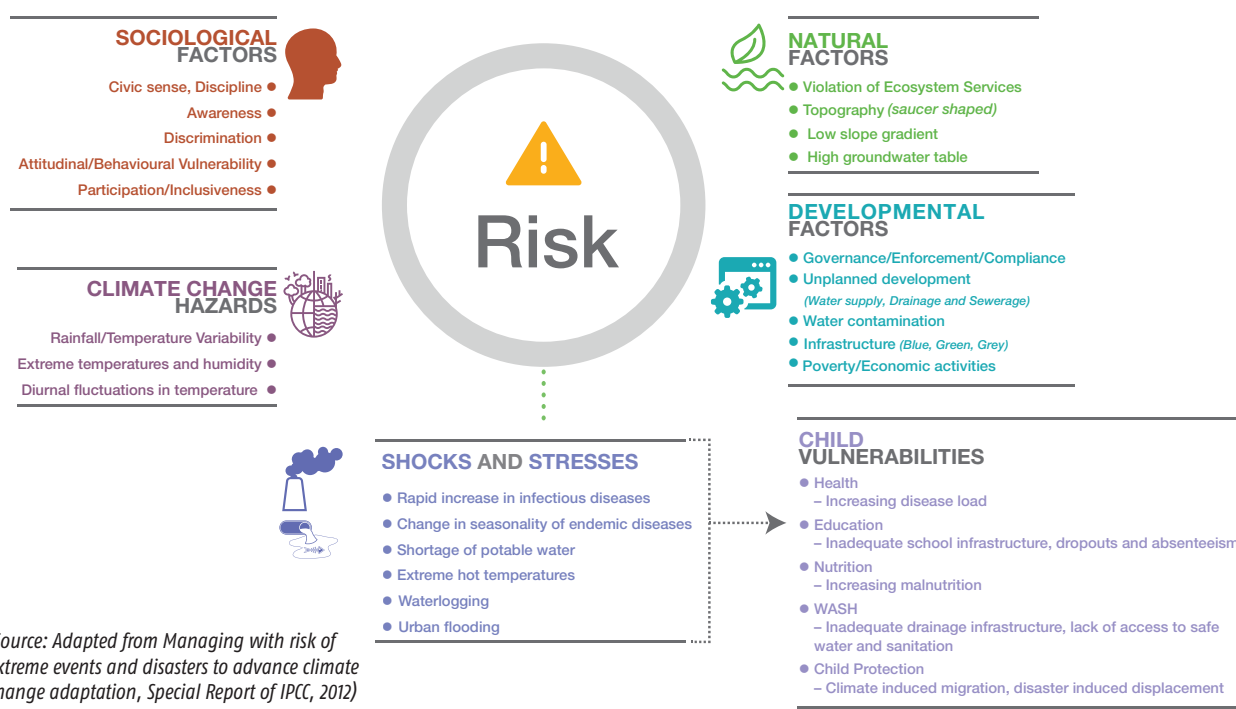


FIGURE 12 : CLIMATE RISK FRAME OF PATNA



consultation, a Climate Risk Frame (Figure 12) comprising of key shocks and stresses of the city which are impacting urban poor children in Patna, has been identified.

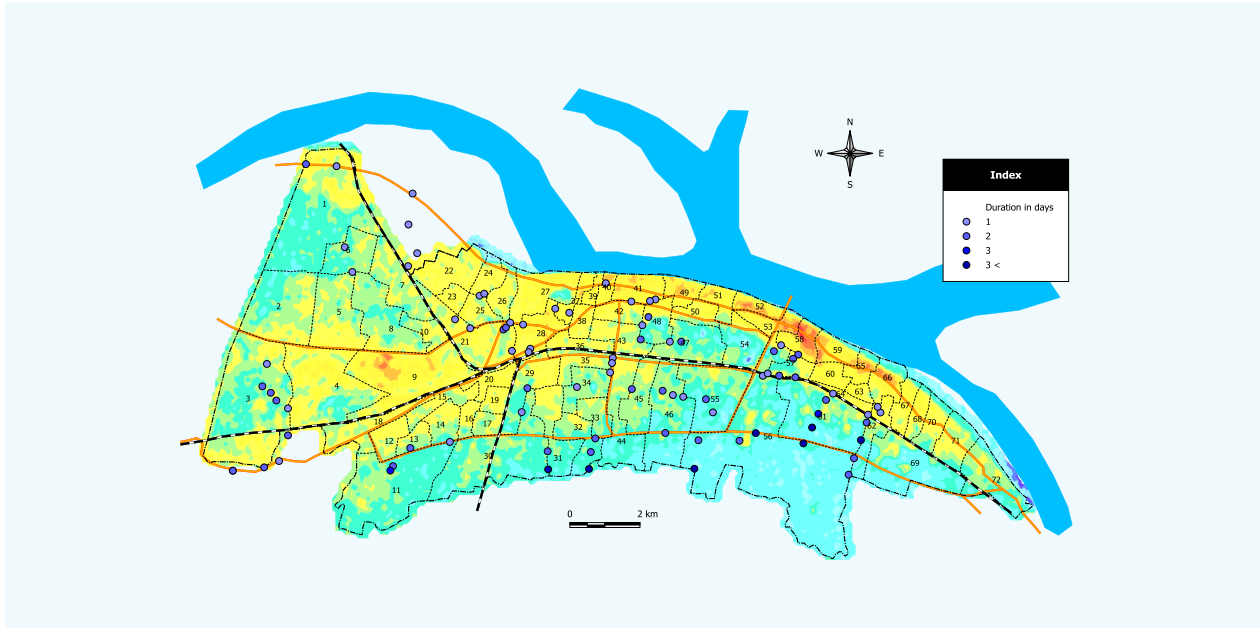
## 8.1 RAINFALL VARIABILITY

The major climate change variability as observed in the city is rainfall variation. The historical data, climate projections and consultations explain that incidences of intense rainfall are increasing. The decrease in rainfall and shifts are other aspects enhancing risks of the city.

In a situation where Patna has three rivers in its vicinity, and large areas in the city are low lying (Patna is known as saucer shaped city) with low slope gradient, there is a tendency of waterlogging. Haphazard development without adequate drainage consideration has amplified the problem and the city is not even able to deal with 60 mm rainfall in 24 hours. There are indicators that incidence of more than 60 mm rainfall will increase in putting Patna to further future risks. The participatory GIS Mapping of waterlogging in Patna urban areas based on different thresholds of rainfall events was

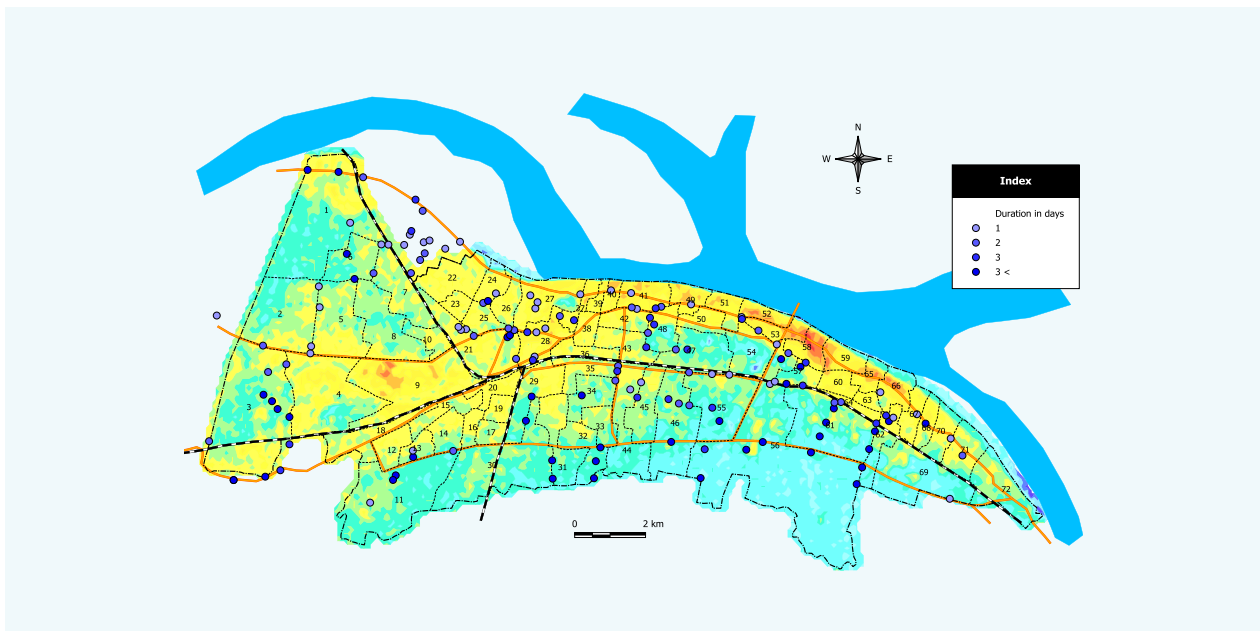
developed. In this process, three scenarios of rainfall events (64-80 mm, 120-150 mm and above 180 mm) of past events were taken into consideration to identify the waterlogged areas in the city. Apart from this, as mentioned earlier in the climate section, the heavy rainfall events over Patna urban area are increasing, the spread of waterlogged areas is also increasing. Thus, based on the scientific data from authentic sources and community's recall about the waterlogging events, the waterlogged points and its spread have been identified (Map 6,7,8 and 9). The problem is not limited to rainfall timing; the waterlogging period and areas have also increased in the last few years with more incidence of water entering houses, particularly in localities where the poor live and in other low lying areas. With a reduction of the number of water bodies and green/open spaces in the city, the water holding capacity, both at micro/local level and city as a whole has enormously decreased, resulting in waterlogged conditions and over spilling of open drains, because of which water stays on streets and in the houses up to 7-8 days and even more in some of the regions. Children and women are specifically vulnerable in such situations.





(Source: Primary Survey Analysis)

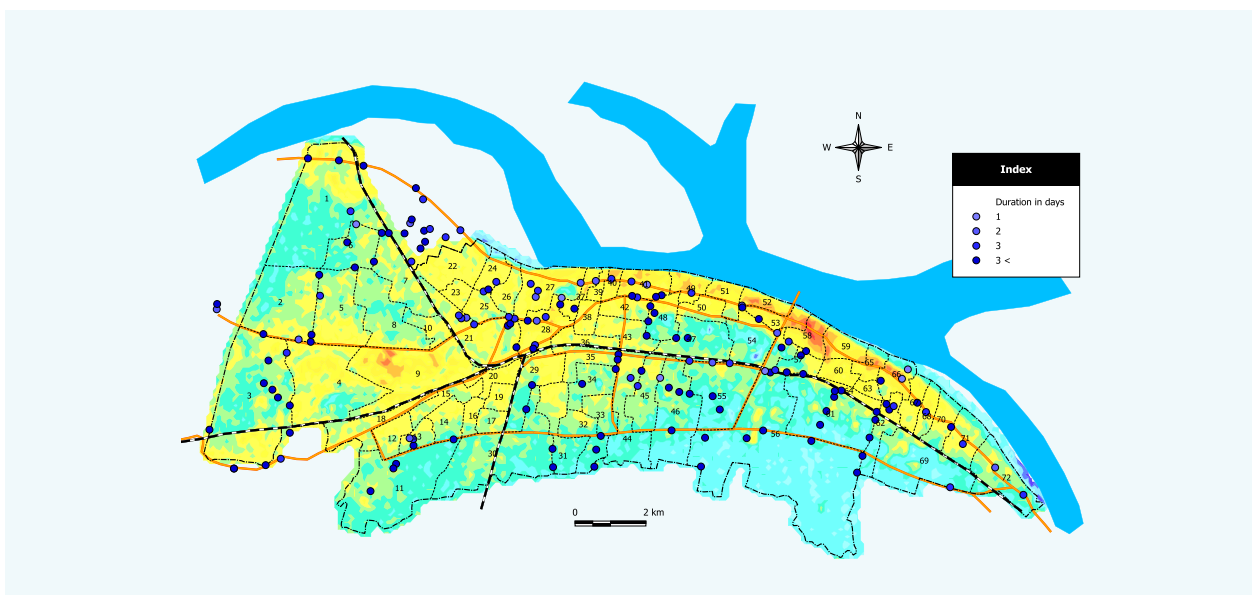
**MAP 6: WATERLOGGING SITUATION UNDER 60-80 MM OF RAINFALL**



(Source: Primary Survey Analysis)

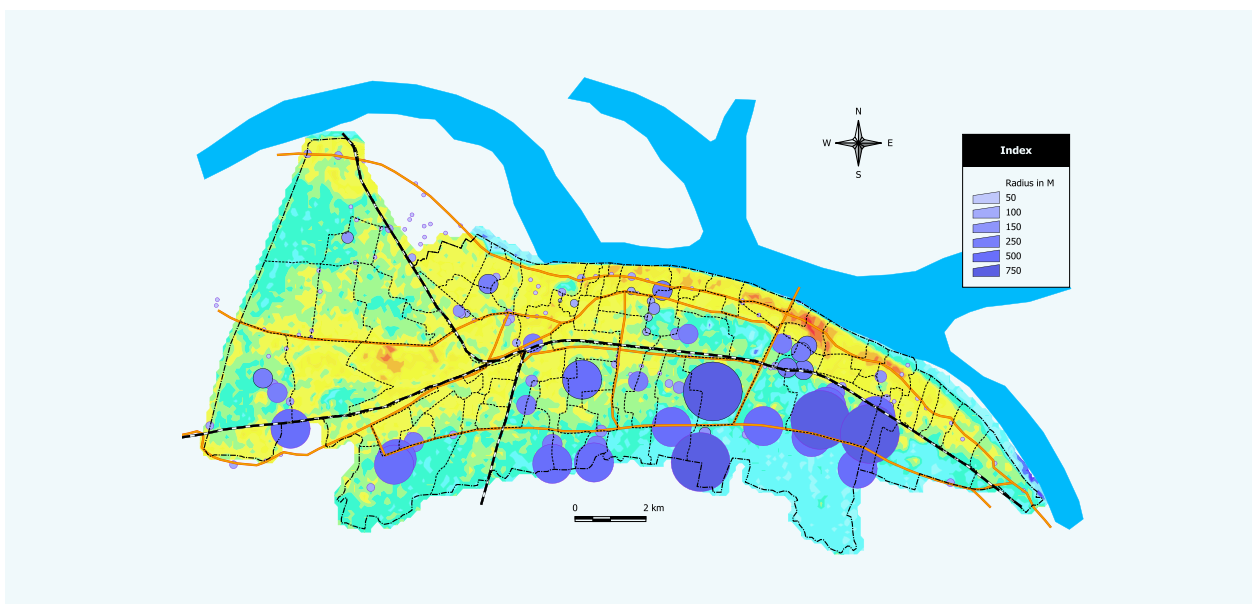
**MAP 7: WATERLOGGING SITUATION UNDER 120-150 MM OF RAINFALL**





(Source: Primary Survey Analysis)

**MAP 8: WATERLOGGING SITUATION UNDER 180 MM AND ABOVE OF RAINFALL**



(Source: Primary Survey Analysis)

**MAP 9: TOPOGRAPHY AND SPREAD OF WATERLOGGED AREA**

Water entering the houses completely disrupts the poor communities (including slums). The daily activities of women take a beating, and in most areas inhabited by women a loss of daily wages and inability to cook food and so leave the family hungry, were reported. There are also large numbers of schools inundated during intense rainfall events resulting in their closure. Walking on roads in these localities also gets disrupted for varying duration.

The implementation of mandatory provisions like rainwater harvesting can help in this direction but

such directives are largely ignored even in government buildings. The city not only has inadequate drainage, but also limited sewage systems, open drains and lack of solid waste management systems. The toilets in slum and dense areas are not connected to drains. These factors cause accumulation of contaminated water in different locations, for a longer duration, providing ample breeding spaces for mosquitoes, while its seepage and mixing with shallow ground water tables, leads to adverse health outcomes.

## 8.2 TEMPERATURE EXTREMES

The historical climate data analysis and future projections suggest that although the city is gradually moving towards an overall average higher temperature, events of extreme temperatures are on the increase in both summers and winters.

The increase in summer temperature has started affecting people of Patna. The sudden increase in use of air conditioners by urban elites and commercial houses has increased the use of power, based on fossil fuel. The reduction in green and open areas and shrinking water bodies has created situations for heat islands in the city. The city though has recently developed a Heat Action Plan, which strongly demands attention.

The incidents of heat strokes have increased in the city, particularly in the low-income population, who are engaged in outdoor livelihood activities (laborers, street vendors etc.). The lack of open and green areas also restricts some respite for such population especially during intense heat hours during the day.

Energy efficient/ Green building norms are rarely adopted and houses have insufficient ventilation provisions. This affects all occupants, especially the women and children not only during the day, but in nights also, causing sleeplessness and stress.

The low temperature extremes are also affecting citizens particularly those who belong to the low income groups. The temperature variability has also resulted in situations where the duration of temperature regime between 10-20 °C has increased, which is congenial for mosquito breeding. In a city, which has inadequate sewerage, drainage and solid waste management, the sewage water accumulation is increasing in different localities providing ample breeding space for mosquitoes. These ultimately lead to an increase in waterborne diseases, particularly in weaker economic groups and children who are exposed to such situations. The number of cold days and cold waves has also increased in the city.

## 8.3 HUMIDITY

The climate data also indicates the shift of Patna towards a more muggy climate, where inter play of temperature and humidity creates situations which are more problematic. On one hand, where lack of



**The number of days above 40 Degree Celsius in the city has increased significantly**

ventilation provision, especially in poor households, results in an un-livable situation in the small/one-room houses, on the other communicable diseases are also on rise in these urban areas. The period of extreme humidity has also increased, and more months and days face humid situations compared to the past. Communities explain how vector-borne diseases have now spread to the months of February-March and October-November.

## 8.4 NATURAL/TOPOGRAPHICAL

The city is naturally vulnerable due to its geographical location. Low-lying areas, surrounded by major rivers, low slope gradient, high groundwater table, saucer-shaped terrain and infrastructure based on such natural conditions accentuate its vulnerability.

## 8.5 BEHAVIORAL/SOCIAL

The city has strong linkages with rural areas and a large floating population comes to the city for daily wages, which comprises mainly of lower middle-income group and has a low level of literacy. There is a lack of responsible behavior towards the up-keep/maintenance of city's services. Lack of ownership, in general, in the people of the city is also a limiting factor, which enhances vulnerability.

## 8.6 BASIC SERVICES

Patna has been, and is continuing to experience unplanned and haphazard development leading to highly congested pockets in the cities. The rampant development of grey infrastructure without proper planning along with encroachments on blue and green infrastructure (open, green spaces) is increasing the vulnerability of the city manifold. Further, lack of proper enforcement of Master Plan, poor governance mechanisms and administration of basic services are some of the key issues enhancing the city's vulnerability. Needless to mention, the impact of climate change are only exacerbating the vulnerabilities on provision of basic services to the urban poor, with the children as the prime sufferers.

## 8.7 MAJOR SHOCKS AND STRESSES

All the above factors are contributing and enhancing climate risks in city, giving rise to several shocks and stresses, ultimately rendering serious vulnerabilities to the people, especially those who are marginalized and live in fragile settlements of the city. The types of shocks that the city faces due to climate change are urban flooding, waterlogging in new areas due to extreme rainfall, sunstroke, and sudden increase in diseases such as Dengue, Chikungunya. Due to these shocks, people of the city have to bear different types of stress. Interaction with the community and other key stakeholders of the city asserted that stresses induced by the shocks manifested in the form of accidents – physical, mental and financial.

While analyzing different stresses on the basis of their effectiveness and recurrence, it was deduced that some forms of stresses occurs repeatedly but their impact is less, while there are some whose frequency is less but their impact is greater on people, especially on the children of a younger age. For instance, in extreme summers, children are affected greatly and as a result, the financial stress increases on their parents.

Shared Learning Dialogues also revealed the following stresses experienced due to climate change:

- Unexpected expenses of rehabilitation
- Increase in prices of food grains
- Debts rising among farmers
- Women and children becoming more vulnerable to extreme hot temperatures
- Traffic congestion due to waterlogging
- Increasing frequency of road accidents due to dense smog during winter
- Water table goes down during extreme summers
- Risks of house collapsing
- The advent of harsh summers creates hindrances for children's education as most of the schools are not equipped with fans
- The problem of shelter for homeless people during winters
- Decreased working capacity due to extreme heat
- Shortage of potable water during summer
- Increase in expenses on treatment of diseases during summer



The aforementioned shock and stresses are caused by different factors. The stakeholder consultations were very helpful in comprehending the sub causes of these shocks and stresses and how these affect the city's infrastructure and basic services. The key stakeholder

interaction revealed the following eight sectors that are playing a vital role in generating the causes of shocks and stresses in the city. The causes and the related sectors are listed below:

**TABLE 6: CAUSES OF SHOCKS AND STRESSES**

Causes of Shocks and Stresses	Sectors Affected
<ul style="list-style-type: none"> <li>▪ Lack of solid waste management</li> <li>▪ Shortage of toilets in slum areas</li> <li>▪ No compliance with technical standards in the setup of the drainage system</li> <li>▪ Poor enforcement of Master Plan</li> <li>▪ Encroachment over flood plains</li> <li>▪ Longer exposure to high temperatures during the day</li> <li>▪ Conducive environment for mosquito breeding due to water clogging</li> <li>▪ Decrease in the number of trees/open spaces</li> <li>▪ Behavioral issues and habits</li> <li>▪ Encroachment upon drains</li> <li>▪ Indiscriminate use of polythene</li> <li>▪ Open defecation</li> <li>▪ Lack of functional drainage system</li> <li>▪ Lack of storm water management system</li> <li>▪ No other alternative for secure drinking water from shallow underground water sources</li> <li>▪ No proper action for nutrition provision in city areas</li> <li>▪ Lack of awareness among people regarding WASH</li> </ul>	<ul style="list-style-type: none"> <li>▪ Solid Waste Management</li> <li>▪ Drainage</li> <li>▪ Sewerage</li> <li>▪ Drinking Water</li> <li>▪ Sanitation</li> <li>▪ Public Health</li> <li>▪ Housing</li> <li>▪ Ecosystem/Water bodies</li> </ul>



## **In this section**

### 9. Urban Systems Analysis & Sectoral Vulnerability

- 9.1 Solid waste management
- 9.2 Drainage
- 9.3 Sewerage
- 9.4 Drinking Water
- 9.5 Sanitation
- 9.6 Public Health
- 9.7 Housing
- 9.8 Ecosystem/Water bodies
- 9.9 Peri-Urban Agriculture
- 9.10 Governance





## 9. Urban Systems Analysis & Sectoral Vulnerability

Climate impact assessment of urban systems helped to assess their fragilities with respect to the climate impacts identified earlier. These urban systems include the core systems such as water, sewerage, solid waste, drainage, etc. which are essential for running a city, and the secondary systems such as public health, sanitation which rely on the core systems. This chapter details out the vulnerabilities of each of the identified urban systems in the context of climate change impacts that the city of Patna is experiencing. Each sector focuses especially on the vulnerabilities of children. Before going into the sectoral vulnerabilities, an analysis of the status of wards in terms of the presence of basic amenities was done using the Census 2011 data. Figure 13 is the matrix depicting the status.

In this analysis, the condition of the houses, sources of drinking water, availability of toilet and situation of wastewater management has been taken into account.

- In terms of the condition of houses, southeastern Patna has more slums like situation. In nine wards (9, 21, 27, 56, 57, 61, 68, 69 and 72), more than 50 per cent housing condition are not good, people live in slums like situation. In ward numbers 9, 19, 21 and 56, more than 10 per cent houses are in a dilapidated condition.
- Availability of safe drinking water is also a serious issue in the city. Western and southwestern Patna has poor access to treated drinking water facilities. The ward numbers 1, 2, 3, 5, 6, 7, 10, 11, and 30 have poor access to treated water. Majority of households in this region have their own borehole.
- Access to toilet or having a toilet in housing premises depicts the level of awareness about sanitation in a city. In Patna, more than 20 per cent households defecate in the open. The spatial analysis of households having toilet facilities in their house depicts that the ward numbers 1, 2, 3, 9, 21, 56, 68 and 72 have poor accessibility to toilet. In these wards, more than 30- 40 per cent households

do not have toilets and defecate in open. The situation of wastewater management in the city is pathetic. In Western Patna, in ward numbers 1, 3, 5, 9 and 11, more than 50 to 60 per cent area do not have drainage facilities. In southeastern part, the situation of wastewater management is not good.

### 9.1 SOLID WASTE MANAGEMENT

Solid waste management is a serious problem for the city. The city does not have its own organized structure for proper solid waste management as per the norm of MSW Rules, 2016. The Patna Municipal Corporation has divided the city into four areas (New Rajdhani area, Kankarbagh area, Bankipur and Patna city) for the purpose of solid waste management. The city generates about 1000 metric tonnes of solid waste per day; but has the capacity to dispose only 65 per cent of the total generated solid waste. The rest 35 per cent of waste remains un-disposed and lies on the roads.

**TABLE 7: PRESENT STATUS OF SWM SERVICES UNDER PMC**

Service	Present Status
Total Waste Generated	Approx. 1000 MT/day
Total Waste disposal	65%
No. of Vehicles	127 Tractor Trolley 386 Hand Carts
No. of Trips	2 per day
Disposal Site	Ramchak Bairia
Type of Disposal	On Roadside
Agency Involved	PMC, A2Z Infra Pvt. Ltd.
No. of Dustbin	1639

(Source: PMC)

It was also deduced from the community during the interaction, that during the transportation of waste, bits of waste from the truck and tractor keep falling on the streets, which results in dirty streets and creates unhealthy conditions for the children who often play on the roads. It is important to note here that the majority

Ward No			Main Source of Drinking Water				Location Within premises	Number of households having latrine	Waste water outlet connected to		
	Good	Dilapidated	Tapwater from treated	Tapwater from un-treated	Handpump	Tubewell/Borehole			Closed drainage	Open drainage	No drainage
8	12	14	72	73	76	77	82	91	106	107	108
0001	65.5	2.3	9.6	6.5	47.7	26.5	75.1	83.8	36.7	35.1	28.2
0002	85.4	3.9	19.9	14.3	7.2	56.9	93.3	93.7	82.9	7	10.1
0003	64.6	9.2	9.9	5.8	49	32.8	82.5	78.1	34.1	38.9	27
0004	66.7	8.7	51.6	3	17.1	25.5	79.5	85.8	53.5	33.6	13
0005	77.3	3.2	32.6	6.5	5.3	54.3	91.4	92.6	87.8	10.8	1.4
0006	78.7	1.3	5.1	4.9	14.3	74.4	96.5	98.7	66.9	9.5	23.6
0007	86	0.7	20.6	10.1	6.5	62.5	96.7	98	91.6	8.2	0.2
0008	74.4	1.8	66	7.4	0.7	25.2	90.1	92.8	78.1	21.2	0.7
0009	30.4	22	41.8	19.5	28.1	9.9	56.9	58.7	35.7	36.7	27.6
0010	76.3	4.8	20.4	14.2	16.3	47.3	88.8	90.1	51.8	29.6	18.5
0011	71.8	4.5	5.8	3.9	40.1	44.8	88	87.3	24.6	39.2	36.3
0012	70.3	4.2	31	19.1	17.4	30.3	91.9	95.4	83.3	12.3	4.4
0013	75.1	2.6	22.2	1.5	22.7	50	91.6	96.8	59.4	28.3	12.3
0014	79.8	2.9	37.6	11	10.6	39.5	91.8	96.4	72.4	19.9	7.6
0015	68.2	4.9	51.3	11.8	3.6	30.5	90.6	93.6	69.9	27.1	3.1
0016	75.4	1.7	49.3	11.6	6.3	32.2	99	99.2	83.4	13.2	3.4
0017	75.2	3.8	27.9	6	14.8	46.8	90.9	97.7	67.7	18.2	14.1
0018	77.5	2.1	33.7	31.7	3	30.5	95.3	98.8	93.1	6.5	0.4
0019	57.7	10.7	55.1	28.7	7.8	7.8	81.7	80.8	67.7	25.2	7.1
0020	77.6	2	30.6	12	3.9	52.8	96.3	95.9	91.4	7.6	1
0021	48.4	13.3	48.2	18.7	23.6	8.6	62.2	64.9	65.5	24.5	10
0022	87.2	1.8	43.8	12.3	1.8	41.6	97.9	99.3	91	8.7	0.3
0023	90.1	3.6	48	10.8	0.9	39.6	98	99.4	92	7.7	0.3
0024	75.3	4	70.6	4.9	3.4	20.8	91.4	97.6	77.8	20.1	2.1
0025	83.1	0.6	51.9	11.4	0	36.5	95.5	99.4	87.6	12	0.4
0026	71.7	6.4	59.6	12.1	10.4	16.6	91.4	93.7	84.8	13.9	1.3
0027	49.1	9.3	69.3	11.2	5.6	13.5	84	86.8	79.7	15.8	4.4
0028	89.2	1.4	64.6	2.9	0.3	31.9	97.3	96.3	94.7	5.1	0.1
0029	73.8	2.7	47.1	11.9	3.7	35	93.9	96.2	80.8	17.2	2
0030	87	1.7	7.8	6.8	30	53.1	94.2	96.8	32.5	42.3	25.3
0031	72.8	1.6	31.5	19.4	14.2	34.1	97	99.2	80.8	11.8	7.3
0032	61.4	1.5	19.8	11.2	26	37.8	91.4	95.7	73.6	10.8	15.6
0033	78.4	1.6	50	14	6.7	27.9	93.8	96.8	90.8	8.2	1.1
0034	66	6.2	67	4.1	1	24.9	96.3	95.6	86.6	8.9	4.5
0035	68.3	1.9	35	7.2	2.3	52.9	92.6	97.2	93	5.6	1.4
0036	61	3.3	63.9	11.4	6	16.6	91.7	95.5	90.3	8.5	1.2
0037	80.7	5.1	58.6	27	0.7	12.8	92.7	94.4	85.7	13.6	0.7
0038	78	1.6	59.4	21.7	1.9	16.2	93.3	98.6	92.6	6.5	0.9
0039	64.8	5.5	72.4	19.2	0.2	7.2	84.1	94.8	91.5	4.5	4
0040	70.8	2.4	75.7	18.3	0.1	5	95.3	98.3	85.4	14	0.6
0041	59.4	5	69.5	8.2	1	20.9	87.6	94.9	85.2	13.9	0.9
0042	77.4	3.5	67.2	11.5	2	18	94.1	97.6	88.9	10.3	0.8
0043	80	4.2	63.7	6.4	2.6	26.2	91.3	96.3	93.6	3.7	2.7
0044	80.6	2.3	45	7.6	5.8	40.7	95.7	97.7	88.7	6.9	4.4
0045	83.8	1.4	43.9	1.3	4.3	50.1	96.7	98.1	97.9	1.1	1
0046	57.7	5.8	44.5	2.2	8.3	39.9	90.7	92.8	76.5	17.6	5.9
0047	78.7	2.8	39.4	3.8	5.3	46	88.8	93	77.2	12	10.8
0048	63.2	4	73.4	13.9	4.4	7.8	92.5	92.4	48.3	51.3	0.4
0049	59.7	8.6	59.2	36.5	0.8	2.4	88.4	93.6	73	24.4	2.6
0050	67.9	3.9	71	14.1	2.5	7.8	89.8	96.6	75.9	22.1	2
0051	65.6	3.6	58.7	15.8	13.3	10.5	83.6	93.3	66	29	5
0052	54.9	7.3	73.3	19.3	4.2	1.7	81.9	94.9	42.7	53.5	3.8
0053	62.1	6.3	73.9	17.6	1.4	3.2	84.2	91.8	63.3	29.5	7.2
0054	67.6	5.2	46.6	11.5	8.2	27.5	88.9	94.8	58.7	33.3	8
0055	84.1	1.3	42.8	1.2	14.8	38.9	89.4	91.7	55.2	21.9	22.9
0056	47.3	9.7	24.8	6.6	35.4	15.2	62.6	73.3	37.8	48.5	13.6
0057	50.6	4.1	65.2	17.8	4.9	4.9	74.1	84.8	50	45.5	4.5
0058	61.9	5.7	67.5	14.8	6.5	6.4	90.5	96	51.3	47.6	1.1
0059	63.4	7	69.3	23.5	2.7	0.7	83.7	91	64.6	30.7	4.6
0060	65.2	4.6	62.5	9	14.1	12.3	91.7	95.9	45.7	52.7	1.6
0061	44.7	6.1	69.2	10.2	8.8	1.2	76	82.6	19.8	68.8	11.4
0062	60.2	5	73.5	14.8	5.3	1.3	91.3	95.8	42.9	48.6	8.5
0063	71.1	3.7	66.8	19.8	6.9	4.2	93.6	98.2	57.9	40.9	1.2
0064	68.6	3.8	62.4	17.3	11.6	5.8	92.6	95.8	70.1	29.2	0.7
0065	57.9	6.8	77.9	12.9	4.3	2.1	91.2	95.9	56.5	39.7	3.8
0066	71.9	5.1	62.6	23.6	5.5	6.2	90.5	97	58.2	40.3	1.4
0067	64.7	4.9	56.4	25	5.1	5.6	84.6	95	45.7	52.2	2.1
0068	41.4	12.1	32.9	15.7	16.3	4.7	56.2	75.8	29.7	48.2	22.1
0069	47.6	8.8	69.6	18.2	4.4	2.8	71.4	84.3	39	50.5	10.5
0070	60.3	3.6	80.6	4.1	4.6	2.7	81.8	93.5	46.3	49	4.7
0071	57.6	4	65.7	6.8	9.1	2.2	75.1	88.8	34.3	59.2	6.4
0072	44	9.4	46.7	21.3	18.3	1.3	46.5	68.2	13.8	54.4	31.8
0074	63.4	3.4	46.6	12.4	18.4	16.5	86.1	92.1	72.5	23.1	4.4

Legends: Dark Red denotes worst condition; Green denotes good condition

FIGURE 13: WARD WISE PRESENCE OF BASIC AMENITIES

of the waste collected from the city is dumped at the dumping ground without any segregation or treatment. The dumping ground is located 22 km away from the city on the Patna – Jahanabad road, on 80 acres of land in Ilahibagh Vairiya, which the Patna Municipal Corporation has acquired for waste decantation. It is important to note here that a large majority of people reside in the vicinity of this dumping ground, and they have to deal with various problems. During the summer season, the municipal corporation staff burns the waste which creates acute air pollution in the area. Children living in these areas were found to have multiple health problems like respiratory diseases, skin diseases, etc.

Even though there are around 870 waste collection centers inside the city as well as around 550 containers, and there is a provision for secondary collection centres, but in the perspective of the present

population, this is insufficient. As a result, unauthorized open collection centers are visible all over the city where people dump the waste generated from their households. In the event of extreme temperature rise and heavy rainfall, the problem accentuates because:

- As a result of increase in temperature, the waste lying in the open decomposes quickly and it increases health related problems in the nearby areas, creating a suitable atmosphere for various diseases. Mosquito breeding happens faster and quicker leading to Dengue and Chikungunya cases, which is quite rampant in children.
- Intensive rainfall (rainfall above 64.5 mm) creates greater conditions of waterlogging which quickly pollute both underground and shallow water, thereby increasing health related problems.



(Solid Waste Management in Patna, Picture Credits: Manoj Kumar Pandey)



If we analyze the area conditions, then all the wards in the city are stricken with this problem but if we look at it from the perspective of the impact of climate change then out of total 72 wards, 63 wards are more vulnerable to waterlogging due to their geographical location, population pressure and basic infrastructure/ services. The detailed description is given below –

**TABLE 8: PROJECTION OF WASTE GENERATION UNDER PATNA MUNICIPAL CORPORATION**

Year	Population	Waste Generation (in Mt.)
2011	1811000	634
2015	2401024	840
2020	2936501	1028
2025	3591414	1257
2030	4392407	1537

(Source: CDP, Patna 2006)

## 9.2 DRAINAGE

Due to its bowl-like shape, Patna is facing the problem of acute waterlogging. During monsoon, when the water increases in the nearby-located Ganga, Punpun and Son rivers, waterlogging in the city also increases. Floods affect the southern side of the railway line that

- The eastern zone comprises primarily of the old city areas and the drainage facility is not very good in this area. As this area is an old settlement and is riddled with narrow lanes, this proves to be a hindrance in setting up a smooth drainage system.



**TABLE 9: DESCRIPTION OF PUMPING STATIONS**

S No.	Description	Quantity
1	No. of pumping stations operated by the Bihar State Council	35
2	No. of seasonal pumping stations	8
	• 6 pumping stations are situated at the bank of Ganga river which are operated when the water level rises in Ganga.	
	• The remaining 2 pumping stations (Pahari Old and Pahari New) are operated to keep the water level of Saidpur and Kankarbagh nala low.	
3	No. of electric pump sets operated under Bihar State Council	74
4	No. of diesel pump sets operated under Bihar State Council	20
5	No. of electric pump sets operated under Patna Municipal Corporation	23
6	No. of diesel pump sets operated under Patna Municipal Corporation	05
7	Total no. of pump sets operated under Bihar State Council and Patna Municipal Corporation	122
8	Total no. of functional pump sets	120
9	Discharge capacity	8976.67 MLD

(Source: Bihar Rajya Jal Parisad)

goes through the middle of the city. For the purpose of drainage, the city has 460 km of **pucca** drain, 340 km of **kuccha** drain and 1200 km of underground drain. The drainage facility of the city can be analyzed by dividing it into four zones – eastern, southern, middle and western.

- In the southern zone, only Jogipur and Lohia Nagar Housing Colony in Kankarbagh have drainage facility. The other areas in this zone do not have a drainage facility.
- The middle zone is flood prone and Bakerganj Nala, Agam Kuan Nala and Krishna Ghat underground **nala** together with three big **nalas** cross this zone.

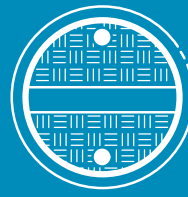
- Due to the low lying ground in the western zone, a number of areas in this zone are affected by waterlogging, and due to this a number of pumping stations of the municipal corporation have been installed here.

From the point of view of drainage, the ward numbers 1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14, 15, 16, 29, 30, 31, 33, 34, 35, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 55 and 56 are the most vulnerable.

Overall, rainwater and sewerage, both do not have an adequate drainage system in the city, which results in increased instances of waterlogging. The areas with maximum waterlogging are Kankarbagh, Rajendra Nagar, Chitragupta Nagar, Mahatma Gandhi LIC Colony and PC Colony. With reference to the drainage system in the city, the causes for increase in conditions of waterlogging are as follows –

- People dump waste from their houses, polythene, debris and inappropriate objects in drains due to which water does not easily flow through it.
- Due to inadequate cleaning services provided by the Municipal Corporation, drains are filled with trash.
- Drains are quite old and decrepit, and are at a much lower level than the city, therefore water does not drain properly.
- The drainage path is obstructed as people have constructed houses on top of the drains.

The proneness to floods and waterlogging, due to its topography and dumping of solid waste in the drains makes the city vulnerable for the health of the children. The water and vector borne diseases occur more in children. Cases of diarrhoea, hepatitis, malaria, skin, and respiratory diseases are quite common amongst them. The increasing waterlogging, contamination of water due to sewage and stagnated water, inadequate treatment and filtration facilities, are some of the factors which contaminate drinking water thereby causing health problems. Poor awareness in citizens and inadequate health services add to the problem of health in children. The inhabited locations of economically weaker groups exposed to waterlogging, open sewage drains, and solid waste dumping increase their vulnerability, particularly that of the children.



**224.6 MLD sewerage is generated in the city per day which may reach 551 MLD by 2020**

### 9.3 SEWERAGE

The city has its own underground sewerage system and it is divided into six zones. Presently, Patna has four sewerage treatment plants and there is a plan to connect six locations to the sewer network. As per official records about 62.51 per cent households have a toilet near the source of water in the house, 20.37 per cent households have a toilet with a pit and 9.01 per cent of population practice open defecation.<sup>xvi</sup> In the light of the Bihar State Water and Sewage Council Act, 1979, the Patna Water Council was established in 1981 for the administration of the sewerage system in the city. According to the Water Council, there is a 24 km long sewer pipeline in the city. Only 20 per cent of the houses in the entire city are connected to the underground sewer. 80-85 per cent of the families use a septic tank and a cost effective toilet, which pollutes the underground water. The water supply line and the sewerage lines follow the same path. Due to the wear and tear of the pipelines, the water from the sewerage line enters the water supply line, thereby polluting it.





In the Municipal Corporation area, there are only 21 public toilets. According to the Census 2011 figures, 224.6 MLD sewerage is generated in the city per day and it is estimated that by 2020, this figure would have reached 551 MLD. If we talk about slums, then according to a survey carried out by DFID in 2007, there were total 107 slums in the city and this number would have definitely increased by now. In these slums, one can find toilet services on and off. On the basis of the above analysis, the sewerage system in the city is simply not enough for the population residing in the city or the population regularly coming in and going out of the city.

On the basis of this analysis, it can be said that the ward numbers 11, 12, 13, 14, 15, 16, 28, 29, 30, 31, 34, 38, 44, 46, 51, 52, 53, 54, 55, 57, 58, 60, 61, 63, 66, 68, 69, 70, 71, 72 of the city are extremely vulnerable in terms of sewerage.

Considering existing sewerage situation, it can be safely assumed that as the city of Patna is expanding, unauthorized construction is increasing in the city, there is encroachment upon the natural watercourses for the purpose of construction, and this will lead to unavoidable conditions of waterlogging in the coming days. The impact of climate change on the sewerage system primarily be seen in three ways –

- In the coming days, because of climate change, the number of extremely hot days will increase which will lead to increased rottenness in the drain water and increase in the number of insects and harmful microorganisms, and the stench will create a negative impact on people.
- There is also a possibility of increase in extreme situations of heavy rainfall in a short period in the coming days, which will lead to an increase in waterlogging. Both the sewerage water and the water from the rainfall will merge and pollute the area, thereby contaminating underground water. There will be an increase in viruses and water borne diseases among humans. This will particularly affect people with low incomes.
- During rains, water from the sewerage spills over onto the roads creating problems in transportation. Children with sensitive skin have higher exposure to infections and they will be more prone to diseases thereby affecting their health.

## 9.4 DRINKING WATER

Provision of drinking water in Patna is the responsibility of the Bihar State Water Council. The main source of drinking water in Patna is underground water. Before monsoons, the average availability of underground water is between 2-8 meters because of which, in many areas of the city, the slums and areas with urban poor population in general, there are multiple shallow hand pumps and the water from these is not fit for consumption. In the entire city area, there are a total of 98 tube wells (11 defective). These tube wells are switched on for around 15 hours per day, and supply water to the city through the medium of a mere 190 kilometers pipeline. In addition to this, there are 30,000 public stand posts and around 23,000 public hand pumps. Despite these facilities, water supply service reaches only 60 per cent of the houses. Consequently, approximately 40 per cent of the houses have water supply through a shallow pump while some houses install a personal pump for their water supply. As a result, whereas the city needs around 215 MLD water per day, it only gets 202 MLDs of water.

- Pipelines laid down in the city for supplying water have leakages at several places which cause a loss of approximately 40 per cent of water and also increase the possibility of pollution. Many pipelines pass right through the middle of the road and as a result, it is difficult to maintain them or carry out repair work, and because of heavy traffic, their capacity of carrying water is also affected. In most of the areas, the pipelines are very old, they are only 10-15 feet under the ground surface, and this creates a problem in getting supply from the main line at the individual family level. In some places, garbage is deposited in the water supply pipelines and due to sudden pressure, they burst causing polluted water from the drain and the drinking water to merge.
- Whereas, on one hand, there is a difference between the demand and supply of water in Patna on the other hand, looking at the conditions of the city, there is a question mark on the quality of the drinking water. According to the Patna Municipal Corporation, approximately 224 MLD of sewage is emitted per day, out of which about half goes straight into the Ganga and the remaining half pollutes the underground water. Even though there are four sewage treatment plants with a capacity of 150 MLD, still only 50 MLD reaches them. It is important to note here that around 20 per cent

of the households are connected to the sewage system and the excrement from rest of the 80 per cent households having septic tanks or cost effective toilets are directly or indirectly polluting the underground water.

- If we analyze the current situation of drinking water in Patna, it is clear that the citizens of the city are bound to drink polluted water. As a result, there is a constant health threat to the citizens of the city and this threat is aggravated for the people living in all the slums of the city.
- Keeping in mind the impact of climate change in the present, the unpredictability of rains and heavy rainfall in a short span of time without any proper water outlet has caused excessive conditions of waterlogging. In such situations, there is an increased possibility of underground water getting polluted by water mixed with dirt and garbage, and there is greater susceptibility to health issues. The citizens in slums settlements do not get water supply and are forced to drink water from shallow hand pumps, obviously the children of these slums in particular are prone to diseases. There is greater possibility of outbreak of diseases like diarrhea and AES in these areas.

**TABLE 10: WATER SUPPLY SERVICE IN PATNA**

Total number of households with direct water supply connection	60%
Total no. of public hand pumps	23,000
Total number of public stand posts including those in slums	30,000
No. of public stand posts in slums	22,000
Total no. of public hand pumps in slums	2,500
Total no. of tube wells	98
Working	87
Not functional	11
Total OHT	23
Average hours of pressurized supply per day to each zone	6 hours
pressurized hours	

(Source: SPUR, DPR Water Supply)

**TABLE 11: YEAR WISE PROJECTION OF PER CAPITA DEMAND IN LPCD**

Year	Population	Per Capita Demand in LPCD	Total Demand in MLD
2011	18,11,000	155	280.7
2015	24,01,024	155	374.3
2020	29,36,501	155	458.6
2025	35,91,414	155	562.0
2030	43,92,407	155	688.8

(Source: CDP, Patna 2006)

## 9.5 SANITATION

As per the cleanliness survey conducted by the Ministry of Urban Development, Government of India in 2016, Patna scored 746 and ranked 70 among the 73 Indian cities surveyed. The cities with points less than 1000 fall in the category of Slow Movers. A member of this category, Patna, needs immediate effort to improve its cleanliness level. A big reason for non-cleanliness and filth in the city is the pressure from its increasing and dense population as well as unplanned development. This is the situation after 70 per cent of the general city population is aware about cleanliness and health. Patna has a total of 1796.23 acres of unplanned land out of 212.82 acres is encroached. This encroached land has services for cleanliness and solid and liquid waste management, sewerage and toilet in an unplanned manner.

There are more than 436 slums in Patna, which do not receive any basic services. 15 per cent of the city's population, which is more than three lakh people depend on shared public toilets as these people do not have a personal toilet and are often left with no choice but to defecate in the open. From this, one can guess the pitiful condition of the public service system. All slums face inadequate cleanliness facilities, poor water drainage system and problems of solid waste disposal. Along with the main commercial areas of Patna, the primary road network is an important part of the informal areas. The slum dwellers and street vendors have occupied the margins of the road, footpaths etc. and have spread over all the urban spaces in the city. Even the community toilets provided in the slums are in a broken condition. Therefore, these toilets are not in use and due to the lack of awareness about health and hygiene among the community, no effort is made to fix them.

Around 3,000 families in Lohinapur slum have two toilets of 10 and 12 units each, out of which an assertive woman from the same slum occupies the toilet with 10 units. She does not let anyone enter that toilet and she has made it into her house. In such a situation, the entire slum is dependent on just that one toilet with 12 units and one can easily guess the situation of open defecation in this area.

*(Source: Community Meeting on 29 July, 2017)*

Presently, in the urban areas of Patna, there are 105 public toilet complexes, which are connected to the sewerage system. In major shopping areas like Ashok Raj path, public toilets are constructed. There are public toilets on Pradarshini Road, Patna Danapur Road, Railway Station, and Bus Stand and in every ward of Patna. There are 28 public toilets under the Danapur City Council, 22 public toilets under the Khagul City Council and 20 public toilets under the Phulwari Shareef City Council. Only 15-20 per cent of the sewage system is covered. Sewage is disposed through the medium of septic tanks and soak pits in the city. Even so, the sewage from the septic tanks goes into the open drains directly and then into the rivers during monsoons.

As per the Water Quality Index, Patna is included in the good zone (73.5 WQI) but Bihar also comes under the areas affected by arsenic contamination. 52 per cent of the people here depend on the municipal corporation tube well for their drinking water. The filth in small lanes, gullies, parks, public spaces and other available spaces is responsible for the outbreak of new diseases in the city. According to data available, if the basic infrastructure likes roads, small lanes, gullies, playgrounds, parks and other public spaces of the city were clean then diseases would reduce by 25 per cent.

## 9.6 PUBLIC HEALTH

Being a capital city, Patna has a good infrastructure of health facilities. It has an AIIMS equipped with state of the art health facilities. The biggest medicine market of Bihar is also located in ward number 41 of Patna. Along with this, the city has a government hospital, two municipal dispensaries, Nalanda hospital and a large number of private hospitals. Interaction with key stakeholders has revealed the following points on public health issues:

- In the last few years, quite a lot of change has been observed in the city's climate. There has been a progressive growth in the number of hot summer

days, which has increased the number of children affected by diarrhea and other diseases.

- Due to increase in humidity, children have been facing respiratory problems.
- People living in densely populated areas of the city where there is no proper ventilation and those living in slums are in particular, grapple with heat and humidity related health problems.
- Because of its geographical structure, the city is faced with the problem of waterlogging. This problem gets aggravated due to the development of unplanned colonies and inadequate drainage system.
- People living in low-lying areas have to wade through waterlogged areas daily, for their means of livelihood. Rickshaw pullers, trolley pushers and garbage collectors in particular have to face the problem of waterlogging due to which they are affected by various skin ailments.
- Children of garbage collecting families are also heavily involved in the work, and during monsoons they are increasingly prone to acne-pimple, rashes, itching and other skin related diseases.
- Due to inadequate sewerage treatment system and sewerage network in the city, the dirty water flows into open drains. In addition to this, the large number of slums present in the city have a shortage of toilets due to which there is an increase in open defecation and because of which, people living in these areas have to face the burden of health related problems.

The health services in the outskirts and slums of the city are merely functioning on hope. Even though there is generally a health center established in these areas, its condition is very shabby. ANM certainly comes on its appointed day but it is not sufficient for the size of the population living in these slums or to the ratio of outbreak of diseases in these areas.

According to the projected climate change figures, there is a possibility of increase in temperatures and conditions of heavy rainfall in short in the coming days. In such situations, there will be an increase in the aforementioned diseases and a spike in new diseases. Additionally, shortage of health centers in relation to the growing population and the dismal situation of availability of medicines and health workers in the present health centers will only make the situation worse.

## 9.7 HOUSING

Increasing population growth and migration from surrounding rural parts has led to unplanned development and construction of residential areas in the flood plain and wet land areas. This is mainly due to the poor implementation of the Master Plan, which is explicitly manifested in the form of dense settlements, hybrid houses, small rooms and cramped lanes. People, particularly women and children, living in small houses with no proper ventilation face respiratory related problems. In slums, child safety, especially that of adolescent girls is also a serious concern. Interaction with Child Line Patna has revealed that most of the trafficking cases are reported from slum settlement areas.

Presently, Patna has 107 slums where more than 25 per cent of the city's population resides. Field visits to these slums revealed that most of the slums have neither living facility nor toilets. Most are settled at the edge of drains. "Shivpuri is one such slum which is located right next to the drain on the land of the railway line going through the city. As it is located on railway land, it does not even have a hand pump for drinking water, let alone a toilet." The municipal corporation provides no service of waste collection in the slums and as a result, the garbage continues to lie on the roads. In some of the slums located next to the drains, the municipal corporation takes out the garbage from the drain and dumps it right in front of the houses in the slums, due to which the health of children in particular gets affected.

## 9.8 ECOSYSTEM/WATER BODIES

Maintaining ecosystems is a prerequisite for the stable development of any city. In Patna, during the last two decades, the ecosystems within and outside the city has been severely affected. Currently, Patna has 42 parks, 67 hectares of globe area and 6.9 per cent of forest cover in the urban and peri-urban areas. In the name of development, trees lining the bypass roads of the city have been cut down rapidly and brick kilns, for the purpose of brick production, have been set up in the peri-urban areas occupying 90 per cent of the agricultural land. Due to the increasing number of brick kilns, the biodiversity of the urban and peri-urban areas has been vastly affected, and consequently influenced the livelihood of farmers, especially the small and marginal farmers, and also created nutritional issues for children. Apart from this, the development of the

city has also affected the existence of water bodies. They are being filled up with garbage or have become receptacles for discharging raw sewage. As per the Master Plan 2030, only one per cent of the area is occupied by water bodies. In Phulwari Sharif, located near AIIMS in Patna, a 17 acre pond has reduced to a mere 3-4 acres. In the community discussion in Phulwari Sharif, it was found that colonies have been developed around the entire pond and the water from all their toilets goes directly into it.

Thus, the biodiversity surrounding Patna has reduced rapidly. As the city is experiencing the impact of climate change, the changes in ecosystems services will further deteriorate the situation of the city and increase the temperature of the city.

## 9.9 PERI-URBAN AGRICULTURE

Peri-urbanisation is a complex process, which is increasing due to land acquisition and rampant city development. The result of this process is not only visible in the peripheral areas of the city but it is also affecting the environment, society and local politics. Similar to other growing cities in India, Patna is also experiencing unimaginable changes in its physical, societal and cultural situation. The total city population is 16.8 lakhs whereas the population in Patna Metro Region is 20.5 lakhs (Census, 2011). In addition to this, the estimated population of daily migrants and floating population like tourists is about two lakh (Poverty Pocket Prediction Assessment, 2009). This kind of population is more deeply stricken with situational and societal stress, due to unplanned urbanization.

Illegal sand and soil mining is happening in the areas near Patna, like the area near the banks of rivers Ganga/Maner, Danapur, Deegha, Alamganj, Kali Ghat, Damki Yahan Ghat, Mahavir Ghat and other regions. The State Level Environmental Impact Assessment Authority (SEIAA) has till now, not accepted the application for mining from any land mining mafia.<sup>xvii</sup> In fact, in 2012, the Supreme Court prohibited any type of mining, until it is approved by the Union Ministry of Environment and Forest.

People in peri-urban areas are farming vegetables on a large scale by the manure, sand and soil brought in by the river Ganga. However, their source of livelihood is in crisis today due to soil mining, as this renders the soil unsuitable for farming. According to Professor R.





K. Sinha, Biology Department, Patna University, due to the large-scale sand mining on the upper bank of Ganga between Maner and Deegha, the water in the northern channel of Ganga is greatly affected. Due to this, the southern channel of Ganga has shrunk and the water from the river has started flowing in the areas of the city.

According to a December, 2013 report by the National Academy of Agriculture Science (NAAS), New Delhi, in 2011-12, a horticulture-related scheme was constituted by the planning commission to promote vegetable production in peri-urban areas. As per the Five Year Plan, 2012-17, a key focus is to develop farming of fruits and vegetables in the peri-urban areas with the main objective to secure nutrition for the people by increasing the output and productivity in the vegetable sector. However, in the areas near the city, there is an increase in the construction of houses on agricultural land due to urbanization pressure. In the community discussion at Phulwari Shareef village, the fact that 80 per cent of the land on which houses were constructed was once used for paddy farming in this area was brought up. Once AIIMS was established in Patna, the population increased rapidly in this area and real estate like Vastu Vihar and other such colonies

started developing in the nearby villages, thereby making it difficult to carry out agricultural activities.

In the peri-urban areas, the garbage and sewage is dumped without any treatment, which pollutes the agricultural land and water bodies in this area and due to this, people are forced to sell their land and move to occupations other than agriculture. In the Master Plan made by the Patna Development Authority, 18.88 per cent land use is marked for agricultural zone so that the livelihood of the people in the village is not affected. Along with the agricultural zone, it is directed not to change the land use of the nearby reservoirs and natural wealth. Despite this, 91.71 per cent of land has been converted into unplanned colonies with no basic services and excessive vulnerability to waterlogging.

If we look at it from the perspective of climate change, then the increasing temperatures and the intensity of the rainfall caused by the rampant development in the peri-urban areas creates further problems. People are even settling in flood prone areas and because of that, there is increased waterlogging in these areas and with adverse impact on agriculture, people are rapidly selling their land and moving away.



## 9.10 GOVERNANCE

In terms of the increasing vulnerability of Patna to climate change, one major cause is its local governance and its methodology. In discussion with various people, the problem of waterlogging came up as one of the main problems in the city. Humans are equally responsible along with the geographical structure of the city for creating the problem of waterlogging. It was clear from the study of the situation of the city that there is no coordination and harmony between the departments responsible for the development of the city. The problem is exacerbated by the lack of coordination among the various departments. Garbage is not collected in a systematic manner within the city, colonies have developed rapidly in the flood plain areas in an unplanned manner and behind all this the lack of political will and administrative perseverance is a major cause in affecting the city's governance. In discussions with various departments, it was clear that climate change is not included as a major issue among the present liabilities. They recognize the problems affecting the development of the city to be solid waste management, drainage/sewerage and unplanned settlements in the city but there is no clear understanding of how climate change will increase these problems in the forthcoming days. Obviously, if there is no priority on climate change and its impact, then there is no question of any adequate technical capacity on this matter within the departments. Along with this, being a second tier city, the responsibility of development is still the onus of government departments here. There is a lack of positive participation between the administration and the society. The main reasons behind this are lack of transparency in the administration and distrust among the society towards the administration, and this hinders active participation between the administration and the society.

Patna Municipal Corporation was established under the Nagar Nigam Act, 1952. After the 74<sup>th</sup> Constitutional Amendment Act, along with the basic framework and urban planning of the city, the power of Patna Municipal Corporation expanded. In terms of administration,

various government departments/agencies work towards the development of Patna. The city can be viewed in terms of five administrative frameworks<sup>xviii</sup> -

- Patna Division – Formed in 1829, a total of six districts come under the Patna Division. These are Patna, Nalanda, Bhojpur, Pohtas, Kaimur and Buxar. A divisional office is also established in Patna.
- Patna District – Patna Police also comes under the Patna District which is responsible for the law and order situation in Patna.
- Patna Metropolitan Region – We also know this by the name of Patna Planning Area. As per notification number 337, dated 13. 08. 2014, Municipal Development and City Housing Department announced the formation of Patna Planning Area.
- Greater Patna and Patna Regional Development Authority Area, which includes Patna Municipal Corporation, and a few other surrounding areas.
- Patna Municipal Corporation Area

The departments under the aforementioned five administrative zones responsible for the development of Patna are Patna Municipal Corporation, Patna Regional Development Authority, Bihar Housing Board, Bihar State Road Transport Corporation, Patna Urban Development Authority, Patna Water Council, City Traffic Police and City Development Department. In addition to this, after the formation of the Municipal Corporation, Patna has developed its own Master Plan since 1962. Presently, the Master Plan 2010-2031 is in effect in Patna.

Looking at the present problems and administrative capacity of Patna, it can be said that there is a possibility of an increase in the number of hot summer days in the future. According to the meteorology analysis, there is also the prospect of rain related extreme weather events in the coming years. In such a situation, problems related to solid waste management, drainage, sewerage and health will get exacerbated and there will be a need to strengthen the city administration and local political will, for a sustainable solution. There is a pertinent need to set up a strong enforcement cell to ensure the implementation of civil services.

## In this section

### 10. Sectoral Vulnerabilities & Impacts on Urban Poor Children



## 10. SECTORAL VULNERABILITIES AND IMPACTS ON URBAN POOR CHILDREN

On the basis of the above mentioned discussion on development and climate change impacts, the vulnerability of children was assessed on five development pillars of children, i.e., Health, Education, Nutrition, WASH and Child Protection. The key impacts on children are summarized in the table below:

**TABLE 12: SECTORAL VULNERABILITIES & IMPACTS ON URBAN POOR CHILDREN**

Health	Education	Nutrition	WASH	Child Protection
Rapid Increase in infectious diseases like Malaria, Dengue, Chikungunya	Due to illness, attendance in school decreases and education is interrupted.	Due to lack of proper arrangement of cleanliness, the absorption of nutrients from the food eaten by the children is not complete, due to which the problems of malnutrition is more in children in such areas.	Due to improper dumping site, the garbage lies unattended and the children play near it; they then eat with the same dirty hands, thereby increasing chances of infection.	Children are engaged in collecting garbage items for sale such as syringes etc., by which the possibility of injury and other types of danger increases.
Increase in respiratory diseases	Children's school is affected due to accumulation of contaminated water in their household and school localities.	Daily waged workers and street vendors are more affected by hurdles due to traffic disruption, and it directly impacts their daily income and livelihood activity. Even their children cannot get clean, hygienic food due to disturbed family incomes and lack of purchasing power.	Inadequate sewerage management pollutes ground water and due to the shallow hand pumps in most areas, cases of water borne diseases are increasing in children.	Children are at a risk of sinking/drowning due to lack of drainage system in the outskirts of the city.
Due to high temperatures, rot is produced, and the surroundings get polluted; And children are affected more as they are the most sensitive to the environment.	Due to schools lying in low land area, waterlogging occurs in the school field and its surrounding area, making school inaccessible to the students.	There is non-availability of work for four to five days due to water accumulation; there is also a problem of healthy food, which affects their nutrition.	Not being able to attend school, children do not get the information related to health and hygiene, which affects their future growth and health.	Especially due to the impact of disrupted livelihoods in slum settlements, people tend to migrate with their family, which affects the physical safety of the children and they tend to fall into unsuitable company and pick up bad habits.
Inadequate solid waste management and garbage filled open drains help spread filthy water all across. Children play and romp in it, increasing their exposure to many types of skin related diseases such as boils and itching.	Easily falling sick, the children are not able to go to school and this directly affects their studies.	Due to the rapid urbanization in the city, farming based livelihood activity is ending, so they are unable to get diverse food and adequate nutrition.	Due to polluted lakes and ponds, groundwater is being polluted, because of which the entire food cycle is disorganized and children face acute side effects.	Children are involved in income generation activities for their livelihood at a very young age.

Health	Education	Nutrition	WASH	Child Protection
Children suffer from viral fever due to the above reason.	Children's education is affected due to illness.	Due to a reduction in farmland, gardens, ponds etc. the cultivation of various livelihoods activities such as fishery, syhada, makhana etc. are coming to an end, which affects a child's nourishment, along with that of the whole family. This increases the probability of diseases amongst the children.	Due to broken drinking water pipelines in slum areas, the potable water gets contaminated with pollutants.	Children living in low-lying areas are unable to go out of their homes for many days due to waterlogging.
Especially in the outskirts of the city, vegetables produced by using dirty water for irrigation get contaminated and this contributes to many diseases.	Due to the presence of shallow hand pumps in the school enclosure, the chances of disease occurring in children are increasing.	Due to non-specific plan for peri-urban areas, due to the indifference of the people towards agriculture, diversification of food crops is ending, which affects the entire family, especially the children.		Children do not have ample space or a proper place to play because of narrow streets near homes.
Due to improper sewer systems, water from the septic tank goes into open drains. In addition, due to lack of toilets in many areas, people defecate in the open, which brings on the onset of diseases among children like diarrhea, typhoid, jaundice, etc., affecting their growth.	School building built in low lying areas are more vulnerable and get damaged in disasters, and until their re-construction occurs the education of children is affected for a long time.	The disadvantaged community is not able to avail benefits of health and nutrition schemes due to the absence of Anganwadi workers and ASHA, in slum area.		The privacy and self-esteem of women, children and men are threatened due to living in narrow and small houses. Bad habits tend to develop in the children.
In many slum areas, there is an increase in infectious diseases in children due to lack of toilets in schools.	There is not enough development of children due to lack of infrastructure in the school such as drinking water, toilets, safety, open playing fields etc.			Due to the rapid growth of the city, migration has increased; farming activity reduced and the children have to work for their livelihood by going out to work at a young age. Children are losing out on their innocence and childhood.
Diarrhea deaths are increasing in children because of drinking water from unsafe source.	Due to lack of adequate arrangement of drainage and sewerage, water accumulation occurs due to which ground water is polluted. The presence of shallow hand pumps in most areas adds to the increase in water borne diseases in children.			
There are many such low land areas, where water gets into homes, which affects the health of children.				

Health	Education	Nutrition	WASH	Child Protection
With farmland, open gardens, water bodies being lost to urbanization, children fail to find enough space to play in, due to which many physical problems are arising in them.				
Due to the lack of health facilities for, both children and women, vaccination cannot be initiated or completed in a timely manner.				
Due to lack of institutional delivery, the possibility of maternal and infant mortality is high.				



## **In this section**

### 11. Resilience Actions



# 11. Resilience Actions

The following table depicts the resilience actions based on children's vulnerability and development deficit in the city.

TABLE 13: CHILDREN FOCUSED CITY RESILIENCE ACTIONS

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/ Programmes	Institutions
Health	<ul style="list-style-type: none"> <li>• Rapid increase in vector-borne diseases like Malaria, Dengue, Chikungunya</li> <li>• Increase in air-borne diseases like asthma, bronchitis, etc.</li> <li>• Skin related diseases such as boils and itching, etc.</li> <li>• Water-borne diseases such as diarrhea, typhoid, jaundice, etc.</li> <li>• Illness due to heat stroke (<i>Loo</i>)</li> <li>• Illness due to cold waves</li> <li>• Increasing bacterial diseases such as pneumonia, T.B.</li> </ul>	<ul style="list-style-type: none"> <li>• Dumping garbage and waste in inhabited areas</li> <li>• Inadequate waste disposal system in residential and public places</li> <li>• Large extent of open and choked drains (indiscriminate polythene use)</li> <li>• Surface/Groundwater contamination</li> <li>• Conducive environment for vector breeding due to waterlogging</li> <li>• Air pollution due to burning of solid waste, increasing traffic congestions</li> <li>• Lack of gas connections for migrants in the absence of identity proofs leads to wood stove cooking which causes fire and air pollution</li> <li>• Unsafe disposal of bio-medical waste</li> <li>• Improper disposal of e-waste</li> <li>• No separate drains for storm water and sewer water</li> <li>• Small, disconnected sewerage accumulation areas getting developed in various locations</li> <li>• Groundwater contamination due to raw sewage dumping</li> <li>• No sewerage system in slum areas and dumping on roads</li> <li>• Open defecation</li> <li>• Lack of safe drinking water</li> <li>• Inadequate health posts in urban areas</li> <li>• Lack of human resources at health posts</li> <li>• Irregular fogging</li> <li>• Behavioural problems – civic sense, personal hygiene, etc.</li> <li>• Poor ventilation in houses, congested settlements especially in slums, etc.</li> </ul>	<p><b>SOLID WASTE MANAGEMENT:</b></p> <ul style="list-style-type: none"> <li>• Develop comprehensive Decentralized Solid Waste Management Plan aligned with Service Level Benchmarking norms; Facilitate 100% door to door collection of waste in the city</li> <li>• Phasing out current dumping grounds, particularly those in the low lying areas of the city</li> <li>• Appoint “<i>Safayi Mitras</i>” at ward level</li> <li>• Need assessment of incinerators to be done for bio-medical waste and their installation</li> <li>• Deployment of adequate human and financial resources for solid waste management and sewerage management</li> <li>• Citizen led (especially children) monitoring systems and actively working “<i>Local Mohalla Samitis</i>”</li> </ul> <p><b>DRAINAGE &amp; SEWERAGE:</b></p> <ul style="list-style-type: none"> <li>• Special cleaning drives for cleaning drains in pre-monsoon period and during the monsoon</li> <li>• Covering the open drains</li> <li>• Banning use of polythene – Prepare a project for plastic recycling and its implementation</li> <li>• Deployment of adequate human and financial resources for solid waste management and sewerage management</li> <li>• Citizen led (especially children) monitoring systems</li> <li>• Strict action on encroachment of drains in dense localities/slum areas</li> <li>• Renovation of existing underground drains specifically in low lying areas</li> <li>• Develop integrated sewerage network for the entire city</li> </ul> <p><b>HEALTH:</b></p> <ul style="list-style-type: none"> <li>• Developing Health Atlas for health risk assessment and preparedness</li> <li>• Develop real time disease surveillance system to monitor and reduce incidences of water and vector borne disease outbreaks</li> <li>• Regular and extended fogging during monsoon/ winter season</li> <li>• Banning the burning of tyres and plastics</li> </ul> <p><b>HOUSING/BUILDING:</b></p> <ul style="list-style-type: none"> <li>• Cool roof technology for resilience against heat strokes in schools, <i>Anganwadis</i>, Health Centres</li> <li>• Awareness and Capacity Building</li> <li>• Community Awareness for behavioural change on SWM</li> <li>• Awareness drives like weekly campaigns like “<i>Chakachak Patna</i>”, educational institutions, hospitals, etc. to be done to keep the city clean</li> <li>• School campaigns on waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Manual on MSW Management 2016, CPHEEO guidelines on solid waste management</li> <li>• <i>Swachh Bharat Mission</i> (Urban), Gol</li> <li>• Waste Plastic Rules, 2016, Gol</li> <li>• Namami Gange</li> <li>• Guidelines of Bihar State Pollution Control Board</li> <li>• SMART City Guidelines</li> </ul>	<ul style="list-style-type: none"> <li>• Municipal Corporation</li> <li>• NGOs</li> <li>• CBOs</li> <li>• Pollution Control Board</li> <li>• Citizen Forums</li> <li>• Media</li> <li>• Concerned Technical Departments</li> <li>• Private Sector</li> <li>• Resident Welfare Associations</li> <li>• National Health Mission</li> <li>• Bihar State Water and Sanitation Mission</li> <li>• ICDS</li> <li>• State Health Society</li> <li>• Private Hospitals</li> <li>• Indian Medical Association</li> <li>• Patna Medical College</li> <li>• AIIMS</li> <li>• Bihar <i>Rajya Jal Parishad</i></li> <li>• Patna <i>Jal Parishad</i></li> <li>• Flood Management Information System</li> <li>• DDMA</li> <li>• DMD</li> </ul>

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/ Programmes	Institutions
Education	<ul style="list-style-type: none"> <li>Absenteeism due to extreme weather events (heat waves, cold waves and excessive rainfall)</li> <li>Absenteeism due to seasonal illness</li> <li>Lack of access to school due to waterlogging and flooding conditions</li> <li>Drop out reasons – seasonal, labour oriented, livelihood loss, distressed migration</li> <li>Behavioural problems – education is not a priority, especially for the girl child</li> <li>Low enrollment, irregular return of girl child after challenging weather events</li> </ul>	<ul style="list-style-type: none"> <li>Lack of separate, clean toilets for girls and boys in schools</li> <li>Lack of drinking and hand wash water in schools</li> <li>Construction of schools in flood plain areas/ inappropriate places such as below flyover (Adalatganj) – leading to inundation due to excessive rains</li> <li>Lack of proper ventilation, safety escape routes and plans in case of fire and other disasters in schools</li> <li>Lack of classrooms, open play areas, green spaces and infrastructural problems (fans and lights) leading to lack of interest among students</li> <li>Ageing and dilapidated school building – seepage during rains</li> <li>Inappropriate student teacher ratio</li> <li>Lack of awareness on the importance of education among parents due to absence of regular counselling</li> </ul>	<p><b>POLICY/ENFORCEMENT:</b></p> <ul style="list-style-type: none"> <li>School Safety Policy to be operationalized</li> <li>Strict implementation of building bye-laws and penalty provisions</li> <li>Considering resilient infrastructure under <i>Sarva Shiksha Abhiyan</i> norms</li> <li>Education department to be part of DDMP/CDMP</li> <li>Geo-tagging of urban schools</li> <li>Coordination mechanism with traffic police department to prepare a “Traffic Plan”</li> </ul> <p><b>SCHOOL PROGRAMMES:</b></p> <ul style="list-style-type: none"> <li>School Eco Clubs for taking up climate resilience initiatives</li> <li>Formation and implementation of school disaster management, fire safety and evacuation plans with signage, mock drills governed by an active School Management Committee (SMC) Alternate school timings in extreme temperatures (summer and winter)</li> <li>Children to develop school resilience plan; Regular mock drills on disasters</li> <li>Regular health check-ups in government schools with the involvement of medical students/ interns.</li> </ul> <p><b>EDUCATION MANAGEMENT:</b></p> <ul style="list-style-type: none"> <li>Climate change and urban resilience aspects to be included in the school curriculum</li> <li>Formulation of “Child Parliament” in schools</li> <li>Parent Teachers Meeting to be made compulsory in all the schools</li> <li>Special programmes for mainstreaming of drop out children (crash courses)</li> </ul>	<ul style="list-style-type: none"> <li><i>Sarva Shiksha Abhiyan</i> Guidelines</li> <li>School Safety Policy</li> <li>DDMP</li> <li>Chief Minister's School Safety Programme</li> </ul>	<ul style="list-style-type: none"> <li>Education Department</li> <li><i>Sarva Shiksha Abhiyan</i></li> <li>Municipal Corporation</li> <li>DDMA</li> <li>BSDMA</li> <li>Traffic Police Department</li> <li>Health Department</li> <li>Bihar Education Project Council (BEP)</li> </ul>
	<ul style="list-style-type: none"> <li>Water-borne diseases</li> <li>Open defecation due to lack of toilets</li> <li>Intake of contaminated water from shallow handpumps, especially in flood plains</li> </ul>	<ul style="list-style-type: none"> <li>Open defecation due to lack of community/ public toilets; Individual Household Latrine</li> <li>Lack of spaces in slums for toilets</li> <li>Inadequate water supply infrastructure and system, especially for slums (damaged pipelines, inadequate number of sanitation workers, high nitrate concentration in groundwater with no treatment facilities)</li> <li>Behavioural problems – handwash, personal hygiene, use of toilets, etc</li> <li>Lack of separate toilets in school for girls and boys</li> <li>Open drains which usually overflow</li> <li>Dumping waste in water bodies</li> <li>Indiscriminate use of polythene bags leading to choking of drains, creating impermeability of soil</li> </ul>	<p><b>DRINKING WATER:</b></p> <ul style="list-style-type: none"> <li>Quality monitoring of water at source and destination levels (Setting up of decentralized lab equipped with modern testing instruments, trained personnel, and financial allocation for conducting sample surveys for water quality testing in a professional manner, available on demand)</li> <li>Localized treatment of drinking water at home and at schools – children to be oriented on this at school level.</li> <li>Identification and renovation of broken pipelines</li> </ul> <p><b>WATER MANAGEMENT:</b></p> <ul style="list-style-type: none"> <li>Groundwater recharge and rainwater harvesting– Use of roof top water for collection and storage made mandatory for schools and public buildings</li> <li>Seasonal Aquifer mapping to identify strata of safe drinking water availability</li> <li>Conservation and restoration of natural water bodies and catchment areas with the involvement of community by using approaches such as Self Help Groups</li> <li>Natural cleaning processes of water bodies (floating gardens) in Patna</li> </ul> <p><b>SANITATION:</b></p> <ul style="list-style-type: none"> <li>ODF Patna Urban in a strict phased manner</li> <li>Construction of community toilets with proper discharge of waste</li> <li>Separate toilets for girls and boys in schools</li> <li>Community approaches to sanitation to solve behavioral issues</li> </ul>	<ul style="list-style-type: none"> <li>Saat Nishchay</li> <li>BSWSM Guidelines</li> <li>WHO Guidelines</li> <li>BIS</li> <li>Swachh Bharat Mission (Urban)</li> <li>SMART City Guidelines</li> <li>CGWB Guidelines</li> </ul>	<ul style="list-style-type: none"> <li>Bihar State Water and Sanitation Mission</li> <li>Groundwater Board</li> <li>Bihar <i>Rajya Jal Parishad</i></li> <li>Municipal Corporation</li> <li>Patna <i>Jal Parishad</i></li> <li>Municipal Corporation</li> <li>NGOs like <i>Sulabh</i> International and UNICEF</li> <li>CGWB</li> </ul>

Sector	Children's Vulnerability	Development Deficit	Needed Actions	Policy/ Programmes	Institutions
Nutrition	<ul style="list-style-type: none"> <li>Disturbance in regular income affecting food availability (Livelihood losses affecting food security of children)</li> <li>Malnutrition</li> <li>Agriculture production and diversity losses (rural-urban connect)</li> <li>Reduced accessibility to nutritious food due to floods and waterlogging in surroundings</li> <li>Absenteeism from schools affects child nutrition due to non-access to Mid Day Meals</li> <li>Unhygienic food practices</li> <li>Burden of diseases causing malnutrition</li> </ul>	<ul style="list-style-type: none"> <li>Dumping of solid waste and sewage in peri-urban areas</li> <li>Inadequate enforcement of land use plan</li> <li>Soil mining</li> <li>Flood plains/inundation</li> <li>Irrigation of crops with sewage contaminated water</li> <li>Encroachment and contamination in water bodies</li> <li>Crop losses and decreasing net gains in peri-urban areas</li> <li>Encroachment on agricultural lands leads to more production on small lands with excessive use of chemical fertilizers which have less nutritional value</li> <li>Unorganized street vendors facing loss of livelihood and income</li> <li>Non-inclusion of migrants in nutrition schemes</li> <li>Access to food supplements especially in slums and low income settlements (ICDS)</li> <li>Less number of Anganwadi and ICDS centres as per the population requirement</li> <li>Lack of awareness among young mothers on complimentary breast feeding</li> <li>Poor Housing infrastructure leads to unsanitary conditions</li> </ul>	<p><b>URBAN, PERI-URBAN AGRICULTURE</b></p> <ul style="list-style-type: none"> <li>Promotion of climate resilient agriculture in peri-urban areas</li> <li>Segregation and household composting options</li> <li>Identification and demarcation of common property resources (water bodies, open spaces, orchards, etc)</li> <li>Develop model water bodies for aquaculture (water nut, etc)</li> </ul> <p><b>URBAN LIVELIHOOD:</b></p> <ul style="list-style-type: none"> <li>Promotion of agro based industries like poultry, dairy, etc.</li> <li>Vendor Plan to be formulated at the city level</li> </ul> <p><b>POLICY/PROGRAMMES/SCHEMES</b></p> <ul style="list-style-type: none"> <li>Ration cards to be provided to migrant labourers</li> <li>Formation of a "City Health Sanitation and Nutrition Committee" with the involvement of communities and creating awareness on consuming the available food hygienically, promoting traditional food like Aam Sattu which can be easily prepared at home</li> <li>There is a need to develop Urban Agriculture Policy</li> </ul> <p><b>SCHOOLS:</b></p> <ul style="list-style-type: none"> <li>Promotion of nutrition garden at school and Anganwadi levels</li> <li>Promotion of urban farming in housing societies</li> </ul>	<ul style="list-style-type: none"> <li>Master Plan 2031</li> <li>National Food Security Mission</li> <li>National Horticulture Mission</li> <li>National Health Mission</li> </ul>	<ul style="list-style-type: none"> <li>Municipal Corporation</li> <li>Patna Regional Development Authority</li> <li>Revenue Department</li> <li>Forest Department</li> <li>Agriculture Department</li> <li>Education Department</li> <li>Housing Board</li> <li>Women and Child Development Department</li> <li>Social Justice Department</li> <li>NASVI</li> </ul>
	<p><b>Child Protection</b></p> <ul style="list-style-type: none"> <li>Child labour to support families</li> <li>Children involved in extremely hazardous activities such as segregation of syringes and needles, e-waste, etc.</li> <li>Substance abuse</li> <li>Child sexual abuse</li> <li>Issues of privacy in congested slum houses</li> <li>Extreme weather events are threat to child safety especially for homeless children</li> <li>Building collapse (school, home, healthcare centre)</li> <li>Electrocution by open unauthorized wire</li> <li>Children fall in open drains</li> </ul>	<ul style="list-style-type: none"> <li>Improper drainage system (open drains)</li> <li>Unsafe habitat in terms of infrastructure (lack of ventilation, fire events, earthquake, waterlogging)</li> <li>Enforcement of laws and rules relating to child safety and protection to be taken on priority (POCSO)</li> <li>Improper maintenance of school and healthcare infrastructure</li> <li>Developmental plans and policies lack child friendly approaches.</li> </ul>	<p><b>ENFORCEMENT:</b></p> <ul style="list-style-type: none"> <li>Strict enforcement of laws governing child safety and protection (POCSO)</li> <li>Linking every child with <i>Aadhaar</i> to ensure child protection</li> <li>Shifting schools from hazard prone locations to safer places</li> <li>Maintenance check of all school buildings during pre monsoon period and carrying out repairs</li> </ul> <p><b>AWARENESS:</b></p> <ul style="list-style-type: none"> <li>Awareness among parents and children on child safety and protection issues</li> <li>School campaigns on anti-tobacco and anti-drug</li> </ul> <p><b>POLICIES/PROGRAMMES</b></p> <ul style="list-style-type: none"> <li>Demand driven actions from community for new child protection policies and programmes</li> <li>Review of existing Child Policy from a climate change and disaster resilience lens.</li> <li>Implementation of school safety policies with a special focus on fire evacuation plan, provision of safety equipments at school and installation of bad conductors to lightning in school buildings</li> </ul> <p>Specific vulnerability mapping of children in high risk zones and the needed measures to be taken up</p>	<ul style="list-style-type: none"> <li>National Plan of Action for Children</li> <li>School Safety Policy</li> <li>Shelter for Urban Homeless</li> <li>Chief Minister's School Safety Programme</li> <li>Building Bye Laws</li> </ul>	<ul style="list-style-type: none"> <li>Education Department</li> <li>DDMA</li> <li>Labour Department</li> <li>Urban Development Department</li> <li>Social Welfare Department (ICDS, Children's Home)</li> <li>Police Department</li> <li>Childline</li> <li>NGOs</li> </ul>

Apart from the above mentioned resilience actions based on children's vulnerabilities and development deficit in the city, there are some cross-cutting issues of planning and governance, which need to be addressed for effective implementation of the resilience strategy:

- a. City can identify the vulnerability hotspots and develop hotspot-wise plan to improve rainwater absorption and drainage capacity of localities (especially in slum areas)
- b. Include a chapter on climate change resilience in the Master Plan of the city
- c. Establishing "Climate Cell" in the Municipal Corporation for mainstreaming of climate change related issues
- d. Creating adequate platforms for effective coordination and convergence between various institutions and departments (formal and informal)
- e. Revisit land-use planning and couple with scientifically designed sewerage/drainage system and solid waste system to further reduce city's vulnerability
- f. PMC must take lead to implement the resilient cities component of the "Bihar DRR Roadmap". The city should develop resilient check list to monitor its implementation process and report to the BSDMA and Disaster Management Department.
- g. Adoption of 74<sup>th</sup> CAA to promote decentralised governance. i.e. zone/ward level governance to be strengthened with citizen participation
- h. Peri-urban areas of the cities play an important role in the city resilience to disasters particularly flood resilience. Peri-urban areas if managed and planned properly can act as buffers and also as outlets to floods in their adjoining urban areas. However, with changing mind-sets these areas are being looked at as potential real estate land markets and hence fall prey to poor speculative

tactics and land mafia. It is therefore necessary and very apt for a scale of city like Patna to value its peri-urban lands and promote rural economy and agricultural practices to maintain the sanctity and ecosystems of these highly valuable land stocks. Maintenance of the peri-urban areas is also necessary for ascertaining sustainable development in terms of food, nutrition and livelihood opportunities for people living in these areas. These areas supply major ecosystem services to the adjoining cities and hence need to be conserved.

- i. Last but not the least, all the above mentioned actions can only be achieved through proper finance and capacity building process. Often the new and progressive plans and schemes are vetted on the question of financing them. More often it is seen that after the challenge of lack of mandates and policies, cities and regions face problems in financing their resilience plans. Also, there is less capacity in the local bodies both technical and financial to support some of the activities outlined in the resilience strategy that is multi-dimensional and multi-sectoral in nature. However, with planned efforts and involving local expertise and academic institutions and support from the state level expert agencies, regular and planned capacity building can be achieved in medium to long-term time horizon. Besides, this integration of resilience parameters in infrastructure design and land-use planning will lead to preparation of DPRs that already account for resilience and will not overburden the city finances with additional financial requirements. This city must also update its financial management mechanisms and revenue streams to be able to update and improve its financial capacities.



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