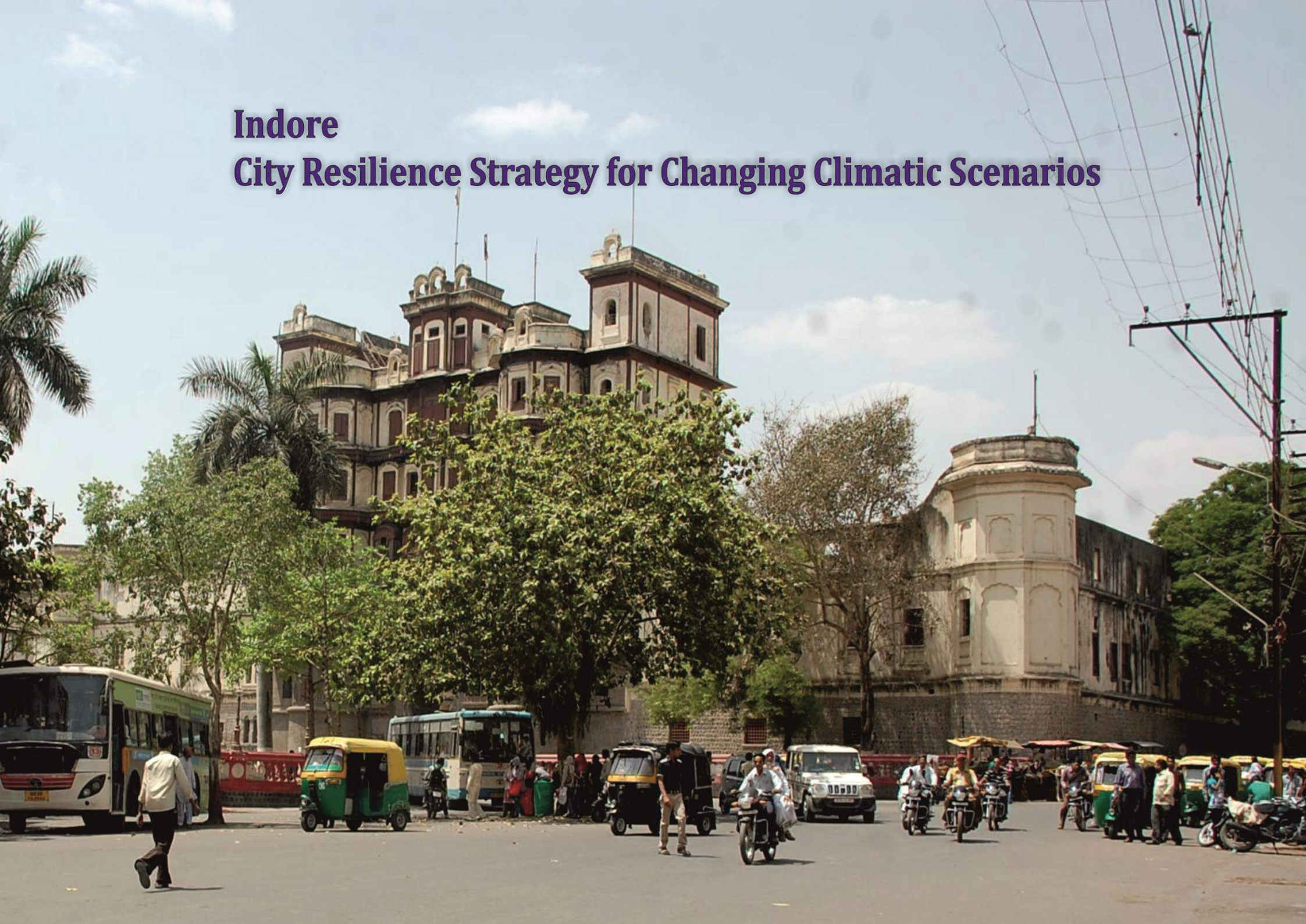
Indore
City Resilience Strategy for Changing Climatic Scenarios



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May 2012

TARU

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Cover Photo: Rajwada is a historical palace in Indore city. Built by the Holkar about two centuries ago. This seven storied structure is located near the Chhatris and serves today as an example of architectural skills.

MESSAGE

This is a moment of great pleasure for Indore city as it takes one more step forward in the fight against climate change related risks. Being a global challenge, climate change has started hitting the city for a long time and there was a need to study the relation of possible Climate Change and their impacts on different developmental aspects of the city.

As per an estimates, by 2030 more than 60 percent of the world's population will live in urban areas, with most of the world's population growth over the next twenty-five years will be absorbed by cities and towns in low and middle income countries. Today, nearly one billion people live in slums, and in the absence of significant intervention that number is set to double in the next two decades.

Remarkably, Indore is also a city that needs sincere efforts in order to deal with the growing threat of climate change related risks. As the study under ACCCRN reveals, Indore is among the vulnerable cities of India and there is an urgent need for interdisciplinary interventions on several fronts. The present document is an example of the city's readiness to bring the issue among the planners and managers. This effort signifies the spirit of the city to fight the climate change allied possible risks in the most efficient way for the city.

I believe the effort in the form of this City Resilience Strategy (CRS) document will help the planners, policymakers and the managers to efficiently deal the challenges ahead and I wish them all the success.

(Krishna Murari Moghe)
Mayor
Indore Municipal Corporation

FOREWORD

It is great pleasure to introduce the City Resilience Strategy (CRS) for the city of Indore. This is a result of long and consistent efforts of many institutions and individuals and I congratulate them.

In past few decades, rapid growth of major cities in India has taken place. The process of urbanization has created new opportunities. At the same time, un-envisaged problems had also emerged for both the planners and citizens due to rapid urbanization. The growth in population, increasing numbers of people migrating towards cities, increase in vehicle numbers and allied factors have created serious challenges for the city planners and managers.

Cities, being the major drivers of the economic and political activities in India are becoming vulnerable towards the possible threats of climate change. Most of the cities have started to experience climate variability related issues. This is a burning reality of our times and every major city needs to tackle the issue in the best possible way. The processes responsible for the climate change on the global scales are not reversible and the damage that has been occurred will need long-term efforts to establish an equilibrium again. Long-term projections of temperature rise and changes in the patterns of distribution of rainfall across the season along with the other characteristics of urbanization may lead to new problems. For example, on health front the increasing average temperature will lead to stretched summers. As a result of that, the risk for vector borne diseases may increase within the city and its surrounding areas. These factor coupled with the commonly seen water logging, especially during monsoons, may intensify the water born diseases in urban areas. Similar threats/risks have been forecasted on various sectors like water (resources & their management), solid waste management, health surveillance and transportation.

The rate/extent of urbanization in India was 27.78 per cent in 2001(285 million). This was much lower than the average extent of urbanization in developing countries. Even though, the urban growth during 1991 to 2001 has been somewhat subdued at only 31 percent, more than 70 million people were added to urban population. 35 million plus cities accounted for nearly one third of the urban population. The growth during 1991 to 2001 has been mostly concentrated in million plus cities with growth rate more than the national urban growth average with cities like Surat growing at more than 60% while Indore growing at more than 40%. The urban growth has been adding pressure on resources and infrastructure which are mostly old and were designed for much lower population. These resource and infrastructure shortages are causing major bottlenecks to sustainable growth. There is a lag in the increased demand and infrastructure development in most of Indian cities; often taking decades . Anticipatory planning is severely constrained by shortfall in finance as well as constraints in planning process itself. As a result, large scale national programs, able to offer huge funds can only meet part of the past demands (e.g. JnNURM).

The decadal population growth rate scenario for Indore city is about 40% that is really a challenge for the city planners and managers. The existing infrastructure available in the city is unable to cope up with the increasing population and expanding city limit area. The growth of industries and of late the service sector in the country have put an immense pressure on the Urban Local Bodies to expand the city limits.

Due to these vary facts and also the possible climate change related variability knocking the doors; Indore Municipal Corporation (IMC) along with the City Advisory Committee (CAC) has facilitated and guided the vulnerability assessment exercise in Indore city over the past three years. The assessment was carried out by TARU under the Asian Cities Climate Change Resilience Network (ACCCRN) project. Under ACCCRN, a CAC was established to overview the studies on possible impacts of climate change, and to recommend strategies that would create a higher level of resilience for its citizens. It is a matter of pride for the city that the CAC incorporates the views, wisdom and commitment of members of all sections of urban life, academia, industry, trade, local government and civil society.

In the line of similar efforts the CAC has initiated the process of (i) assessment of the likely impacts of climate change on the socio- economic life of Indore; (ii) identifying future challenges and (iii) initiating the formulation of viable and thoughtful strategies to address the same. The process essentially involved the analysis of some of the critical sectors, such as water, energy, health & environment, transportation, green buildings. More significantly, perhaps for the first time, an assessment was made on the vulnerability of different sections of the population to the changing weather patterns that may result in, increased precipitation, Waterlogging, changes in disease patterns, increasing energy demand etc. The work under the ACCCRN initiative in Indore over the past three years establishes the nexus between urban systems, poverty related challenges, underlying city vulnerabilities and the overriding phenomena of climate change and the risks posed thereby. Vulnerability of the city, if not recognized and addressed, will only exacerbate with accelerated incidence of extreme weather events.

Therefore, the process of formulation of a city resilience strategy was initiated in Indore during 2009-2010. Realizing the cross-sectoral nature of the impacts, the CAC adopted an interactive and holistic approach entailing engagement with a wide array of stakeholders through Risk to Resilience (R_2R) workshops held during the ACCCRN programme. I appreciate the concerns shown towards the future climate change variability are addressed timely in the form of City Resilience Strategy developed under the Phase II of ACCCRN. I also take an opportunity to acknowledge the efforts of the municipal corporation officials, various government departments, National Institute-Industry Forum For Energy, School of environment & Energy Studies, DAVV, Indore, Mehta & Associates, TARU & several local organisations and individuals (Mr. Mukesh Chouhan & team and Professor T. A. Sinhorwala & Team) in contributing in towards the climate resilience efforts.

The City Resilience Strategy (CRS) is an attempt to assess the scale of vulnerability on key sectors, the risks and challenges likely to be faced by the city of Indore due to possible climate change impacts, the likely impacts on crucial sectors and the kind of adaptation and interventions which can be taken to address the same. The CRS is the result of consistent and sincere efforts by a many enlightened and committed citizenry and crucial stakeholders of Indore. It is gratifying to note that all stakeholders actively as well as passionately contributed to the process to ensure that the document becomes a live and vibrant strategy which is owned and acted upon by all through a convergence of approaches and action. The CRS highlights innovative methods such as GEOPSY and scenario exercises which can also serve as effective urban planning tools in future for cities on the move.

I hope this document will serve as an important guideline in the direction of actions in dealing with the possible Climate Change related uncertainties particularly for the Indore city. The efforts put in the sector studies and subsequently preparing this resilience strategy will not only help various organizations, institutions and individuals but also inspire one and every citizens who have been working for the similar cause.

(Yogendra Sharma)
Municipal Commissioner
Indore Municipal Corporation

THE ROCKEFELLER FOUNDATION

MESSAGE

The Rockefeller Foundation has been extremely proud to partner with the city of Indore under its Asian Cities Climate Change Resilience Network (ACCCRN) initiative. As an important urban centre in the heart of the country, the manner in which Indore responds to the challenge of climate change can serve as a model for many other places. Though climate change is a global problem, actions need to be taken locally to help communities prepare for and weather climate-related impacts. The efforts of the city to date are indeed impressive, but much more remains to be done.

The stakes for cities such as Indore are particularly high given its importance as a growing economic centre, and the challenges it faces with regard to water management, heat stress and other climate-related issues. Cities now house more than half of the global population, including hundreds of millions of poor and marginalized households, making it essential that steps are taken to increase their resilience to withstand the shocks and stresses spurred by climate change. In this context, the Rockefeller Foundation is delighted to see the launch of the Indore city climate change resilience strategy. This strategy reflects a tremendous amount of leadership, effort and dedication shown on the part of a wide range of institutions and individuals within it, from government, business, academia, technical centres and civil society. We look forward to seeing the city continue to serve as a globally recognized leader in strengthening resilience to climate change.

(Mr. Ashwin Dayal)
Managing Director, Asia Office
The Rockefeller Foundation

ACKNOWLEDGMENT

On behalf of the Indore City Advisory Committee (CAC), I am happy to engrave few words on this City Resilience Strategy (CRS) document. This document is a result of three years of sincere efforts made by Indore Municipal Corporation (IMC), State government departments, academic institutes, NGO's, professional bodies and many individuals. Indore city is fast growing city and will certainly be affected by impacts due to possible climate changes. The impacts may vary in their scales across various sectors (water, health, sanitation, and solid waste disposal, infrastructure); as all sectors are interrelated. The efforts during the implementation of Phase II of ACCCRN programme remained very much crucial in identifying the sectors vulnerable towards the impacts of anticipated climate changes in the region. The exhaustive studies undertaken to assess the risks and vulnerabilities in sectors, engagements of various academics and private institutes, NGO's and also time to time meeting of these sectors during CAC meetings including the Risk to Resilience (R2R) workshops in the city; provided valuable inputs towards finalizing the short, mid and long terms interventions. This will be required for adapting to the possible threats/impacts of the climate change by the city.

The work carried out through ACCCRN programme, with the sincere and dedicated efforts, is just the beginning towards making Indore city more prepared for future climate variability and change.

I am extremely happy to pen down here that the city of the Indore has initiated the process to deal with possible threats related to the climate change impacts which are currently gaining global attention. The document in your hand has been designed by using pictorial representation to make it more interactive. At the same time the various studies undertaken in the past are presented in very lucid manner in the present CRS document. This document will not only help technocrats but will also help common man to understand the impacts of climate change on the life of an Indorian.

I congratulate one and all associated in bringing out this very useful City Resilience Strategy document.

(V.P. Kulshreshtha)
Secretary, City Advisory Committee,
Asian Cities Climate Change Resilience Network - Indore.

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Indore City Resilience Strategy

The 20th century has been a period of greatest warming in at least a thousand years. The IPCC Working Group found evidence that recent regional climate changes have already affected many physical, biological and in human systems. Water, energy and material consumptions has increased due to population increase & rapid urbanization. This has significantly altered Land Use & Land Cover (LULC). Apart from natural changes in climate, drivers such as urbanization and pollution influence climate systems directly and indirectly. Ability to manage climate risks and other hazard risks depends on a number of critical factors including city's baseline infrastructure. Several attempts are underway to minimize the effects of climate change on priority sectors and vulnerable section of the society through building adaptation mechanisms.

Indore is the most prominent city within the state of Madhya Pradesh. The issue of climate change is cross-cutting, it has a potential to affect a numbers of sectors augmenting the growth of the city. Risk and vulnerability assessment was conducted for the city in consultation with Indore City Advisory Committee (CAC), Indore Municipal Corporation (IMC), academic institutions, private sectors and community. Sector studies were undertaken to determine the degree to which existing systems can adjust in response to, or in anticipation of, changed climatic conditions. The assessment results supported in framing an integrated resilience approach for the city of Indore to deal with climate variability and climate change.

City Resilience Strategy (CRS) for Indore has been informed on the basis of the assessment studies & aims to reduce the impacts of climate change by identifying sectors, communities most vulnerable to the climate variability & climate change risks and by suggesting resilience measures.

The aim of City Resilience Strategy (CRS) Document

This document is prepared with the aim of providing a framework for development of climate resilience strategy for the city of Indore. It has been developed based on interaction with city stakeholders, sector studies conducted to understand different dimensions of current situation, information from secondary literature, and through conduct of risk to resilience workshop.

CRS, is aimed at city managers and people at large. This document is based on the current situation and has a scope for updation to reflect emerging trends over time. The resilience strategies will therefore evolve over time with better understanding of climate change phenomena as well as emerging city level issues.

There are four sections in this document:

1. **Variability & Change** : Dynamic factors that would affect the city
2. **Possible Impacts**: Understood based on the infrastructure of the city
3. **Evaluation & Assessment**: Determines the Capacities, Vulnerabilities & Constrains of the city towards the better CRS
4. **Prioritized Strategies**: To reduce the impacts of the climate change on the city

General

ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank
CAC	City Advisory Committee
CBO	Community Based Organization
CDP	City Development plan
CEPRD	Centre for Environmental Protection and Research
CRS	Climate Resilience Strategy
DFID	Department For International Development
DPR	Detailed Project Reports
ICDS	Integrated Child Development Services
IDA	Indore Development Authority
IDP	Indore Development Plan
IMC	Indore Municipal Corporation
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MPEB	Madhya Pradesh Electricity Board
MPPKVVCL	Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited
MPUSP	Madhya Pradesh Urban Services for the Poor
NGO	Non Government Organization
NIPFP	National Institute of Public Finance and Policy
NREGS	National Rural Employment Guarantee Scheme
NVBDCP	National vector Borne Disease Control Programme
PEARL	Peer Experiences and Reflective Learning
PIP	Priority Implementation Projects
RAY	Rajiv Awas Yojana
SJSRY	Swarna Jayanti Shahari Rozgar Yojana
SRES	Special Report on Emission Scenarios
STEP	Support to Training & Employment Programme for Women
SWM	Solid Waste Management
TCP	Town and Country planning
ULB	Urban Local Bodya

Technical

CC	Climate Change
CGCM3	Coupled Global Climate Model 3
CNRM	Centre National De Researches Meteorologiques
CSAG	Climate System Analysis Group
DEM	Digital Elevation Model
CVCC	Climate Variability and Climate Change
DSVI	Drainage and sewerage vulnerability Index
ECI	Education Capacity Index
EPRE	The instances of extreme point rainfall events
GCM	Global Climate Model
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
ISI	Income Stability Index
LPCD	Liters per capita per day
LVA	Loan and insurance vulnerability Index
MLD	Million Litres Per Day
MPI	Max Planck Institute
MSL	Mean Sea Level
PCI	Park Cool Island
PRECIS	Providing REgional Climates for Impacts Studies
RCM	Regional Climate Model
SCI	Social Capacity Index
SEC	Socio Economic Class
SLR	Sea level Rise
SPT	Sewage Treatment plant
SRTM	Shuttle Radar Topographic Mission
UHI	Urban Heat Island
UFW	Unaccounted-for-Water
WSI	Water Scarcity Index
WTP	Water Treatment Plant

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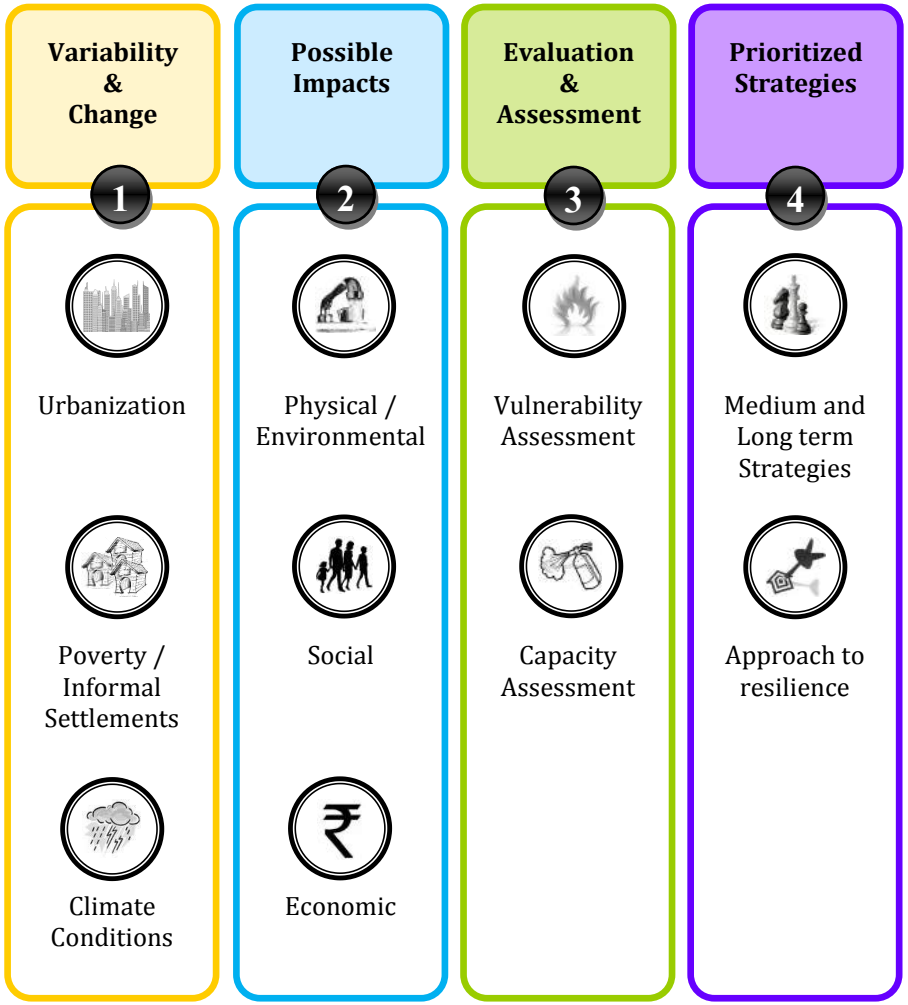


VARIABILITY AND CHANGE

Urbanization	Poverty / Informal Settlements	Climate Conditions
		
Population	Living (Environment)	Temperature
Industrial & Economic Growth	Livelihood (Earning)	Precipitation
Land Use & Land Change (LULC)/ Environmental Transition	Lifestyle (migration/social status, access to resources)	

Population

1. Growth and Present Population
2. Future Projections

1. Growth and Present Population

The population of the city increased from 57 thousand in the year 1911 to 16 lacs in 2001. The city's population density ranges from 100 persons/ha within the peripheral areas to as high as 1,028 persons per ha in the core of the city. On an average, the decadal growth rate has been around 40% which is higher than the national growth rate of 22%.

Growth of Indore Planning Area
(1975—2002)

Sl.	Year	Area (Ha.)	Growth (%)
1	1975	2,284	-
2	1990	6,115	167.73
3	1996	7,747	26.68
4	2002	10,725	38.44

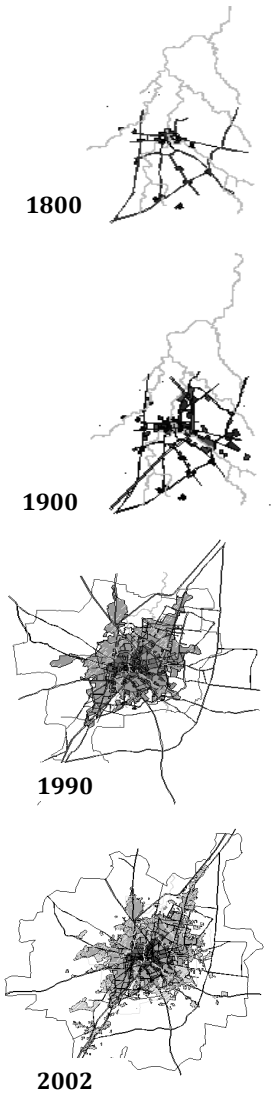
Source: CDP Indore

Migration is increasingly playing an important role in the population growth of the city. Being the only major city in the Western Madhya Pradesh, Indore serves as educational, medical and trade hub; catering to a large floating population. With rapid urbanization, a significant section of this floating population may become city residents. As per the census of India 2011, provisional population of Indore is 19,60,631. It is 21,67,447 by including the urban agglomeration.

2. Future Projections

Future population projections have been attempted by IMC with various methods. The projections by geometric progression method indicate the population of Indore to be around 3 millions (30 lacs) by the year 2021(IMC).

Indore City Growth

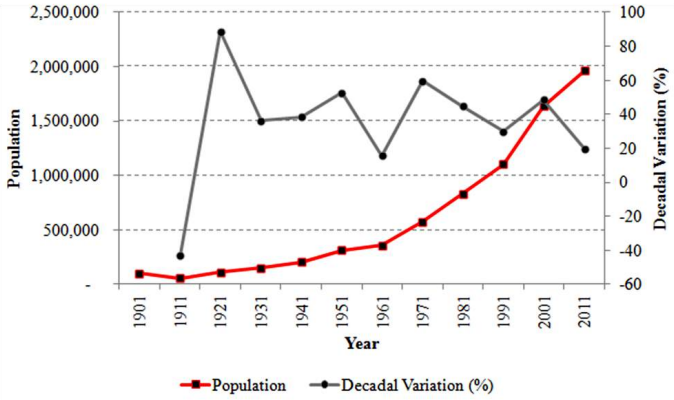


Decadal Population Variation

Year	Population	Slum Population	Area IMC (Sq.km)	Decadal Variation (%)	Population Density
1901	99,880	-	-		-
1911	57,235	-	-	-42.7	-
1921	107,948	-	-	88.6	-
1931	147,100	-	-	36.27	-
1941	203,695	-	-	38.47	-
1951	310,859	67,619	-	52.61	-
1961	359,000	83,174	55.8	15.61	6,434
1971	572,622	112,352	-	59.60	-
1981	829,327	126,300	-	44.68	-
1991	1,104,000	168,600	130.1	29.86	8,481
2001	1,639,000	259,577	130.1	48.46	12,598
2011	19,60,631	529,370	130.1	19.62	15,070

Source: Census of India & IMC

Population Trends



Source: Census of India, 2011

Land Use and Land Cover Change

1. City Growth
2. Land Use Pattern & Changes

1. City Growth

The Indore city which derives its name from Indreshwar temple was initially known as 'Indur/ Indrapuri' is located on the western part of Malwa drained by two rivers namely Khan & Saraswati. The growth of Indore can be broadly placed in three distinct stages through history and the present stage is 400 year old.

Pre– Holkar Period

In year 1728 , Maratha king Bajirao Peshwa, handed over his kingdom to Malhar Rao, who ruled Indore between 1728-1766. During that time the total area 28.5 parganas. This area was developed cantonment while later it developed into commercial city. The region emerged as an important military camp, owing to its location.

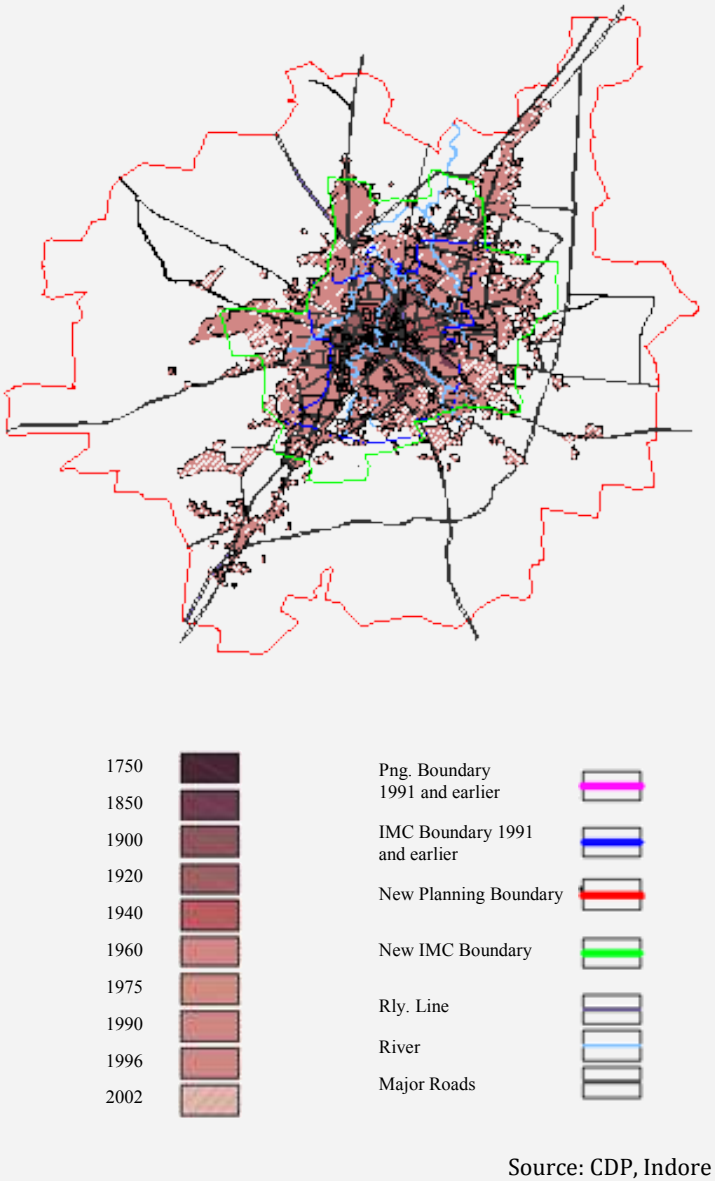
The Holkar Period

Establishment of Holkars capital at Indore provided new forces for development of the city. In 1912 H. V. Lancaster was invited, by the local body to advice on expansion of the city and improvement in the sanitary conditions of the residential areas. In 1918 Sir Pattrick Geddes was invited, by Maharaja Tukoji Rao Holkar to advise the Government and local body to advice in respect of expansion and improvement of the city. He prepared drainage and water supply schemes, industrial development schemes, suburban development, housing schemes and landscaping etc. for city.

The Post– Independent Period

1920 Indore Improvement Trust
1956 Indore Municipal Corporation
1973 Indore Development Authority

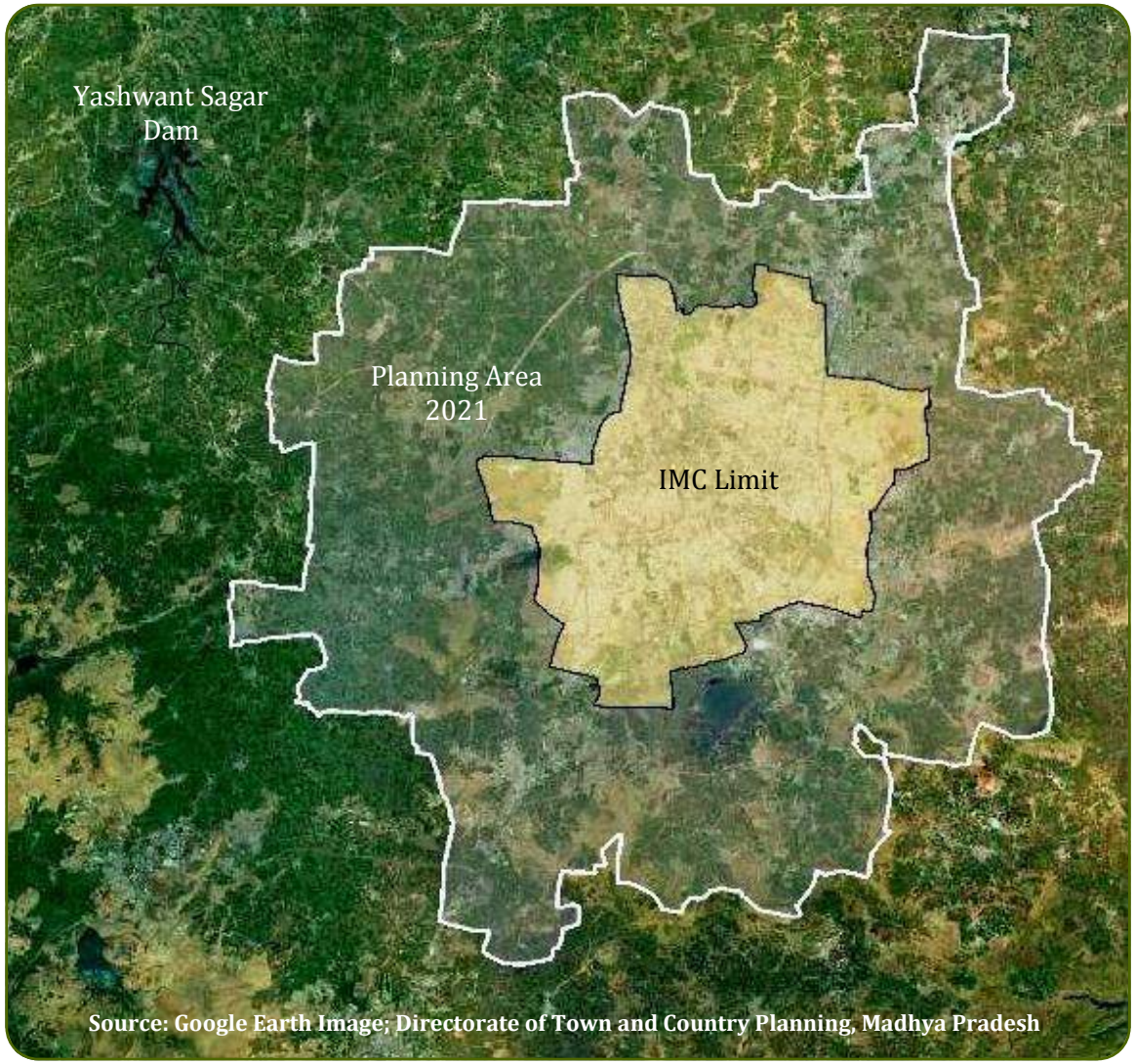
Growing Indore



Source: CDP, Indore

Land Use and Land Cover Change

1. City Growth
2. Land Use Pattern & Changes



Source: Google Earth Image; Directorate of Town and Country Planning, Madhya Pradesh

2. Land Use Pattern & Change

Rapid spread and densification of the Indore city has occurred over the period of time. Patterns of land use land cover change of the past four decades indicate growth being guided by the socio-economic processes which include population growth, economic development, trade, intellectual capital, location advantage and migration.

As per the real estate planners, about 100,000 additional houses are required annually to meet the growing housing demands of the city. This intensification of land-use can significantly and strongly magnify the effects of extreme climate events (*change in water use, micro-climate, urban heat and energy balance etc.)*. Further, climate change scenarios and urbanization trend indicate the possibility of competing demands rising from upstream irrigation, energy generation and urban users.

Industrial and Economic Growth

1. Present Industrial Base
2. Expected Growth

1. Present Industrial Base

Indore is essentially a trading center, and due to its strategic location serves as a hub of trade and commerce for the entire west part of India. While there was presence of quite a few industries in the area, textile industry for a long time remained the central industry of the city. Multinational and national companies have chosen to set up their industries here, solely because of the availability of suitable infrastructure.

There are two main industrial areas outside the Municipal limits. Pithampur is about 25km in the south (popularly known as 'Detroit of India'). The Indore SEZ is established here. Other is in Dewas, northeast part of the city. There are about 120 large and 480 small & medium scale units in these estates and has considerable impact on the city's economy. These industries are capital intensive and high-tech.

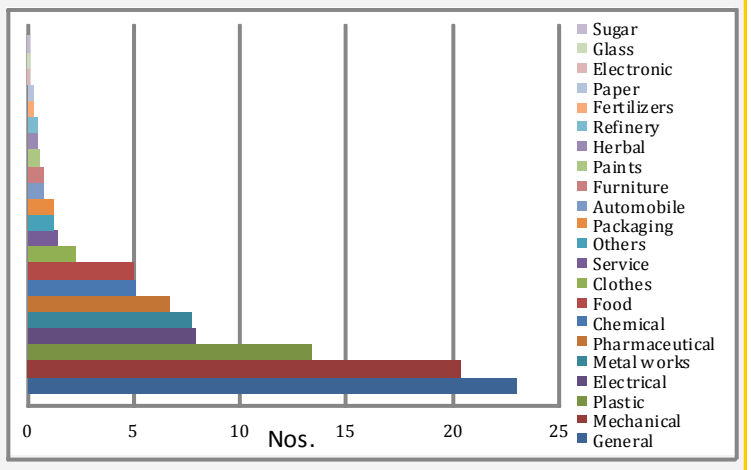
2. Expected Growth

As happening in other cities of this country, Indore has also observed decline in the traditional industries and has witnessed restructuring of the economy. There are three main industrial areas within the city – Sanwer Road, Polo Grounds and Udyog Nagar with 1,272, 137 and 67 small and medium scale units respectively.

Trade & commerce, financial sector & new high tech companies have replaced the traditional industries in Indore. The dominant sectors are engineering, pharmaceuticals, fabrication and food processing. Indore has trade spread across cotton textiles, chemicals, machinery, iron and steel, food and edible oil, confectionery, paper and straw board, RCC pipes and poles, machine tools and accessories, electrical machinery and appliances, electronic goods, pharmaceuticals, snacks and educational services. Pharmaceutical, Textile, Food Processing, Information Technology, Apparel Park, Gem and Jewelry Park, Software Technology Park and Herbal Park.

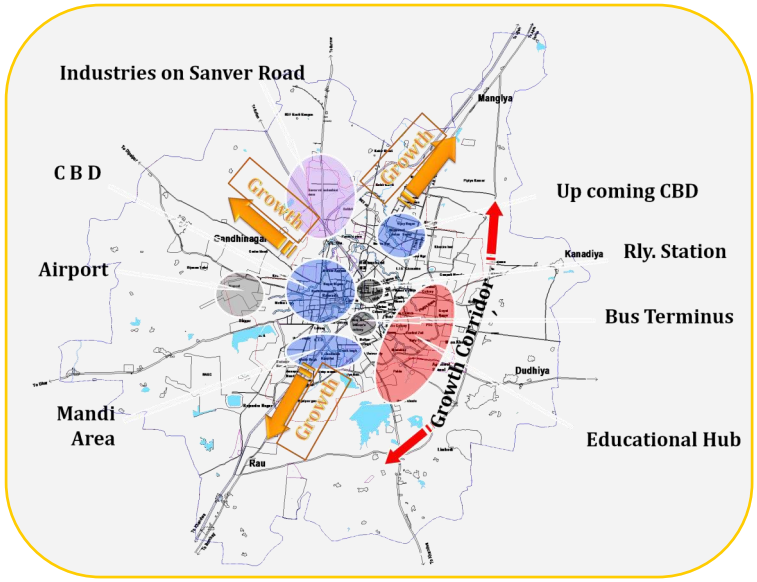
Indore registered work force participation rate of 30% and during 2001 census, with 63.4% working population employed in tertiary sector and 33.4 % Population employed in secondary sector. Projected population of Indore metropolitan area is estimated to be 3.6 million by 2021.

Present Industrial Distribution



Source: Industry Association Indore, 2008

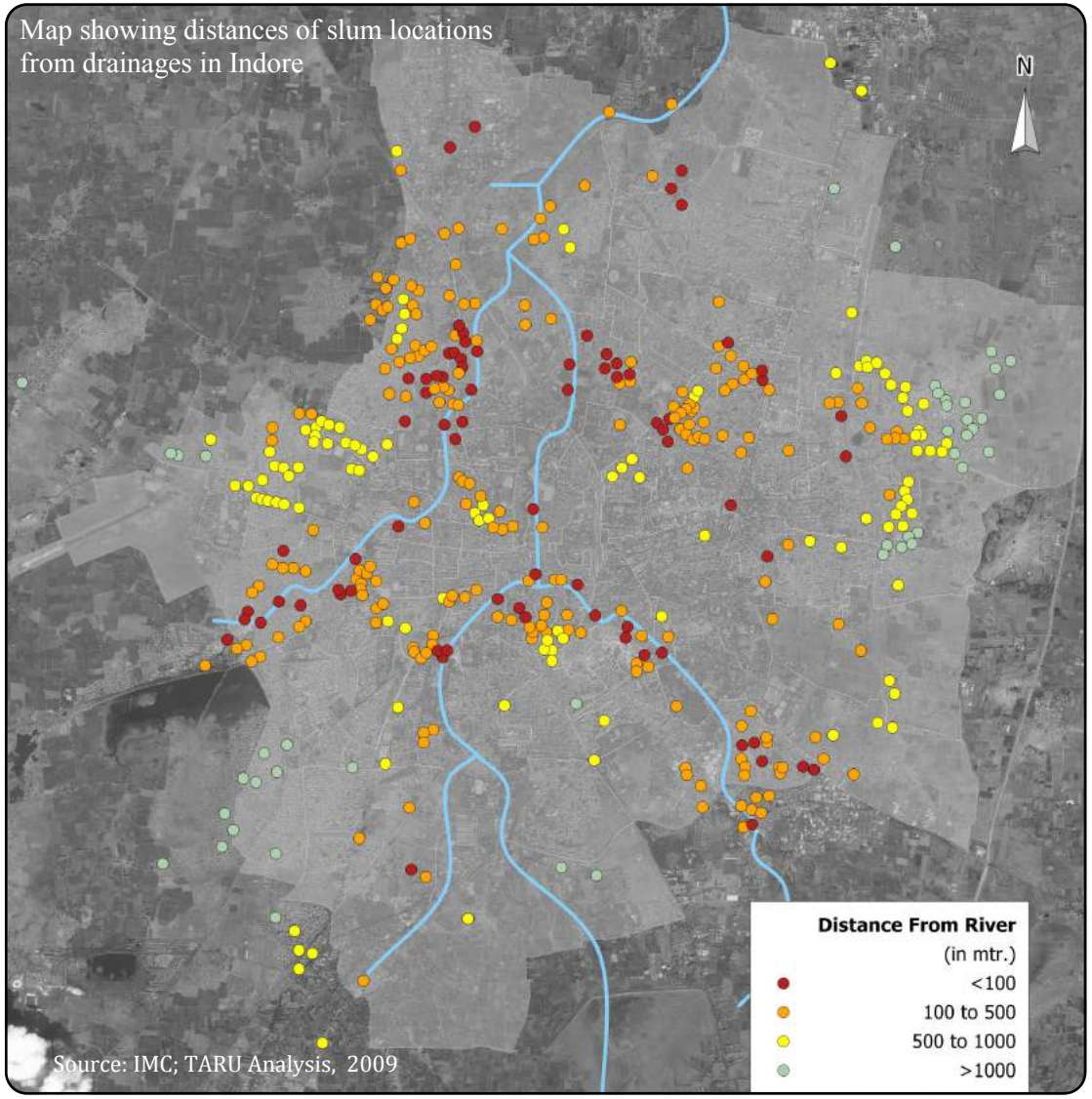
Expected Growth of Industries



Source: IDA, 2010

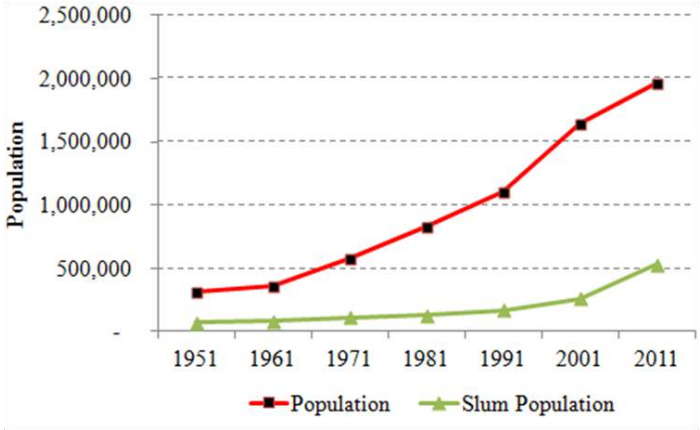
Poverty

1. **Living (Environment)**
2. **Livelihood (Earning)**
3. **Life Style (Social Status, Aspiration)**

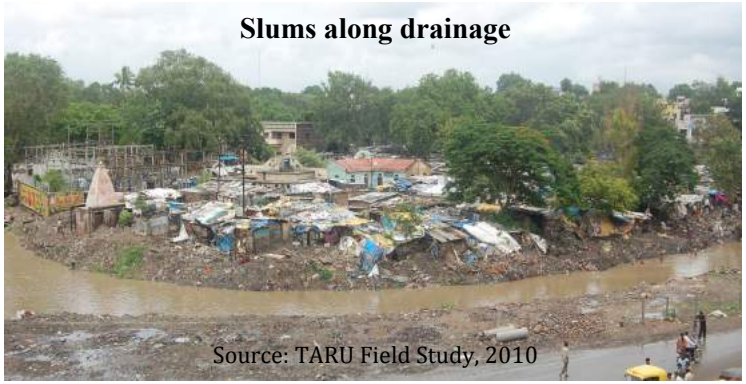


1. Living Environment & Differential impacts on poor

Around 27 % of the city's population currently live in slums. Significant proportions of slums in Indore are located along the stream and are prone to floods. They are also vulnerable to water logging and vector-borne diseases due to their proximity to flood plains and water logged areas. The temperature increase is also likely to cause differentially higher impacts on poor due to overcrowded settlements, low ventilation and poor vegetation cover. Since most poor cannot afford space cooling devices beyond fans, nor the increasing costs of electricity, they are likely to be impacted differentially.



Source: Census of India & IMC



Poverty

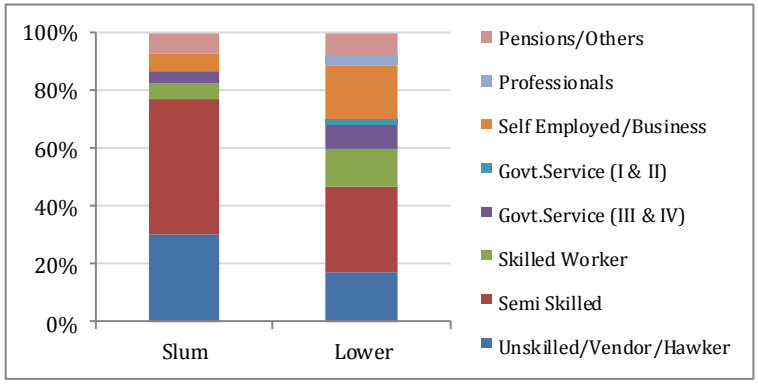
1. **Living (Environment)**
2. **Livelihood (Earning)**
3. **Life Style (Social Status, Aspiration)**

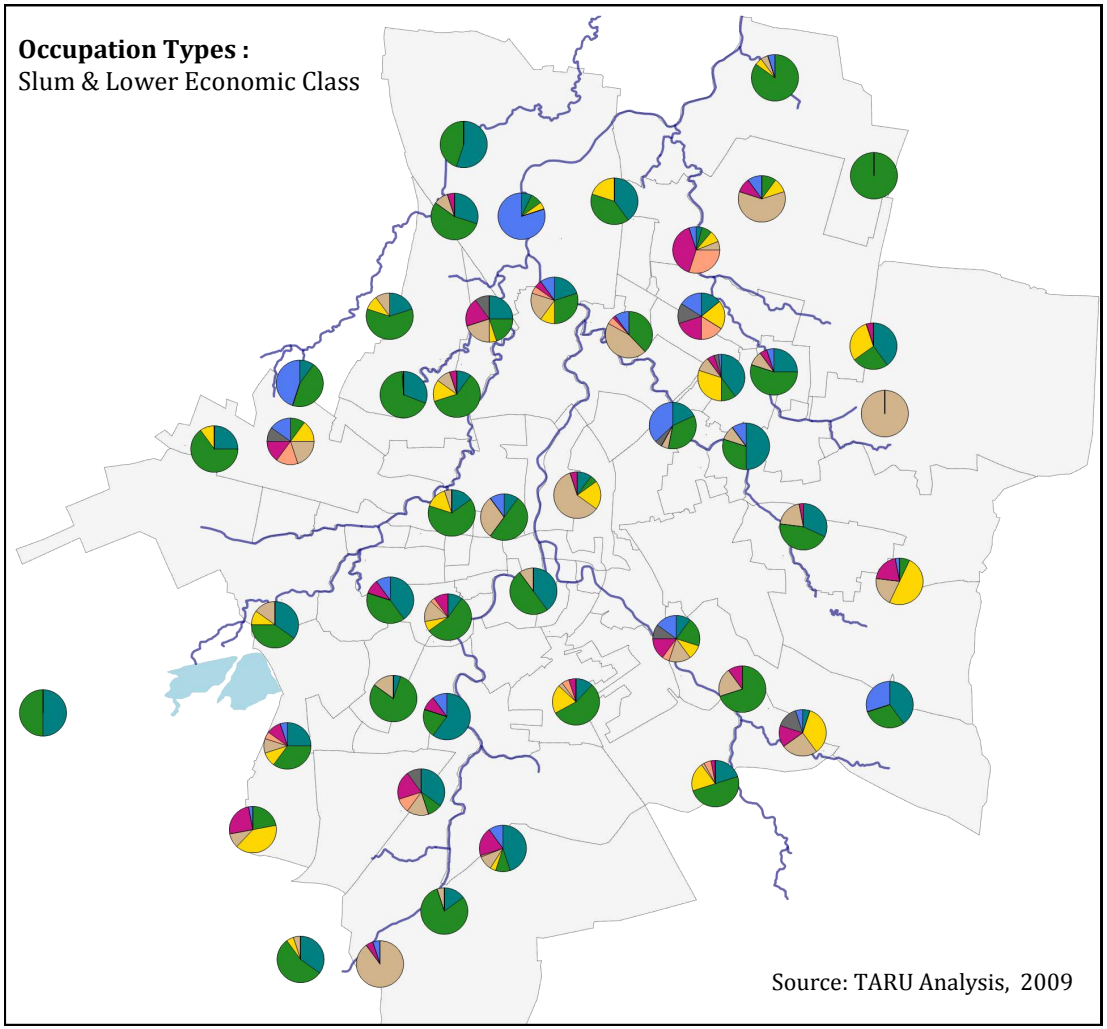
2. Livelihood (Earning)

Indore city emerged from being a trading centre to textile manufacturing city to a hub for automotives, light engineering, food and pharmaceuticals industries. While most of the large industries are located outside the city limits, Indore provides a variety of services to support these industries, in addition to large hinterland. Household food industry also contributes significantly to the economy of the city.

Indore is the business and trading capital of the state. Located at the crossroads of western and central India, Indore has relatively good connectivity and has been the hub of trade and commerce not only for the state but also for western India. The city hoods a dominant position and is a vibrant center for trade and commerce.

The population living in slums of the city can be broadly classified by occupation type as: (1) Unskilled/Vendor/Hawker (2) Semi Skilled, (3) Skilled, (4) Government Service (Class III & IV), (6) Skilled Professionals, (7) Self Employed/Business & (8) Pension/Others.





LEGEND

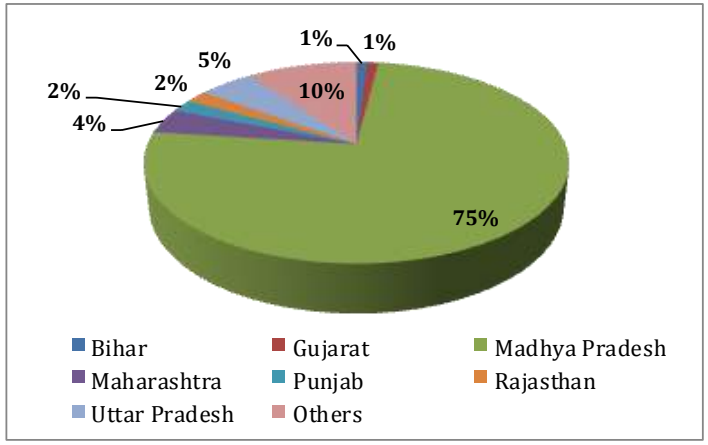
Poverty

1. **Living (Environment)**
2. **Livelihood (Earning)**
3. **Life Style (Social Status, Aspiration)**

History of Slum Improvement Programmes

Since early 1980's, there is a history of externally aided projects in Indore for slums up-gradation including the award winning 'Indore Habitat Improvement Project' (IHIP) funded by the Overseas Development Agency. IHIP, executed by the Indore Development Authority, was a comprehensive project dealing with construction of roads, extension of piped sewerage, construction of sewage treatment plants, and slum up gradation. Amid other works carried out under the project, the Indore Slum Networking project won the Aga Khan Award for Architecture. Under various donor funded programmes, improvement of slum areas are being attempted. But the outcomes of such measures do not last beyond the project periods. The recent of donor funded programme, MPUSP, has overcome many of these issues, but the issue of solid wastes still needs attention to provide sustainable solutions.

Place of Origin : Migrants



Source: TARU Analysis, 2009

Housing for Urban poor:

The eight year project which was implemented in 183 slums demonstrated the potential of improvement of slums, rather than their clearance. Under VAMBAY and JNNURM schemes about 5,000 housing units were constructed for urban poor and 1,000 units are being built. There are 5,000 more units proposed.

Although the city population doubled from 1971 to 1991, the slum population almost quadrupled over the same period. In 1991, the population of the city was 1.25 million out of which slum dwellers accounted for 0.35 million

Source: Presentation by Sh. D.L.Goyal, Chief City Planner, IDA ,2009

Temperature

1. Observed Climate
2. Temperature Change Prognosis

1. Observed Climate

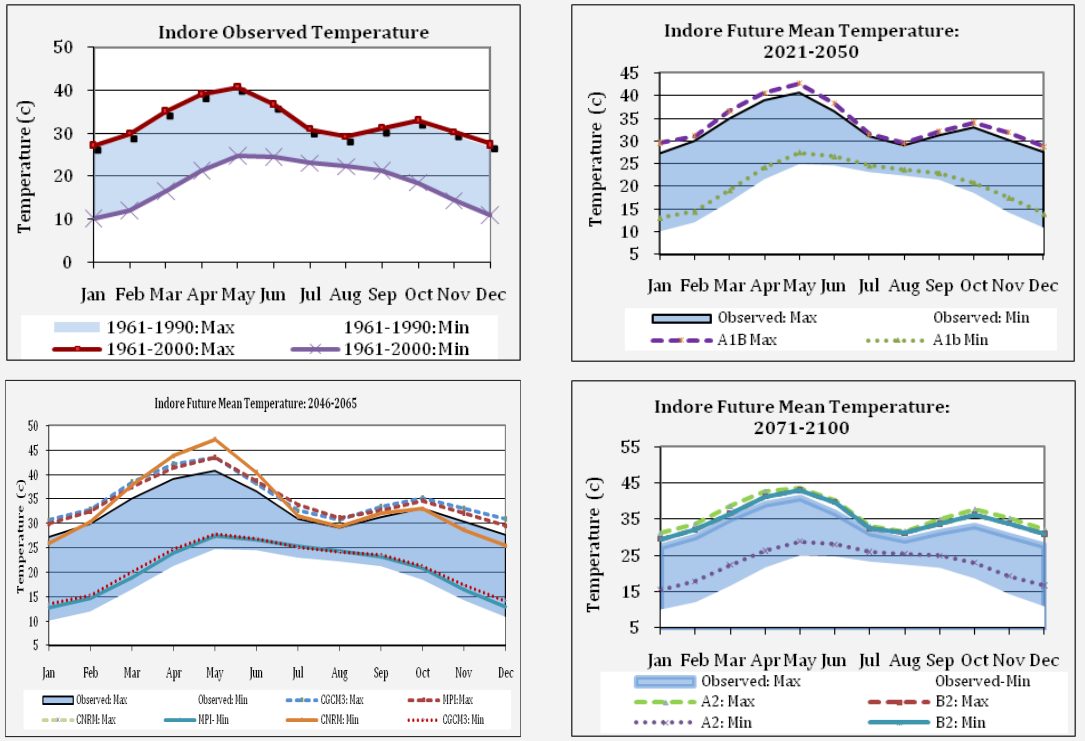
Indore is located on the drought prone Malwa plateau. Indore was known for salubrious climate with night temperatures less than 25^0 C and day temperatures reaching around 40^{o}C in summers. The winter temperatures at present go as low as 10^{0}C. The long term average annual rainfall is about 943 mm, with variation within the years. The monsoon rainfall account for about 90% of the annual rainfall.`

2. Temperature Change Prognosis

Result from the climate change models indicate that the monthly notable average minimum temperature in Indore may increase by about 2^{0}C by 2030's to about 3-4^{0}C by 2080's. The Urban Heat Island (UHI) effects may add another 2-4^{0}C over and above these figures.

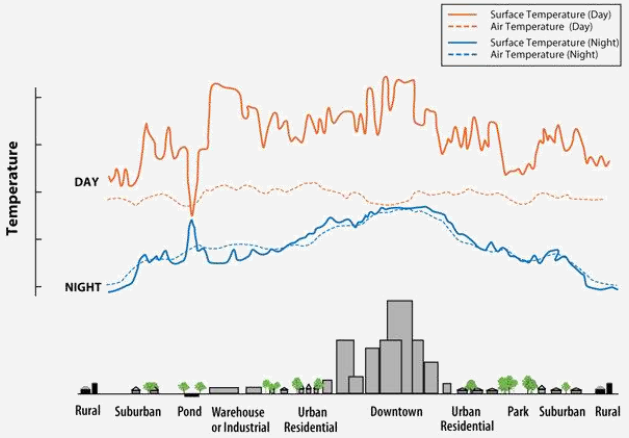
Most of the models indicate that the maximum increase is expected during winters. This may extend viability period of some of the disease vectors well into winters. The March to September period may require space cooling devices working through the day and night, considering the addition from UHI effects. The maximum temperatures on some summer days may reach close to 50^{0}C, which impact people who maybe travelling for work. This increased temperature may increase the consumption of energy for cooling.

Observed and Future mean monthly temperature ranges: 2021-2100



Source: TARU analysis, 2010; GHCN 2009 and CSAG, 2010

Urban Heat Islands Effect



Source:
Based on Voogt, 2000

Precipitation

1. Precipitation Change Prognosis
2. Data Sources

1. Precipitation Change Prognosis

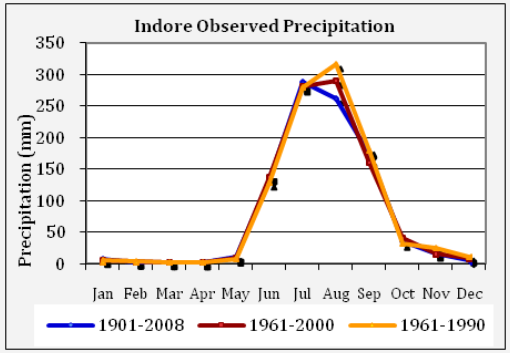
Rainfall scenarios for Indore city show higher diversity. An increase in annual rainfall of about 200 mm is predicted by A1B scenario of PRECIS regional model for 2030's, while an increase of about 100-150 mm is predicted by CGCM3 for 2050s while CNRM and MPI models do not indicate much change. The A2 and B2 scenarios under PRECIS predict an increase of about 330 and 250 mm in the annual total rainfall.

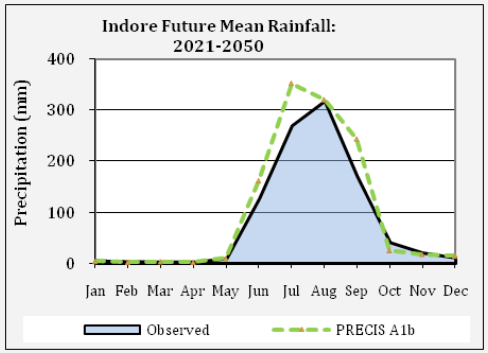
There are a number of low lying areas across the city and therefore excess rainfall/intense precipitation will increase short term flood risks. Water logging and associated health risks may be of great concern. The city severely lacks sewerage infrastructure. The rainfall prediction is less certain than temperature changes, especially considering the terrain of Indore city.

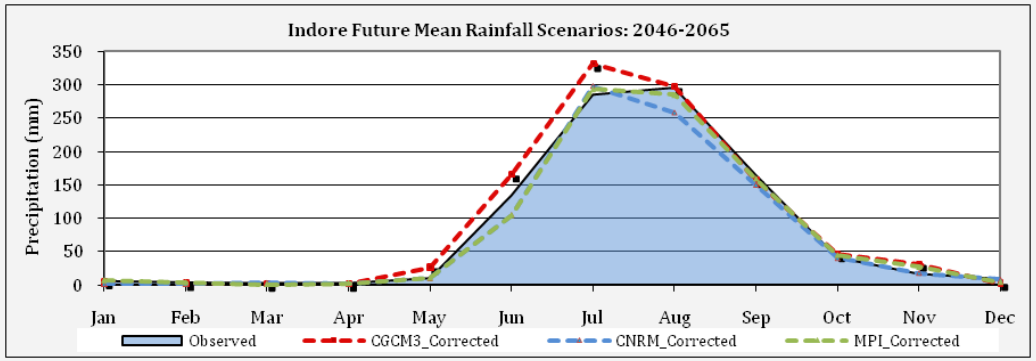
2. Data Sources:

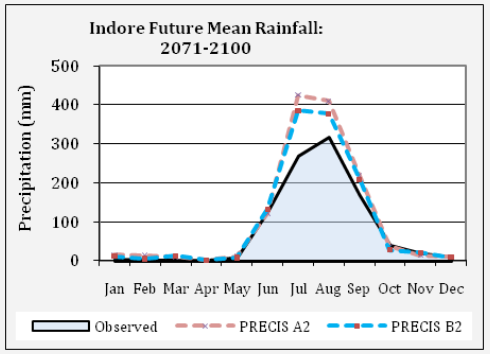
Global Climate Model (GCM) results were procured from Climate System Analysis Group (CSAG) and downscaled Regional Climate Model (RCM) results were procured from India Institute of Tropical Meteorology (IITM), pune and were analyzed for Indore city by TARU.

Future mean rainfall ranges: 2021-2100









Source: TARU analysis, 2010; GHCN 2009 and CSAG, 2010

POSSIBLE IMPACTS

Physical / Environmental	Social	Economic
		
Water: Water supply/ Sanitation / Water Logging	Public Health	Energy
Land use and Planning	Social Cohesion	
Solid Waste Management	Institutional	Domestic (Life style) / Industry Loss Estimation– Gross value added Capital Water Scarcity
Transport		

Water Supply

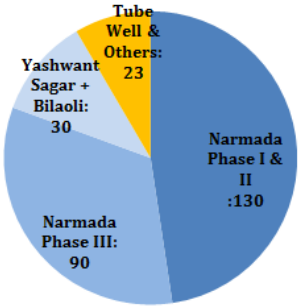
1. **Supply Sources**
2. **Present Need Vs Supply**
3. **Possible impacts due to urbanization, poverty, Climate Change**
4. **Projected need vs projected supply**

1. Water Supply Sources:

Indore Municipal Corporation manages the water requirements of city. The water need of the city is catered from multiple sources such as Narmada river, local reservoirs, ground water and private water suppliers (tankers). The two groups Surface and Sub-surface has following shares in fulfilling the water requirement of the city.

a. Surface Water: About 92% of Indore's water supply comes from surface water. The Narmada Water Supply Scheme contributes to (81%), remaining is from Yeshwant Sagar Reservoir and the Bilaoli Tank.

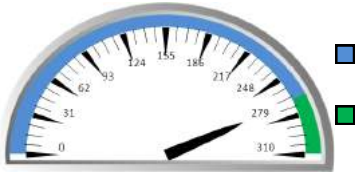
b. Sub surface water: Tube wells as a public water supply source constitutes to about 8% of the total water supply. There are also more than 30,000 private tube wells & precise information regarding these tube wells is currently unavailable.



(Values in MLD)
Source: IMC, 2011

2. Present Need Vs Supply:

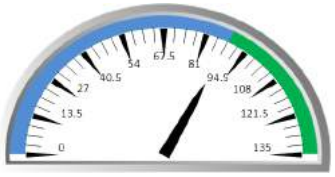
Out of the 273 MLD of water supply to the city, the ground water is estimated to provide around 23 MLD. The water security study (ACCCRN Phase II, 2010) reports illegal water connections in the range of 20,000 to 40,000 accounting to 30-50% loss. Failure or repair of Narmada supply is witnessed occasionally. The local sources (reservoirs) have silted up and have lost nearly 25% of their capacity. Based on the projections form the past growth rate it is expected that the population will increase to about 4 million by 2030. Industrial demand is expected to double from 30 MLD to 60 MLD by 2030. After deducting the current supply, a gap of 360 MLD is expected by 2024. Total net requirement is expected to reach 564 MLD by 2024. Narmada piped supply is expected to provide 360 MLD by 2011 and an additional 360 MLD by 2024. Based on climate change and urban growth scenarios, the study indicates possibility of competing demands rising from upstream irrigation and urban users.



Present Water Supply - 273 MLD

Installed Capacity - 309 MLD

Source: IMC, 2011

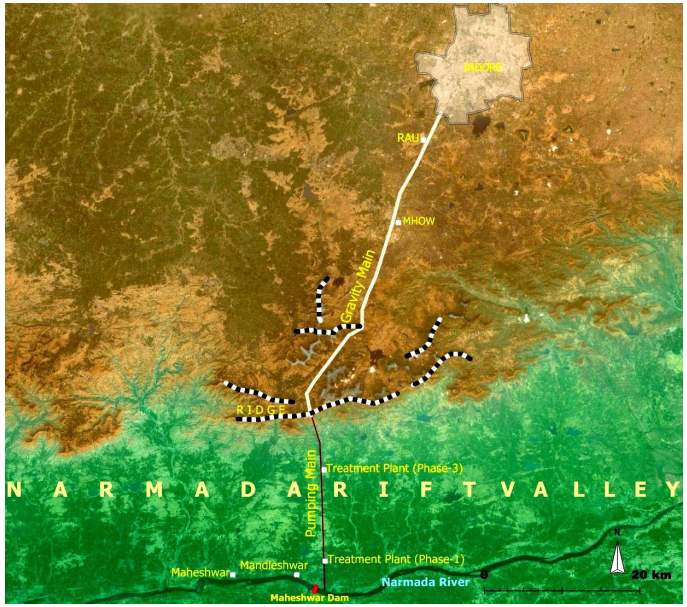


Present per capita water availability - 90LPCD

CPHEEO Standard - 135 LPCD

Narmada Water Supply (NWS) Scheme:

Today the most important source of water for the city of Indore is the Narmada Water Supply Project which involves pumping water from a distance of 70 kms. away from Narmada River, and supplied to the city by pipelines. Despite the long distance and costly supply of the water to the Indore; the per capita water availability remains still under the prescribed standards of CPHEEO (Central Public Health & Environmental Engineering Organization). The total water supply to Indore is 273MLD including the third phase of Narmada project. The water is supplied on every alternative day in the city for maximum of two hours.



Water Supply

1. **Supply Sources**
2. **Present Need Vs Supply**
3. **Possible impacts due to urbanization, poverty, Climate Change**
4. **Projected need vs projected supply**

3. Possible Impacts

The important issues which are likely to adversely affect the water requirements of the Indore city will be rapid urbanization, changing the land use land cover of the city, increasing migration (floating population) in search of education, employment. With water crisis already set in the city and further impacts of climate variability; indicate a bleak water security in future. This demands to reverse the accelerated depletion of existing water sources of the city of Indore and also to work towards strengthening the water supply in Indore. Water supply will remain as the critical service sector for Indore.

a) Impacts of Poverty & Migration:

The city is located in the semi-arid zone with high variability in annual rainfall. Agricultural risk prone region lying in rain-shadow zone of Western Ghats surrounds the region. The terrain is hilly especially towards west and south. The land quality is poor with rocky exposures and low per-capita cultivable land. The region is inhabited by a mix of tribal and caste base population who are predominantly poor. Any changes in climatic conditions can further increase the risk to subsistence agriculture. This is currently forcing the rural population to migrate to the nearby cities. With booming economy, Indore is providing opportunities of employment for in-migrants. These rural migrants are skill poor and the city economy may be affected by the push migration.

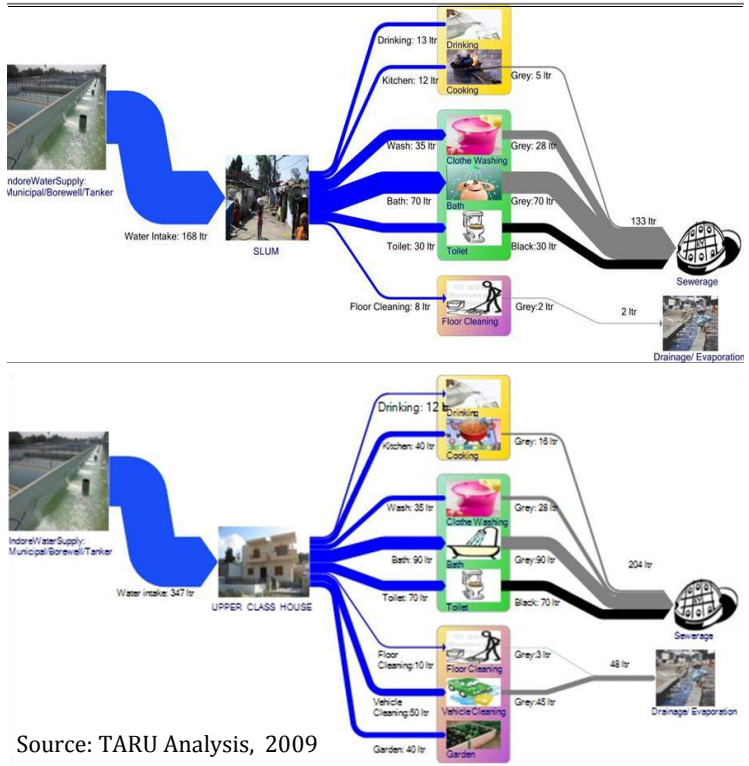
On the other hand, Indore may attract skilled workers with the growth of secondary and tertiary sectors. Its current potential to attract educational and medical institutions will be an added advantage. Such pull migration is likely to result in demand for better services and ability to pay for better services.

Therefore, the combination of **Push and Pull** migration pattern will be most important critical uncertainty for the future and it will also impose pressure on resources and there will be additional load on the water supply and infrastructure to cater the needs of the expanding city.

The average requirement of the water in the Indore city is presented in following diagrams. First represents the requirements of slums of upper Socio Economic Classes (SEC) of the city.

Installed capacity and current status of water supply (MLD)

Water Source	Existing Capacity	Supply	Status of source
Bilawali Tank (BT)+ Yashwant Sagar	30		Rain fed - Seasonal. Completely dried up this year
			Rain Fed - Sustainable. Being augmented
Narmada Phase I & II	180	130	Perennial - sustainable
Narmada Phase III	90	90	Perennial- sustainable Initiated in the year 2011
Total Surface Sources	309	250	-
Tube Well & others		23	Unsustainable, drying up, over exploited resource, prone to contamination, uneconomical. Difficult to get exact numbers
Total all sources	309	273	-



Source: TARU Analysis, 2009

Water Supply

1. **Supply Sources**
2. **Present Need Vs Supply**
3. **Possible impacts due to urbanization, poverty, Climate Change**
4. **Projected need vs projected supply**

b) Impacts of Climate Change:

Water requirement of Indore city is currently met from river Narmada and Gambhir of Ganga Basin. The rivers are monsoon fed and dependent on ground water and regeneration for their base flow. The average annual rainfall is expected to rise by 200-400 mm for Narmada basin (including Choral) and about 150-200 mm for Gambhir, which is around 10-30% of average annual rainfall. Most of future requirement will also be met from Narmada water upon the completion of Phase-III of Narmada water supply project.

Studies indicate that there is a possibility of only a marginal increase (+200 mm) in annual rainfall during year 2021-2050. Even with increased precipitation, the city may have to depend mostly on Narmada resources due to lack of capacity of the local reservoirs and also deteriorating quality of water due to urbanization within the catchment areas. The water security study has indicated about 5% increase in evapo-transpiration, which will offset much of the increase in precipitation.

Narmada Water Dispute Tribunal (NWDT):

As per NWDT award provisions, Madhya Pradesh is mandated to release a uniform annual flow of 10,015 MCM (8.12 MAF) e.g. Maheshwar, for downstream use in Sardar Sarovar Project of Gujarat state. In a year with 75% dependability, MP has 18.25 MAF of water and there is no shortage of water from Narmada water supply. But when the minimum flow of 12,870 MCM (10.43 MAF) is further reduced by 10-20% in severe drought year due to climate change than Madhya Pradesh government might have to release 5,150 MCM (4.176 MAF) and is left with only 5,490 MCM (4.26 MAF) for allocation to 25 Major, 130 Medium & Thousands of minor irrigation project upstream of Maheshwar Hydel Project i.e. intake of Narmada Water Supply. Additionally, in year 2041, when planned withdrawals from Narmada for Indore would be 720 MLD i.e. about 263 MCM(.213 MAF), other water supply schemes for Mega cities like Bhopal and Jabalpur would be competing with Indore for water and desired quantity of water may not be available to the city.

Water demand calculations for 2024 and 2039

Sl. No.	Particulars	Year 2024	Year 2039
1.	Population (millions)	3.30	4.80
(a)	Population with house connection facility (83.75%)	2.764	4.020
(b)	Population with public stand posts facility (16.25%)	536	780
	Sub Total	3.30	4.800
2.	Water demand @ 135 lpcd for connections & 40 lpcd for public stand post		
(a)	135x2.76 (year 2024), 135x4.020 (Year 2039)	373.14	542.70
(b)	40x.536 (Year 2024), 40x.780 (Year 2039)	22.44	31.20
	Sub Total (MLD)	396.00	574.00
3.	Fire fighting demand @ √100/ P	6	7
4.	Provision for enroute villages	5	10
5.	Provision for industrial demand	30	60
6.	Provision for MHOW	35	50
7.	Provision for Institutional demand-CAT	7	20
	Gross Demand Ex. Bijalpur	479.00	721.00
8.	Distribution losses @15%	85	128
9.	Provision for Dewas	10	15.00
	Total Net Requirement	564.00	864.00
10.	Deduct quantity presently available from various source		
(a)	Narmada – 170 MLD	170	170
(b)	Yashwant Sagar – 20 MLD	29	44
(c)	Biloali – 9 MLD		
(d)	Tube wells – 15 MLD		
	Net Demand	360.00	650.00
	Source: Water Security Sector Study, 2009		

Sanitation / Waste water

1. **Present Condition**
2. **Possible impacts due to urbanization, poverty (aspirational growth), climate change**

1. Present Condition:

Indore city did not have a proper sewerage collection and disposal system. Sewer line were laid 67 years back for a population of about 150,000 covering 10% of the city. With local network of 1,710 km of roads only 600km is provided with a sewerage system including the 47 km of sewers by IDA under ODA project without provision of any sewage treatment along river & natural drains. River Khan flows from south to north and traverses through the densely populated area of Indore city. Various Nalla join Khan River are as follows:

- Piliakhal Nalla, flowing through populated area of eastern Indore joins River Khan at Kulkarni Bhatta.
- Palasia Nalla flowing through populated area of western lndore joins Khan river near Sukhaliya village.
- Bhamori Nalla flowing through populated area of eastern part joins Khan river at Kabit Khedi.

All these nallas are khacha (semi engineered) i.e. no lining or proper bunding of these nalla has been done till date. The total length of these nallas is 200 km. These nalla are water logged round the year as large quantity of Municipal Solid Waste (MSW) are dumped into them.

All these nallas pass through the densely populated areas of the city. Thus dumping of solid wastes drainage create water logging. These water logged nallas, turn into breading ground of larva and many water borne viruses. The condition of sewerage and drainage is poor in most areas due to limited investments in the past along with poor maintenance. The results also indicate that significant proportion of middle class and upper SECs do not have adequate access to sewerage (septic tanks, soak pits etc) and drainage.

2. Possible Impacts:

Increase in intensity of precipitation can result in increased frequency as well as intensity of water logging. Since the city has black cotton soil, in the events of floods very low coverage of storm water drainage and limited sewerage will prolong the duration of water logging/flooding. Without integrated storm water drainage and flood control plan, the city may be subjected to more frequent and intense floods under climate change scenarios. Haphazard growth and blockage of natural drainage may further worsen scenario. The low permeability of black cotton soils as well as poor solid waste collection system may further aggravates this situation. During and after rainy seasons, outbreaks of mosquito borne diseases like malaria and dengue may prevail.

Sewerage Network under JnNURM programme:

Under the JnNURM, IMC is developing primary sewerage network (300mm to 2200mm diameter pipe) of 149.84km. Out of that 136.07 km network is completed. Planning for secondary sewerage line will be beginning by this year 2012.

Sewerage treatment facility under JnNURM programme:

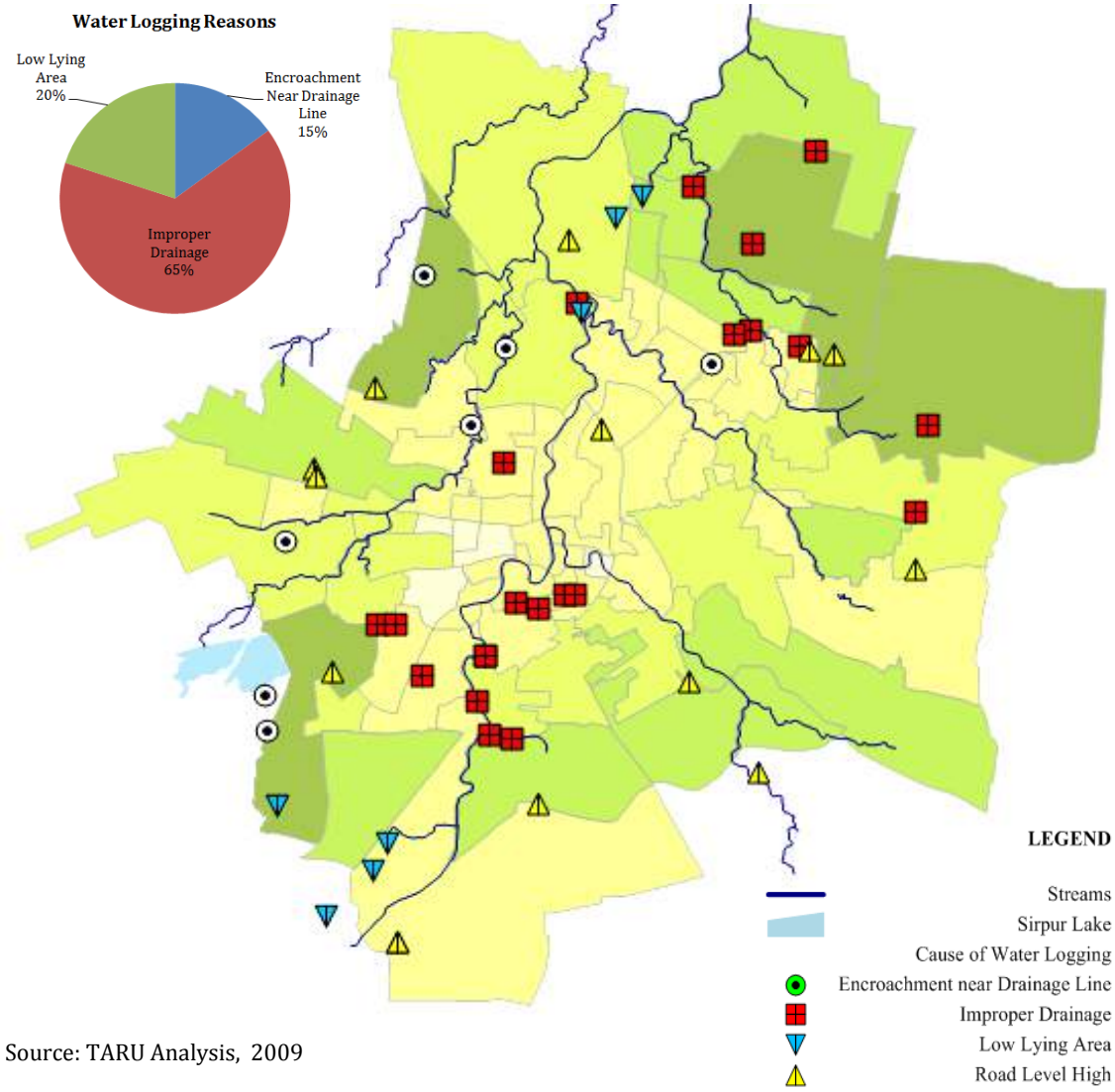
IMC is planniang to build STP of 245 MLD capacity under JNNURM. Presently, STP of 122.5 MLD capacity is under construction at *Kabitkhedi* by IMC. It is being constructed with C-Tech technology (sequential bed reactor). This plant is addition to the existing STP plant which has capacity to treat 90 MLD. The technology being used is USAB for existing STP plant.

- Two Sewerage Treatment Plant of brick and arch type are operational with capacity of 78 MLD and 12 MLD. Later the treated sewerage is discharged in Khan River.
- Choking due to solid wastes and breakage in lining of this system are important issues and need to be addressed.

* National Institute of Public Finance and Policy

Water Logging

City Experience (2009)



Source: TARU Analysis, 2009

Water Logging Scenarios:

With sudden down pouring the short duration floods (pluvial) occur and pose risk to this city. Flat terrain, insufficient drainage and settlements, especially slums growing along and on the drainage lines and immediate flood plains increase the risk exposure. Majority of slums are flood prone due to blockage of local drainage with construction of roads, building, and boundary walls. The road construction is also increasing the flood risks since less than 20% of the roads have drainage.

Water logging often continues for weeks after floods. Some areas are perpetually water logged due to lack of sewerage and blockage of natural drains.

City Experience

During the last decade, three events of floods (2002, 2005, and 2009) with increasing intensities have taken place. For example, during the 2009 floods, water logging continued for three days in many places and several weeks in some areas even after the cessation of rains. This happened largely due to new roads and blockage of drainage channels. Many residents reported having invested in increasing plinth heights and other coping mechanisms. A bout of dengue fever was reported across the city for several weeks after the rains.

Land Use and Planning

1. Mounting Urbanization
2. Impact of Urbanization, poverty and Climate change
3. Land use patterns

1. Mounting Urbanization

Land is not a major constraint in Indore, except for the core area of the city. The population growth within municipal wards indicates that the core area is getting depopulated and converted into commercial areas, while there is higher growth in outer side of core and periphery. Except for the core and lower income group colonies, Indore has significant open areas. The population growth is likely to put pressure on these open areas.

While there is growing trend of building multi-storey buildings as well as increasing use of glass cladding in the city, the urban heat island effect and increased energy use density(for space cooling) can worsen with haphazard high raised buildings blocking free flow of winds. A significant number of low height buildings (up to 3 story) especially along the main roads currently seen in the outer core may get converted to high rise buildings.

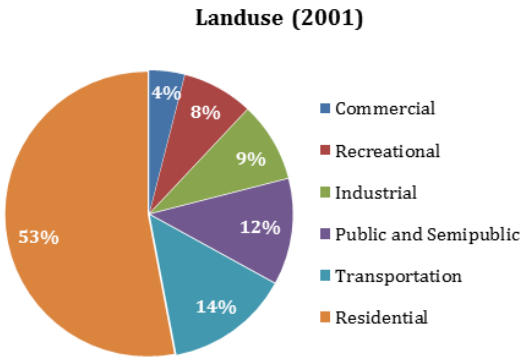
Two main growth axes are visible in the development pattern of the city. They include South-west (towards Mhow) & north (towards Ujjain).

2. Impact of Urbanization, poverty and Climate change

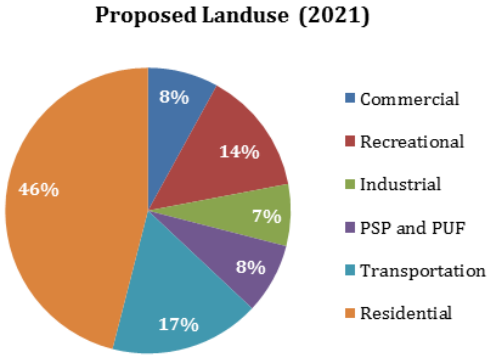
Migration is also an important and a dynamic factor in projecting the future population. However, there are no figures, which can suggest the migration rate or its pattern. But there are enough evidences to show that migration is indeed a very important criteria for projecting the population. Many people from small to medium towns come to Indore. Moreover, people from one area cross over to another area in the same city due to many reasons. Though these are not seen in overall figures, they may have a major effect on the housing and residential patterns of the city.

3. Land use patterns

Demand for commercial space in the city is highly increased as Indore is among one of the major commercial hub of central India. Percentage of residential space has remained relatively constant in last 30 years as. More high rise apartments are taking their place in the city and result is less plotted development. Indore development authority gives more emphasis on recreational space in the city as about 15% of developed area is assigned for recreational buildings in Indore Development Plan (IDP) 2021.



Source: CDP, Indore



Source: Green Building Sector Study; 2009

IDA has developed approximately 30,000 properties for residential, commercial and other uses

Solid Waste

1. **Present Status - Waste generation**
2. **Transportation, processing & disposal of waste**
3. **Future Projections - Impact of Urbanization, Poverty and Climate Change**

1. Present Status: Waste generation

At present, about 850 tons /day of Municipal Solid Waste (MSW) is generated. The stages of SWM are very poor, from collection to transportation and disposal of refuse. Presently the IMC removes only about 70% of generated solid waste from the city. The waste is crudely dumped at *Devguradiya* trenching ground, about 12 km away from the city, that too with an inadequate approach road.

120 Dumpers

1,120 Garbage containers

2. Transportation, processing & disposal of waste:

MSW is collected and transported by 120 dumper placer vehicles and 1,120 containers of different sizes ranging from 2.5 cum to 7.5 cum capacity. IMC has employed 5,400 sanitary workers for street sweepings and primary collection of waste. Recently Secondary collection and transportation of waste is outsourced to a private contractor due to which the collection efficiency has increased from 50% to 70%. There are 2 land filling sites in *Devguradiya* developed by IMC funded by ADB and JNNURM. Based on the data for the year 2008 (700 metric tons), a land filling site requiring 40% inherent material for land filling is constructed (Source: IMC).

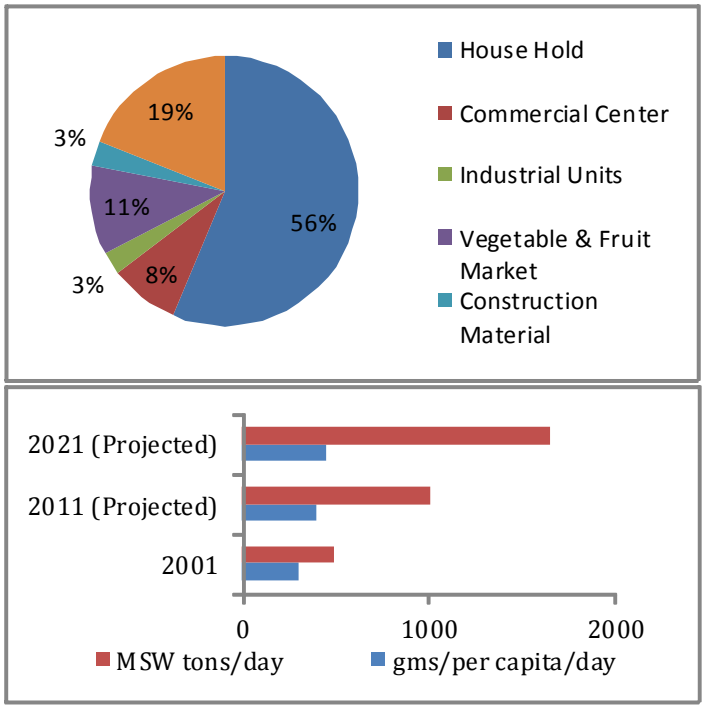
3. Future Projections: Impact of Urbanization, Poverty and Climate Change

Rapid urbanization and changing lifestyles will result in increased generation of municipal solid waste in Indore city. Moreover the municipal area of the city will increase in the future too. Proper collection, transportation and disposal system as per MSW rules 2000 is required for the city. This includes training and awareness for existing staff and citizens of the city.

Piliakhal, Palasia & Bhamori nallas are Kacha and currently has no lining or proper bunding. These nallas have length of 200 km, average width of 10 to 15m, depth of 5 to 8m and average MSW layer of 1 to 2 m. These nalla are water logged round the year as large quantity of MSW is thrown into them, which lead to formation of methane, NOx, H_2S etc. Water logging and dumping of MSW in these open drains make them septic. The total quantity of septic mass generating methane, NOx, H_2S etc. is more than 2000 MT. The polluted water of these nallas pollute surface water as well as ground water sources due to which various diseases like dengue, malaria, chikungunya, typhoid, yellow fever etc are prevailing, in the city of Indore. Future projections for population and MSW generation is presented in the table. It shows that per capita generation will increase from 400 gms/capita/day to 1013 gms/capita/day.

MSW Generation	
Population 2001	1,639,000
Population 2011	19,60,631
Population density , 2011	15,070
No of Households	435,018
% slum population	27%
No of wards	69
No of zones	15
MSW (2001)	617 mt/day
MSW (2012)	850 mt/day
City Area	130.17 sq.km

MSW generated per day at source



Source (figure and table): Solid Waste DPR, IMC

Transport

1. Present Condition - Travel Mode & Existing Problems
2. Possible Impacts due to urbanization, Climate Change

1. Present Condition - Travel Mode & Existing Problems

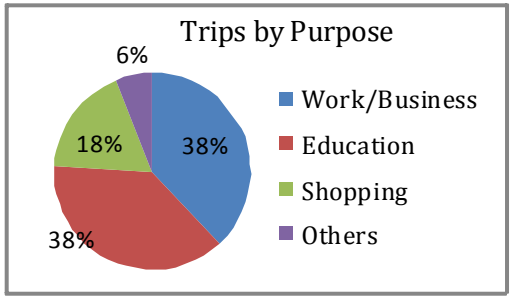
Indore, like other cities across India, is facing explosive growth of vehicles with no commensurate increase in road lengths. The annual growth rate of vehicle population in city is about 8.8%. The city has on an average 0.98 vehicle per household. Nearly half the trips are performed by private vehicles. Two wheelers account for nearly half the vehicle km covered. Nearly 75% of the trips are scheduled trips for work and education. Further more than 57% of the vehicles are parked on the main roads due to lack of parking facilities. Nearly 78% of the road network has no drainage and 15% has drainage on only one side of the road.

The study points out that increasing and intensification of precipitation is a major hazard for managing the transport network. Intense rainfall and water logging will be major issues that would increase the maintenance costs of road network in this city with expanding soils and flat terrain.

The temperature increase is likely to increase impacts of pollution as well as discomfort during summers, especially for two wheeler passengers .

The following important points requires suitable adaptation means to ease the traffic congestion in the city, especially during the peak hours.

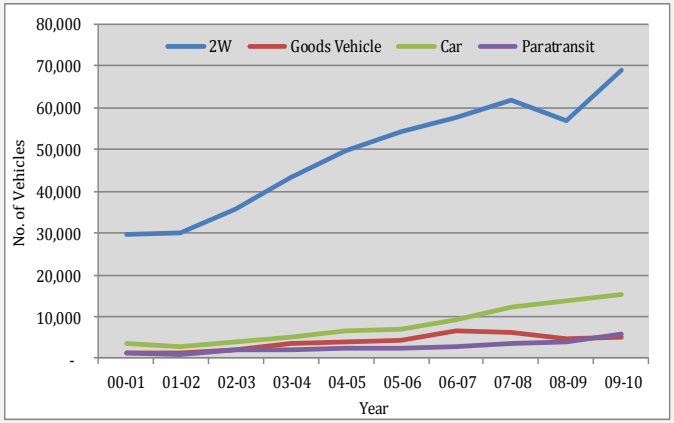
- 57% of the road network does not have on-street parking, thereby reducing the carriageway width for traffic movement.
- 78% of the road length does not have roadside drainage facility.
- 82 % of the road length in the city has undivided carriageway and from capacity and safety consideration needs attention to prevent possible head on collisions.
- 90% of the road network, there are no provision for service lane
- 92% of the road length does not have footpaths, thereby forcing the pedestrian to walk on the carriageway, which in turn reduces the available width for vehicular movement.
- There are about 400 Kms of missing links as per the Draft Indore Development Plan 2025. This problem of missing links are planned to be addressed within future Projects.
- 17% of the network does not have any street lighting facility endangering the safety of road users at night..



Transport

1. Present Condition - Travel Mode & Existing Problems
2. Possible Impacts due to urbanization, Climate Change

Growing vehicles numbers



BRTS:
Mass public transport system will be introduced & Reduction in traffic congestion and road accidents

Para - Transit Vehicle in Indore City

Van

Magic

Auto Rickshaw

City Bus

Tonga

Transport

1. Present Condition - Travel Mode & Existing Problems
2. Possible Impacts due to urbanization, Climate Change

2. Possible Impacts due to urbanization, Climate Change

Temperature:

Impact on Urban Transport Infrastructure

The impacts on urban transport infrastructure in Indore are attributed to infrastructure construction and development activities. The construction and development practices in urban transport infrastructure are been designed considering prevailing set of climatic conditions. The climatic change in terms of temperature increase will affect the infrastructure; this will be seen as impacts on pavement condition for both flexible pavement (Asphalt) and rigid pavement (concrete). The asphalt pavement may face higher level of weathering action due to temperature increase and heat waves, while the concrete pavements may face higher thermal expansion than anticipated at the time of design. The same effect may imply to concrete structures such as bridges.

Impact on Urban Transport Operations

The impacts on operation of urban transport may be expected in terms of higher maintenance cost of vehicles. This will be because like vehicle overheating and faster wear & tier of tyres. Further, the over crowding situations in the public transport might not be comfortable with increase in temperature and heat waves which may discourage people in using public transport.

Precipitation:

Impact on Urban Transport Operations

The intense rainfall event will increase the water logging (pluvial flooding) risk and may disrupt of transport operations. This problem will increase in the absence of proper storm water drainage system. The disaster management during severe flooding will take blow due to disruptions in transport operations.

Impact on Urban Transport Infrastructure

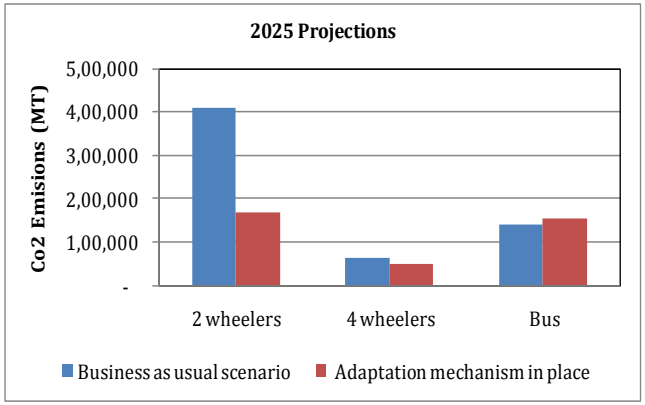
The soil type in Indore is black cotton soil; which is highly sensitive to moisture and has expansion and shrinkage characteristic. This might damages the pavement in the event of water logging situations. The intense rainfall event will cause water logging on the transport corridors. The prolonged water logging in the absence of planned as well as poorly maintained storm water drainage system will deteriorate the pavement condition which will have adverse effect on maintenance cost of transport infrastructure.

Expected Green House Gas (GHG) Emission and its impacts

Total base year GHG emission in Indore due to urban transport is 146,378 Metric Tones of $C0_2$ equivalent GHG emission. The major share of $C0_2$ equivalent GHG emission is due to two wheelers i.e. 65% while that of un-organized Public Transport is 20%.

Though there are adaptation measures in place in the form of proposed comprehensive mobility plan and integrated transportation plan for Indore, which targets large scale modal shift to public transport and maintaining the existing share of cycle trips, the GHG emission due to urban transport in Indore for Horizon Year (2025) in the business as usual scenario is estimated.

The total horizon year (2025) GHG emission in Indore due to urban transport in a scenario of successful implementation adaptation mechanisms already in place is 372,976 Metric Tones of $C0_2$ equivalent GHG Emission, which is 2.5 times the base year emission.



Source: Transport Sector Study, Indore; 2009

The major share GHG emissions still is from two wheeler users with 45% share followed by MRTS and standard buses with 24% share and Indore Para Transits (IPT) with 17% share.

Health

1. Present Issues
2. Possible Impacts

1. Present Issues

Vector borne disease outbreaks have become more common over last decade due to combined effects of urban development without sufficient drainage. Integrated drainage development has not been done so far. Only about 20% of roads have drainage. Poor solid waste management has further blocked the natural drainages. Along with water logging, increase in humidity, increase in minimum temperatures are likely to extend the disease vector viability periods and may worsen the health scenarios with increased vector borne disease incidences.

Health hazard due to air pollution:

Climate change results from both natural and human processes. Emissions of greenhouse gases affects human health at different scales. Major primary pollutants produced by various human activities leads to deterioration of ambient air quality are as follows:

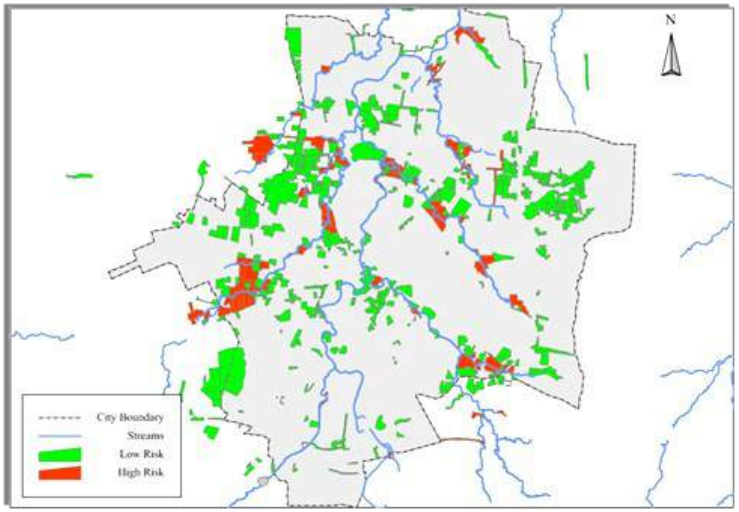
- **Particulate matters:** Increased level of fine particles in the air are health hazard causing heart diseases, altered lung function, seasonal bronchitis and lung cancer.
- **Oxides of Sulphur:** Coal and petroleum products contain sulphur compounds, their combustion contain sulphur dioxide which causes various health hazards.
- **Oxides of Nitrogen:** Oxides of Nitrogen are emitted from high temperature combustion. During winter brown haze plume downwind of cities can be seen which indicates the air quality deterioration. Oxides of Nitrogen causes various health hazards.
- **Carbon Monoxide:** Carbon Monoxide is generated from vehicular exhaust, incomplete combustion of fuel, such as natural gas, coal, wood etc. it is a very poisonous gas and causes various health hazards.

2. Possible Impacts

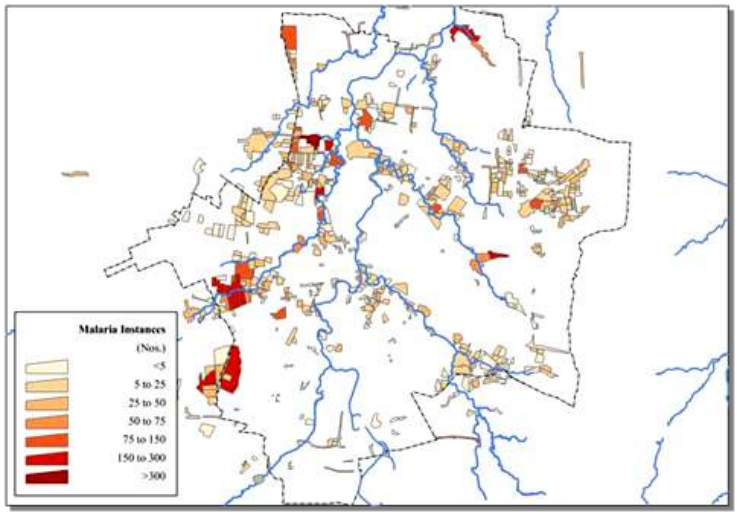
Water logging locations of the city

The dengue epidemic of the year 2009, is believed to be due to prolonged water logging in the city and affected all socio-economic groups. The threat to the health is high due to poor water quality, and vector borne diseases. The disease surveillance system is not able to provide advanced information and hence, the urban authorities are forced to take knee jerk control action after the outbreaks which creates panic in the city. It becomes too late to take actions, except providing medical aid until the winters reduce the mosquito breeding. The situations are more sever especially in the slum areas of the city and the poor remains the more vulnerable to such disease outbreak event.

Water Logging in Slums of Indore City



Malaria instances (2009)

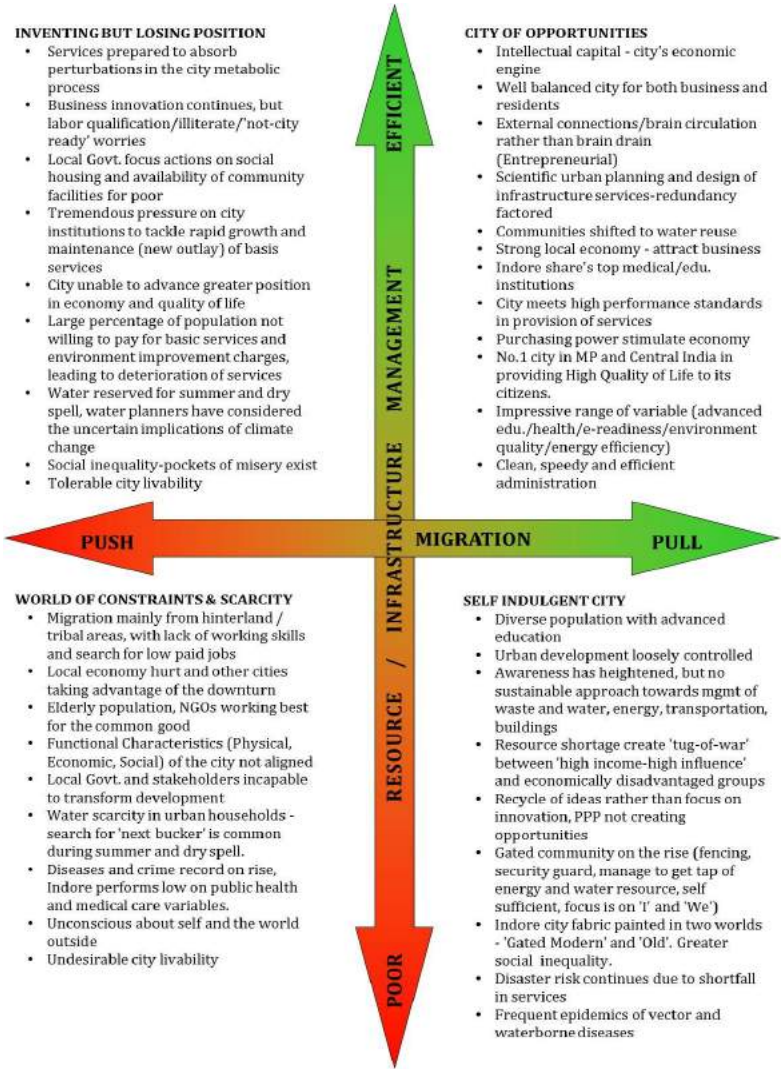


Source: TARU Analysis, 2009

Social Cohesion

1. **Critical Uncertainties: Migration and Migration patterns & Resource/ Infrastructure Management**
2. **Scenarios**

Critical Uncertainties & Scenarios



1. Critical Uncertainties:

As a part of the study in the city during ACCCRN P-II project, TARU and the City Advisory Committee (CAC) undertook a scenario building exercise to understand the possible future uncertainties and possible future for Indore.

The Risk to Resilience Workshops identified two major uncertainties that would determine the growth of Indore. (a) Migration Pattern and (b) City Level Resource/ Infrastructure Management.

(a) Migration Patterns:

The city is located in the semi-arid zone with high variability in annual rainfall. Also, it is surrounded by complex, diverse risk-prone agricultural region lying in rain-shadow zone of Western Ghats. The terrain is hilly especially towards west and south. The land quality is poor and per capita cultivable land is low. It is inhabited by a mix of tribal and caste population who are predominantly poor.

Any change in climate can further increase the risk to subsistence agriculture and rural population is forced to migrate to the nearby cities, with economically stronger Indore becoming the destination for the migrants. These rural migrants are skilled poor and the city economy may be affected by the push migration.

On the other hand, Indore may attract skilled workers with the growth of secondary and tertiary sectors. Its current potential to attract educational and medical institutions will be an added advantage. Such pull migration is likely to result in demand for better services and ability to pay for better services. Therefore, the migration pattern will be most important critical uncertainty for the future

(b) City level resource / infrastructure management:

Since Indore city is more dependent on distant water resource i.e. Narmada River to meet its growing water demands, the cost recovery will be a challenge for managing water infrastructure of the city. Also, the increasing energy costs can add additional burden on the IMC. The maintenance as well as capital investments required will depend on the city's ability to recover the costs. Considering the huge gap in municipal finances, the ability to charge the consumers and to maintain the infrastructure will be another major critical uncertainty.

Figure provides a schematic view of the two critical uncertainties i.e. improvement or deterioration in city level resource/infrastructure management in tandem with the city's migration pattern and possible outcomes that could arise.

Social Cohesion

1. **Critical Uncertainties: Migration and Migration patterns & Resource/Infrastructure Management**
2. **Scenarios**

2. Scenarios

Resource Use Growth Under Various Scenarios:

Critical issues:

Two critical issues will determine the use of resources and quality of services.

First, is the issue of technological options for conservation and reuse. Over next two decades, several technologies and systems are expected to emerge to improve energy use and water reuse options. However, these would require concentrated efforts and investments to implement these technologies and processes. The experience so far indicates that IMC has continued to depend on new investments on capital infrastructure without focusing on reducing leakages and wastage of existing local resources, while many other cities have already gone ahead with demand side and supply side interventions.

Secondly, the actions for meeting demands for services and better governance are required for change. This should also take care the capacity building and harmonization of changes in the system as a whole requiring lots of efforts. At the administration level, the willingness to change is not pervasive. Continued donor involvement has not resulted in major changes and most of the changes are transient. Citizen involvement is more critical and their constructive and constant engagement is necessary for change.

Resource use:

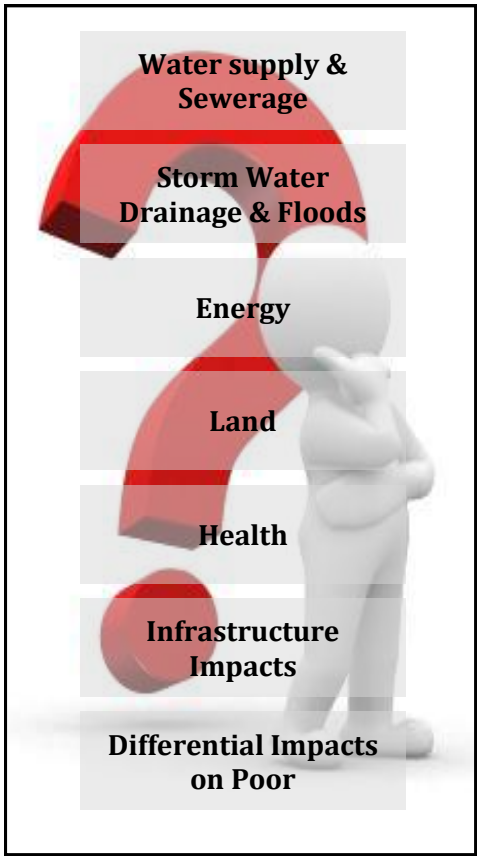
Under pull migration led growth scenario, the resource use is likely to grow more than the population growth as indicated in energy sector study. As seen in the past, actual demand is likely to overshoot the demand projections used for designing new infrastructure. The ability of the IMC to improve resource use efficiency will be critical in maintaining the lowest possible growth in demand and increasing reliance on high energy demanding external resources.

Under push migration led scenarios, the growth rate of resource consumption is expected to be much lower due to low capacity to pay and no significant change in quality of life. Poor O&M will also result in continued high losses.

The urban growth have significant impact on the city's natural environment. High population growth may increase the demands, which cannot be met concurrently with the poor infrastructure, poor financial condition of the urban local body, lack of capacity, issues of political will and consensus. This would mean partial solutions leading to worsening of the urban environment. This may affect water supply, drainage, sewerage and solid waste management. Unless there is a paradigm shift among institutions, planning, infrastructure design and management of services, the environmental conditions are likely to worsen. Climate change is likely to add to above mentioned problems.

Scenarios

Based on two critical uncertainties identified by the City Advisory Committee, four future scenarios were developed. This provide a combination of push or pull migration and resource/ infrastructure management. This scenario reflect the situation which may appear for the year 2030-2040 time period and are based on the set of certainties and uncertainties identified by CAC members.



Institutional

1. City Government Setup & Institutes
2. Possible Impacts

1. City Government Setup

Madhya Pradesh is one of the first states to initiate decentralization after the 73rd and 74th constitutional amendments by the enactment of the conformity legislation in 1993. It has conducted four rounds of elections to form the local governments and has been the front runner in implementing the recommendations of the State Finance Commissions.

The 74th amendment gave the local bodies a constitutional status and assigned them a large number of functions, ensured more stability, provided a framework to function with greater freedom and also made institutional arrangements for devolution of financial resources.

The city of Indore had its first municipality in 1870. In the year 1956, it was declared as a Municipal Corporation and is currently governed by the Madhya Pradesh Municipal Corporation Act, 1956. The **Indore Municipal Corporation** (IMC) is divided into 14 Zones (2010, update in 2011) administered by two functional bodies namely Political Wing (deliberative) and Executive Wing*.

Indore has a much narrow taxation base and the municipal financial situation is not strong in the city. With most of the industries located outside the city limits, the IMC has not been able to balance the operating and management costs of most services. Despite its current size, the IMC is not able to generate excess revenue to invest in infrastructure. This has led to the city administration highly dependent on the state and central administration for new investments.

Indore Development Authority was formed in 1973 under the Town and Country Planning Act of the state (1973) to assist the municipal body in its developmental activities. Primarily IDA develops new residential areas and basic infrastructure. Once a sizeable number of plots are sold, the area is formally handed over to IMC to administer. IDA is also involved in infrastructural development schemes such as construction of major roads, traffic squares, public gardens, lakes etc.

Indore has a fairly large group of **Civil Society Organizations**, with few of them working on urban issues. Some of these NGOs have influenced the city development policies by working in partnership with the IMC and implementing the urban development programmes. A few of them have influenced development plans through advocacy.

IMPORTANT INSTITUTIONS IN INDORE

- Indore Municipal Corporation (IMC)
- Indore Development Authority (IDA)
- District Urban Development Authority
- Indore Cloth Market Cooperative Society
- Malwa Chamber Of Commerce
- Public Health Engineering Department (PHED)
- Indore Municipal Corporation
- Madhya Pradesh Pashchim Kshetra Vidyut Vitaran Company Ltd. (MPPKVVCL)
- District Hospital
- Maharaja Yashwant Rao Hospital
- Bombay Hospital
- Devi Ahilya Vishwavidyalaya
- Shri Govindram Seksaria Institute of Technology and Science
- Indian Institute of Management (IIM)
- Indian Institute of Technology Indore (IITI)
- Indore School of Social Work

2. Possible Impacts

Increase in urbanization will create additional demand on the services of the municipal corporation. Sectors that will pose challenges are water supply, solid waste management, urban community development, transportation & poverty reduction (slum development) etc.

Indore city remains highly dependent on external water resources, communities face perpetual shortages of water, poorly performing sewerage, drainage and solid waste collection systems and emerging market to fill the service gap not created by the ULB. The management capacity and the availability of resources (human, infrastructure) will be the critical issue in urban governance.

* The Deliberative Wing is an elected body of Councilors from different wards in the city and is headed by the Mayor. The Executive Wing is headed by the Municipal Commissioner and looks after the functioning of the Corporation and assists the Deliberative Wing in the decision making process.

Energy

1. Present Energy Demand
2. Possible Future Scenarios

1. Present Energy Demand

The requirement of energy especially electricity in any urban area is bound to grow rapidly as the standards of living of people improve. As per the State Government Notification dt. 16th June 2009, the total available capacity in M.P. is as per table given below:

Sl. No.	Source of supply, MP State	MW
1.	Central Sector (Western Region)	2,084.40
2.	Central Sector (Eastern Region)	117.51
3.	DVC	200.00
4.	Indira Sagar Project	1,000.00
5.	Sardar Sarovar Project	826.50
6.	Omkareshwar Project	520.00
7.	Lanco Amarkantak	300.00
8.	Genco Thermal	2,857.00
9.	Gencp Hydel	927.17
Total		8,832.80

Source: Energy Security Sector Study, 2010

The tariff order 2009-10 issued by Madhya Pradesh Electricity Regulatory Commission on 29th July 2009, states that the demand projected by distribution companies will be more or less met during year 2009-10 except in February 2010. Thus the shortage of power is minimum. The shortage has occurred more recently due to poor monsoon and reservoirs having not filled in. Over the years the outlook is better.

Energy Consumptions in year 2009

Description	R	C	I	M	A
Connected Load (MW)	405	159	99.97	16	1.73
Actual Consumption (MWh /Yr)	494,533	172,465	114,413.31	24 ,917	3,119
Total Demand (MVA/Yr)	618,167	188,582	143,016.66	31,146	3,899
No. of Consumer	301,045	71,579	6,000	2,329	534
Per capita connected load (KW)	0.2	0.08	-	0.009	0.00087
Per capita actual Electrical Energy Consumption (KWh)	249.75	87	-	12.58	1.58
Per capita total demand (KVA/ year)	312	95	-	16	2
Connected load per consumer (KW)	1.35	2.22	16.66	7.26	3.24
Actual Electrical Energy Consumption per consumer (Kwh)	1,642	2,409	19,068.89	10,698.83	5,841

R.: Residential; C: Commercial; I: Industrial;
M: Municipal; A.: Agricultural (Population: 1,980,132)

Source: Energy Security Sector Study, 2010

Energy

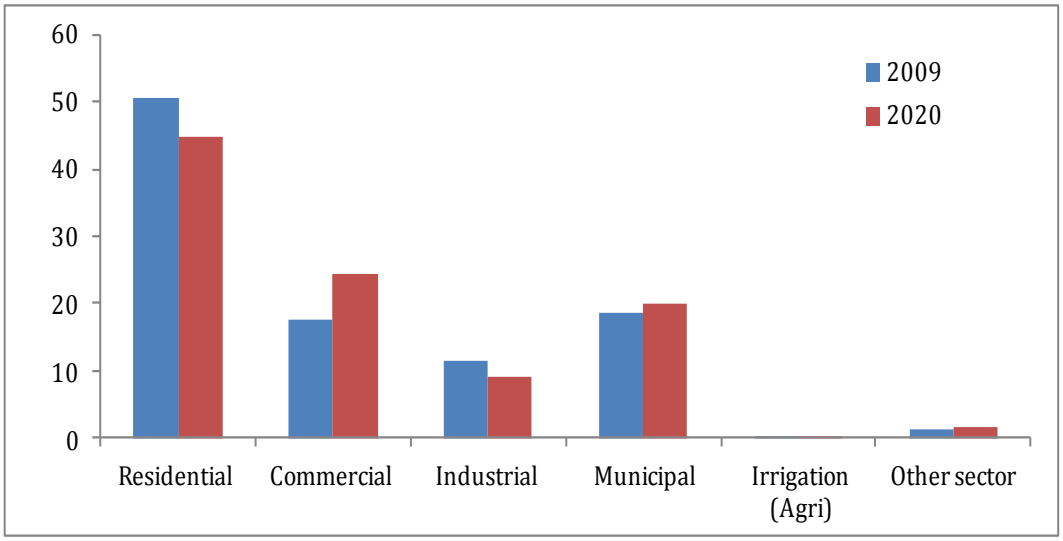
1. Present Energy Demand
2. Possible Future Scenarios

2. Possible Future Scenarios:

Indore city has over 0.3 million domestic consumer and they consume about 494 million units annually with per capita consumption of 1,642 units/year. The total consumers are expected to increase by 39% and electricity consumption is expected to increase by 61% by 2020.

There are about 71,000 commercial consumers with per capita consumption of 2,400 units/year. In 2020, the numbers of commercial consumers are expected to increase by 23% and consumption is expected to increase by 103%. There are about 6,000 industrial consumers, with average annual consumption of 19,000 units. The industrial consumers are expected to increase by about 8% and consumption expected to increase by 41% by 2020. The total consumption of the city is currently about 823 million units and growing at the rate of 2% per year. Climate change, especially temperature increase may add on to this projected demand. Sectors requiring attention in respect of energy conservation are Residential, Commercial and Industrial due to Increase in air -conditioning requirements, extra domestic pumping & additional growth in population.

Scenarios for 2020 (%)



Aspect considered for possible future scenarios:

- Increase in usage of air –conditioning and cooling devices load due to climate change
- Extra domestic pumping load
- Air conditioning & pumping load in commercial buildings
- Growth in population

Distribution Planning & Reduction in Aggregate Technical & Commercial Losses:

One of the major problems faced by the Indian Power System is the high level of losses with technical & managerial reasons. This is a problem which can be solved and solutions are being found by the existing organizations in the country. We propose to address the problem in the following way.

The losses are divided in three categories

(i) Technical
(ii) Commercial
(iii) Theft of Energy.

Indore: Solar City

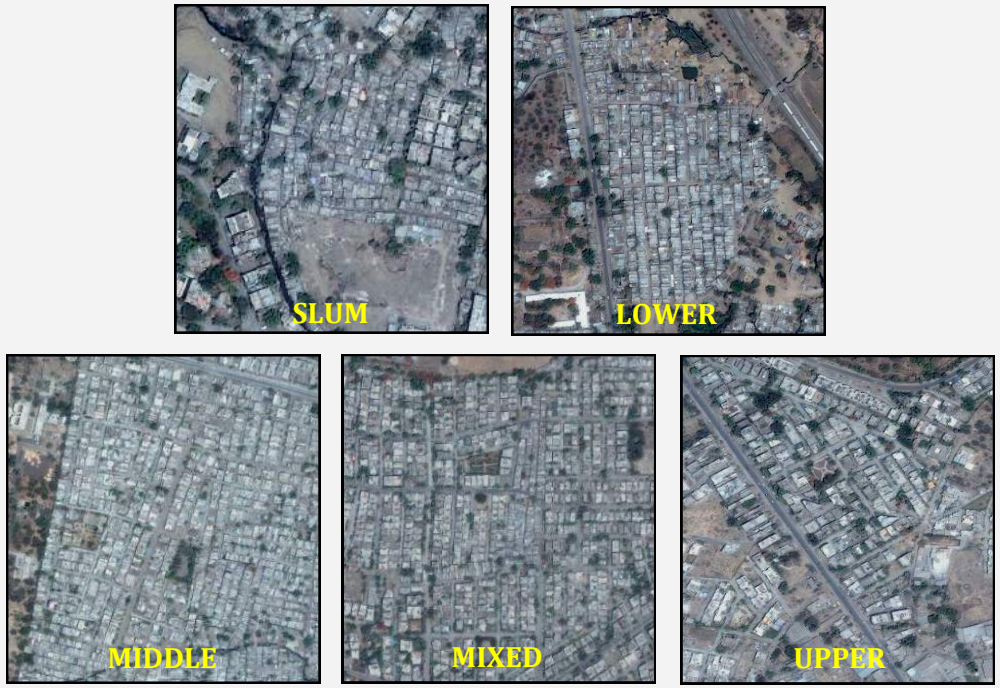
Indore is recommended for being selected as "**solar city**". This status is being given to sixty cities in the country. In these cities, it will be made mandatory to install the equipments in all houses exceeding an area of 1500 sq. ft. The equipments will also be available at subsidized cost.

EVALUATION AND ASSESSMENT

Vulnerability	Capacity
	
Drainage and Sewerage Vulnerability Index (DSVI)	Education Capacity Index (ECI)
Loan and Insurance Vulnerability Index (LVA)	Income Stability Index (ISI)
Water Scarcity Index (WSI)	Social Capacity Index (SCI)

Main objective of the vulnerability assessment is to understand different facets of risks and quantify the components of vulnerability across the study cities to inform adaptation framework focused on poor and vulnerable urban residents.

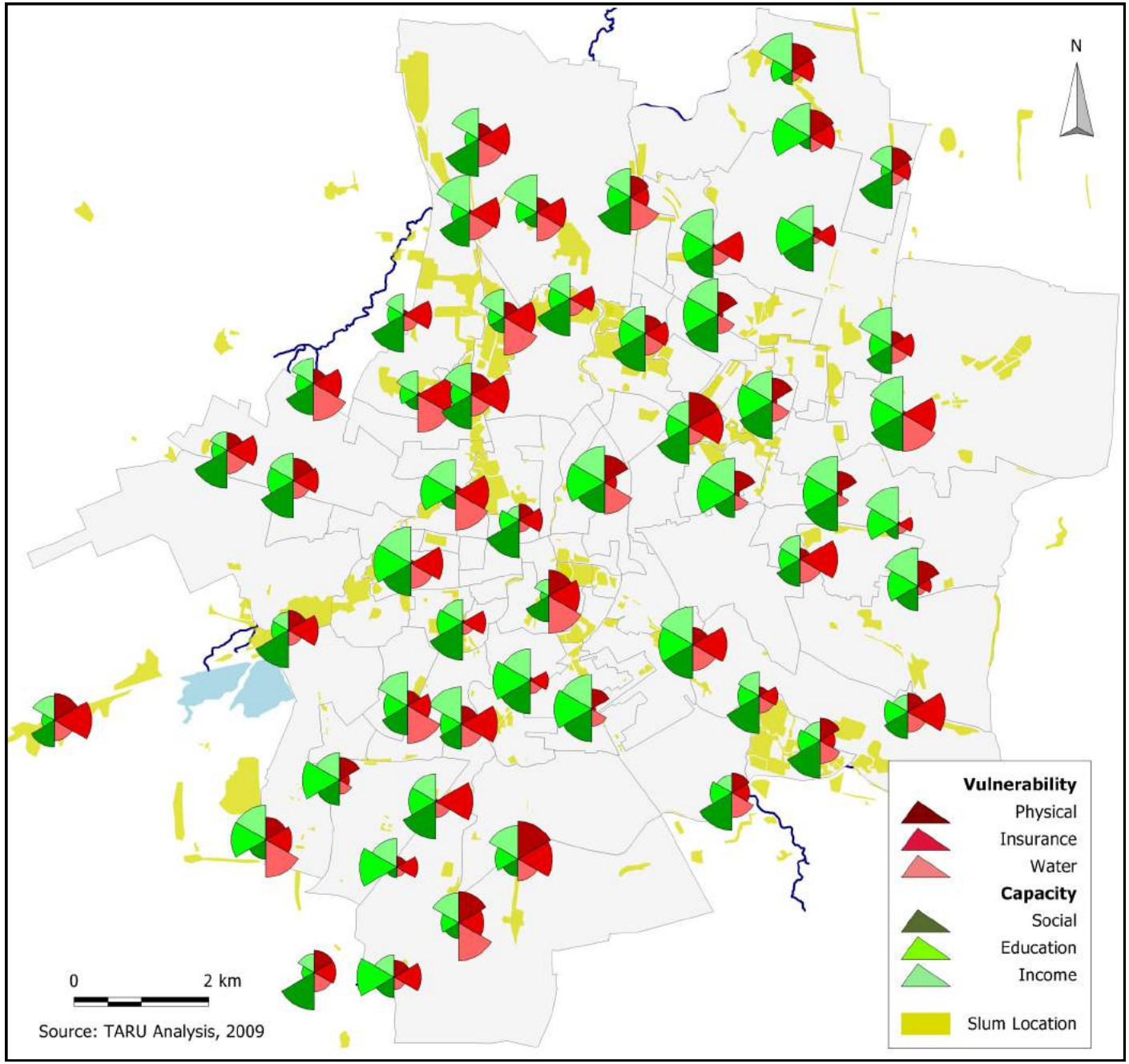
Socio Economic classes covered for the vulnerability and capacity assessment



Vulnerability and Capacity Assessment

To assess risks and vulnerability across socio-economic categories (SEC) spatial analysis has been carried out. 1,250 households were surveyed from 125 settlements and 125 Geopsy* samples. The samples were well distributed over space and across the socioeconomic groups. The aggregated results indicate the number of households across various SECs in the area covered under the GIS analysis. Three separate indicators of vulnerabilities were used to assess the vulnerability of the sample households across the city and were aggregated to city level.

* Gopalakrishna Bhat, Anup Karanth and Umamaheshwaran Rajasekar 2010, Geopsy based urban vulnerability analysis, *International Disaster and Risk Conference IDRC Davos 2010*, Davos, Switzerland, May 30 - June 3, 2010.



Vulnerability Assessment

1. **Drainage and Sewerage Vulnerability Index (DSVI)**
2. **Loan and Insurance Vulnerability Index (LVA)**
3. **Water Scarcity Index (WSI)**

1. Drainage and Sewerage vulnerability index (DSVI)

The condition of sewerage and drainage is poor in most study areas due to limited investments in the past along with poor maintenance. The study also indicated that significant proportion of middle class and upper SECs also do not have access to sewerage (septic tanks, soak pits etc) and drainage is inadequate. As per NIPFP, 55% population has access to sewerage network and 80% of sewers are under utilized for want of maintenance and only 20% of roads have storm water drainage (NIPFP, 2006).

More than half the sample households (predominantly poor) reported dumping of solid wastes in open areas or streams, resulting in clogging of the drainage system which further deteriorates the environment and increase water logging during and after rainy season. Large sections of the new areas included into the municipality still have septic tank toilets. The low permeability of black cotton soils as well as poor solid waste collection system further aggravates this situation. During and after rainy seasons, outbreaks of vector borne diseases like malaria and dengue are common. The analysis indicates that there are two types of slums; one having minimal drainage and sewerage while the other has fairly good facilities. This is due to focused investments under many pro-poor programmes including Madhya Pradesh Urban Services for Poor (MPUSP).

2. Loan and insurance vulnerability Index (LVA):

Loan is the most common issue as vulnerability for the poor. Mainly it is towards insurance, to protect the households against loss of assets or medical emergencies to family members. The penetration of insurance is poor (less than 25%) as well as incidence of loans is higher in case of lower and slum SECs. This causes higher financial vulnerability to these households. These results have to be seen in conjunction with income stability index.

3. Water Scarcity Index (WSI)

Water availability is observed to be 52-67 LPCD and is very low as per CPHEO norms of 135 LPCD (Water Sector Study-Draft, 2009). Only 54% of population is covered by piped water supply (alternate day for an hour), while the rest utilize the ground water or buy water (water tankers).

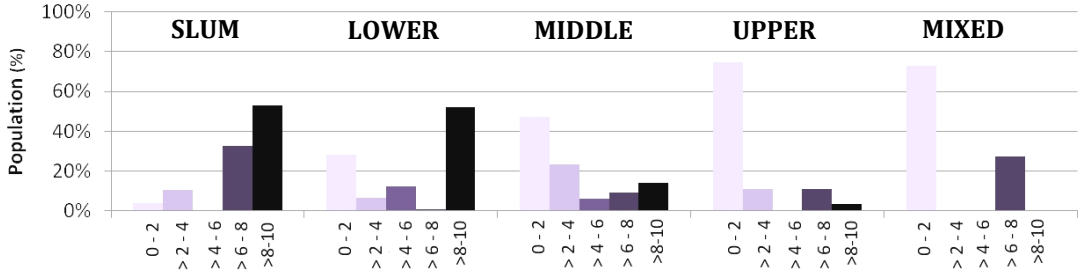
The vulnerability analysis indicates that all the SECs suffer from water scarcity with more than 40% of households reporting WSI >4. Slum and lower middle class are the differentially vulnerable with nearly half the households facing acute water scarcity (>4).

Presently water supply of additional 90 MLD water under phase III has already started. This has partially relived the scarcity of water at the city level.

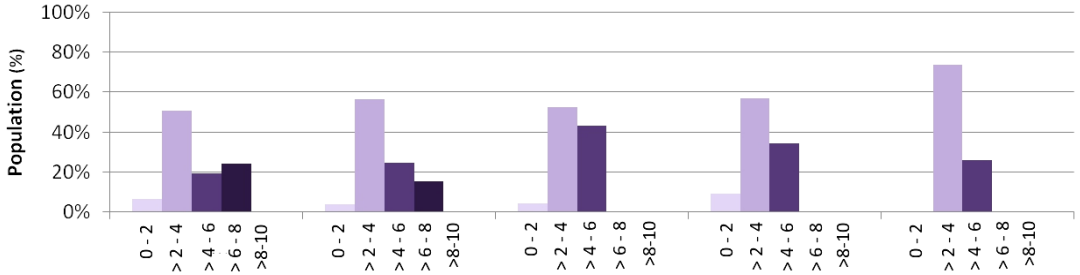
Vulnerability Assessment

1. **Drainage and Sewerage Vulnerability Index (DSVI)**
2. **Loan and Insurance Vulnerability Index (LVA)**
3. **Water Scarcity Index (WSI)**

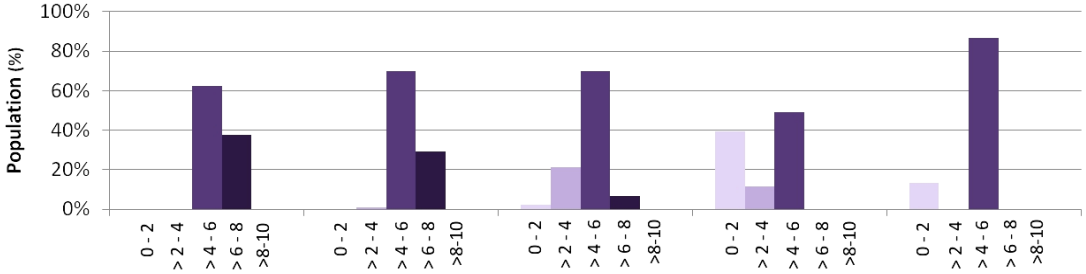
Water Logging



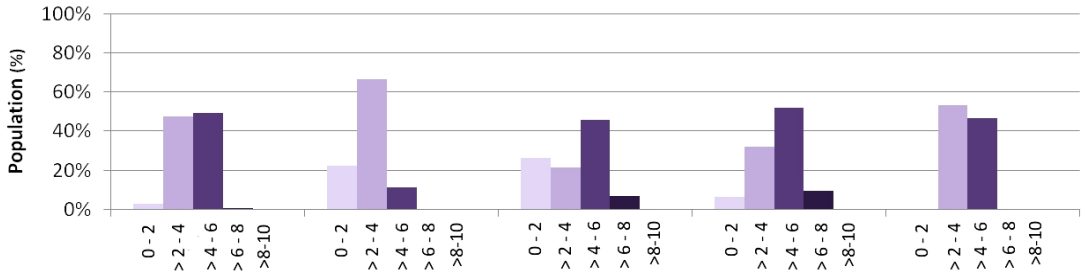
Water Scarcity



Insurance



Drainage



Capacity Assessment

1. **Education Capacity Index (ECI)**
2. **Income Stability Index (ISI)**
3. **Social Capacity Index (SCI)**

1. Education Capacity Index (ECI)

Indore has a literacy rate of 82.1% (Census, 2001). Unfortunately, better education is not able to raise the income levels due to non availability of better opportunities. ECI in slum and low income households ranged in 3 to 5 (less than high school education). Middle class shows 40% of people with ECI <5. This signifies that their livelihoods are also not dependent on education.

2. Income Stability Index (ISI)

During last three decades, Indore city emerged from being a trading and textile manufacturing city to a center for automotives, light engineering, food and pharmaceuticals industries, but even today, about one third of the city households have their livelihoods from self employment or trade.

The ISI analysis indicates that one third of the city's households (predominantly slum, lower and middle income categories) have <5 in terms ISI. The remaining population is equally divided between range of 5 to 6 and >6. Both the categories are dominated by middle and upper classes.

3. Social Capacity Index (SCI)

This is considered based on access to social networks and benefits derived from these networks. About 3/4th of the households reported to have born in the city or migrated from other parts of the state. The remaining (in-migrants) are mostly from UP, Maharashtra and Punjab. Most of in-migrants from Punjab were refuges during the partition (1947).

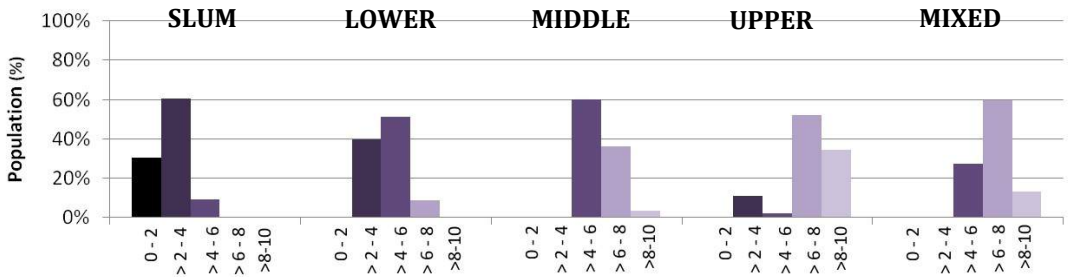
In the recent years, there has been a improvement in social capacity especially amongst poor. This is mainly due pro-poor development programmes by the government, donors and NGOs. The strong patronage cultures developed by political parties have empowered the poor, and are able to address their grievances to the political leaders and also lobby for better urban services.

The study indicates that the percentages (60%) of average SCI (4-6) is found for the slum areas. On the other hand the Higher SCI > 6 up to 10 is prominent in the higher SECs.

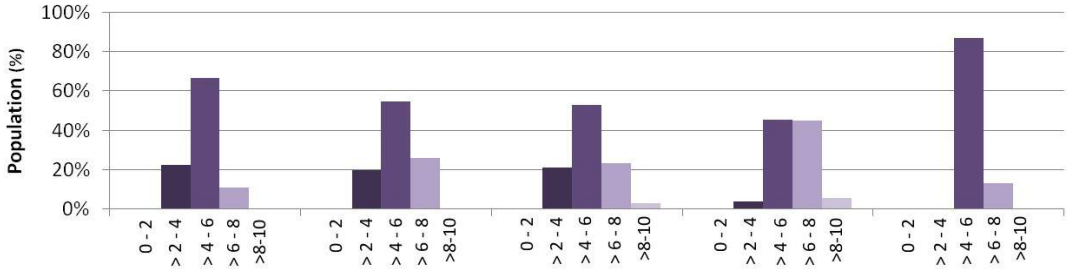
Capacity Assessment

1. **Education Capacity Index (ECI)**
2. **Income Stability Index (ISI)**
3. **Social Capacity Index (SCI)**

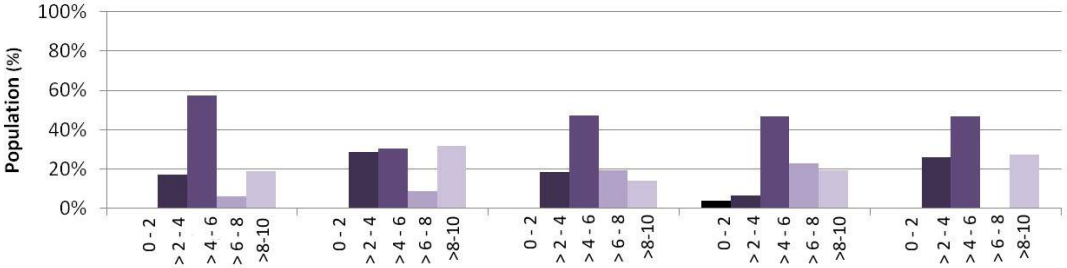
Education



Income



Social



PRIORITIZED STRATEGIES

Medium and Long term Strategies	Approach to Resilience
Water	Build on addressing current risks and vulnerabilities with Climate Change context
Energy	Create awareness about climate risks and generate demand
Natural Disaster Management	Demonstrate resilience projects to generate interest among the ULBs and other decision makers
Transport	Generate Multi-Sectoral Information & Shelf of Project Proposals
Health	Building synergy with state and national institutions
Sewerage/Waste Management	Integrated waste processing facility

Prioritized Strategies

Indore presents challenges in terms of city administration, resource constraints and the over all attitudes of citizens. However, it has attracted donor attention over last two decades and has implemented several donor funded projects, aimed at improving the access to urban services to poor. Valuable lessons have been learnt from these projects which informs this resilience strategy. Indore is expected to continue to attract donor funds for pro-poor inclusive urban development.

City ULB faces challenges of administrative, municipal financial autonomy and health, political will and lack of consensus. Indore resilience framework is based on following strategies to initiate and sustain climate change resilience strategy

Approach to the Resilience

- Addressing current risks and vulnerabilities with CC context
- Create awareness about climate risks and generate demand: Bottom up approach
- Demonstrate resilience projects to generate interest among the ULBs and other decision makers
- Generate Multi-Sectoral Information & Shelf of Project Proposals
- Building synergy with state and national institutions

Sector	Issues	Short Term	Mid/Long Term
Water 	Sufficient water availability, Below standard per capita supply, UFW losses (leakage, revenue), increasing dependency on the long distance sources, Vanishing local groundwater resources	**Assessment of water resources:** • Water from the River Narmada, and reservoirs built on rivers passing nearby fulfills the water demand of the Indore city. Assessments of these potential water resources (e.g. Yeshwant Sagar, Bilaoli tank etc.) around city in context of climate change impacts is necessary. • Details of abandoned and unused traditional open wells or such other resources are available with Municipal Corporation. Immediate attention on rejuvenation of such resources should be given with the high priorities by cleaning programs of such resources. Scientific approach in developing them would help in improving the local ground water resources of the city and relieve the water dependency & scarcity. **Comprehensive water management plans by Municipal Corporation:** • The ULB of the city is facing the serious revenue losses related to water supply systems. This seriously affects the maintenance programmes. Dedicated programmes on leak detections are immediately required. This should be on maintenance related matter as well as illegal water connection/water withdrawal practiced in the city. • Municipal Corporation's expenditure on the tankers supplying the water experience heavy transportation losses. This should be checked. Instead, the amount spent on this should be transferred towards leakage repairing and formulation of active maintenance and vigilance team. • The ULB should take lead role to set examples of conjunctive water management practices at institutional level and transfer to community level. **Developing Alternative for Water:** • Efficient implementation of the 'Rainwater Harvesting Systems' at community and house level must be supported by the active involvement of Municipal Corporation. • A dedicated workforce can be established which will focus on exploring technological options for the waste water recycling and reuse options at community level by adopting the internationally recognized practices. • Pilot projects can be developed and be implemented on various alternative methods of water usage in the city and such examples should be assessed in the details for shared in open domains to establish the confidence of the public. • Public awareness programmes on the economics of water through IEC. Mass awareness on water conservation and reduction of water wastage at household level.	**Strengthening the existing infrastructure:** • Presently available infrastructure catering the needs of water supply needs to be augmented by laying down additional 400km of the water distribution pipeline in the city to cover the entire municipal corporation area. • To check the distribution of water from supply end to user end, there is a need to develop water audit system, supported with information technology (dedicated software). At present, metering system exists for the industrial supply only, this should be extended to residential areas also. • Water supply through two different color distribution pipe lines can be provided. Fresh water (Narmada) for drinking & higher purposes would be provided through one pipe line, another pipe line would supply treated water from sewage treatment plant which will be used for gardening, washing, car washing, cloth washing etc. • Interlinking and gridding of various water supply projects/tanks. • Pressure monitoring at important points should be started. Entire water distribution network should be mapped and a control room be set up to monitor those areas witnessing reduction in pressure. • Adequate numbers of active maintenance teams should be set up and zero tolerance monitoring system should be prioritized using technological support (e.g. Geographical Information System). • Improving redundancy of the water supply system (including ground water recharge, waste water recycling). • Hotline maintenance in monitoring of lines and transformers • Setting up of cogeneration plant **Attention on groundwater & rainwater harvesting system development:** • Ground water surveys may be carried out to locate the confined aquifers and their recharge area. 50% of ground water recharge should only be utilized so that over the years, the water table rises to its historical levels. • At least 20% of open space in Indore should have facilities for rain water harvesting and intermediate zones should be recharged. Similarly, the recharge area of confined aquifers should also not be urbanized or unnecessarily paved. • Formulation of policy on restriction on the overexploitation of groundwater resources with support from Central Ground Water Board (CGWB). • Encouraging community level groundwater resource development rather than at individual level (community bore well supply). **Water User Groups:** • Urban water user groups for conjunctive water management of local and distant water resources with focus on building resilience to Climate Change.

Sector	Issue	Short Term Vision	Mid/Long term Vision
Energy 	Cope up with the increasing energy requirement for growing population and commercial requirements. Ensure reliability of energy supply, reduce space cooling costs. Build redundancies to meet demands and control price, meet shift in energy demands	**Infrastructure & Management:** • The energy sector study has indicated that there is a scope of 20% reduction in the energy consumption with proper demand and supply management. • As per the section 55 of electricity Act 2003, every consumer should have the electricity meter. • The cool space should be increased in the designs of the urban buildings and landscapes. • Up gradation at technological fronts in the energy transmission network of the city. **Energy efficiency:** • Promotion of energy efficiency products: Encouragement to the use of CFL and LED lamps should be made priority. • Codes for passive cooling and energy efficiency for residential, commercial and industrial buildings, and incorporation of these codes in weaker section housing projects • Develop guidelines and regulations for environmentally sustainable building design, construction and operation (Water/Energy/SWM) • Documentation of projects implemented on renewable energy options at various scales. Their availability in public domain for the awareness.	**Assessment of the infrastructure:** • Climate Change Variability studies have indicated that there is a likely change in temperature and precipitation scenarios in the city. Especially, there is possibility of increased rainfall activity leading to pluvial flooding in the city. • The energy distribution network of the city should be mapped using latest technology i.e. GPS and GIS integration. • The existing energy transmission infrastructure must be assessed to ensure the energy supply during increased water logging (flood like) situation in the city. • The conventional transformers should be replaced with the energy efficient 'amorphous core transformers'. • Major conservation of electricity can come up, if solar energy is used for house hold purposes. This can be solar heating, solar cooking and solar photovoltaic in place of inverters. • The Bureau of Energy efficiency has developed 'Building Codes' under the energy Conservation Act 2001. The State Govt. will shortly adopt the code based on the climatic condition of the state. It is recommended that as soon as the code comes into effect, the Indore Municipal Corporation can make it mandatory for all the new buildings in the city and in all townships under development.
Natural Disaster Management 	Reduce risk exposure, especially for poor Warning and forecasting products for severe weather events, Strengthen city disaster management plan	• City level storm water drainage master plan including rainwater harvesting options • Improving disaster response plans including evacuation of citizens from water logging zones • Flood plains risk zoning along with advance warning system	• Systematic, large scale mapping of the flood plains along the river passing through the city for identification of water logging prone area of the city.

Sector	Issue	Short Term Vision	Mid/Long Term Vision
Transportation 	Urban transportation sector accounts for a large part in emission of the Green House Gases. Growing numbers of the vehicle contributing to pollution.	• With rapidly growing size of city, the city need to address the institutional gap in transport planning. Cities require an appropriate institutional body that will integrate the plans of bus, rail, road, air, waterways, traffic police, and urban growth • Planning framework focused on urban transport needs with the policy guidelines from National Urban Transport Policy 2006.	• The Impact on Urban Transport Infrastructure in Indore is attributed to Infrastructure Construction and Development Practices. • Special care in the Planning & construction of the road infrastructure for the immediate relief from the water logging after heavy down pouring.
Health 	In the year 2009 flood event, there were significant cases of vector borne disease. In recent years the numbers of patients of Malaria, Dengue, Chickenguniya, Swine flu, typhoid, yellow fever etc have increased	• With the epidemiological research support, disease monitoring system and Health GIS should be planned for the city. • In the Surat city, SMS based health monitoring system is operational, a visit of IMC official to understand this system may be planned.	• The possibilities have been modeled on temperature and rainfall changes. Scenarios for their impacts on the development, diseases spread should be carried out which can be integrated with GIS based health monitoring system.
Sewerage/ Waste Management 	Inadequate storage facilities and mixing of various types of solid wastes. Poor management of solid waste management system resulting in clogging of natural drainage within the city.	**Solid Waste Management:** • Public awareness programmes on the segregation of solid waste at household level. • Modernization of SWM system with route planning, waste transfer systems and integrating processing facility. • Strengthen the house to house garbage collection system. • Integrated processing facility should be designed to utilize biodegradable, recyclable and inert waste in such a manner that the maximum waste is utilized and negligible waste is sent for land filling **Methane liberation from MSW:** • Quantity of methane liberation is increasing day by day as population of the city and solid waste is increasing. This can pose hazardous situation, systematic studies should be made out on this.	**Maintenance**: • The ULB can initiate and plan drainage cleaning programmes passing from the city. • Scientific studies to be conducted on the impact of climate change (temperature, precipitation) on the decomposition of the waste disposed. • There are settlements developed along the natural drainage in the city, their resettlement should be planned to reduce the impact of water logging on them. • IMC should design and develop municipal waste processing facility supported by scientific means. To achieve this goal, an integrated waste processing facility should be developed at the earliest where in about 90% of the MSW should be converted in useful products.

Approach to Resilience

1. Build on addressing current risks and vulnerabilities with CC context
2. Create awareness about climate risks and generate demand: Bottom up approach
3. Demonstrate resilience projects to generate interest among the ULBs and other decision makers

1. Build on addressing current risks and vulnerabilities with CC context

The citizens, especially poor are mostly focused on meeting their day to day needs. The city specific impacts of climate change is either not known or is beyond their capacity of understanding. Therefore cc impact resilience is not in their priority. Therefore this resilience strategy has focused on current risks and vulnerabilities, while keeping the Climate Change resilience in view. This would mean taking advantage of windows of opportunity as the future unfolds.

2. Create awareness about climate risks and generate demand: Bottom up approach

The citizens have learnt to live with the current levels of water scarcity, lack of sewerage, poor solid waste management and react only when the conditions rapidly deteriorate below the standard levels. This is due to limited alternative options and higher priority issues like income stability and livelihoods dominating their lives. The situation is worst for the poor. The upper SECs have resorted to household level coping measures like bore wells, which are showing serious signs of mal-adaption. Many a times the citizens are not aware of their right to demand essential services and the responsibilities of the ULB to provide the same. Further, they stay ignorant of the extent of risk and future damage such negligence can bring about. Therefore, creating awareness about existing and emerging issues is necessary first step for resilience strategy. The interventions would include awareness generation about linkage between services and climate issues, resilience options at various scales. This would not be a standalone intervention, but would be built into all resilience interventions as a first step approach.

3. Demonstrate resilience projects to generate interest among the ULBs and other decision makers

The ULB mainly focuses on city level issues, especially management of day to day activities. The donor funded projects and recently centrally funded projects have given ULB the exposure to the advantages of community level interventions. The potential of demonstration projects to influence city level decision makers have been proved by the DFID funded Madhya Pradesh Urban Services for the Poor (MPUSP). Based on specific issues, similar demonstration projects will be planned to build resilience. These demonstration projects will be informed by the analysis of issues at various spatial and social scales. The demonstration projects will be aimed at providing leveraging points to influence ULBs, and in building stronger links with the communities.

Approach to Resilience

4. Generate Multi-Sectoral Information & Shelf of Project Proposals
5. Building synergy with state and national institutions

4. Generate Multi-Sectoral Information & Shelf of Project Proposals

First, while the city is able to raise funds for specific sectoral projects, they are often not informed by the cross-sectoral issues and gaps. For example, a good integrated drainage master plan can provide further insight into road and slum relocation/regularization projects. Under current situation the planning is informed only by past trends, the emerging global and regional, resource issues are often left unaddressed.

Second, the current ULB revenue base is limited to manage the city infrastructure and services or less. Most Indian cities largely depend on national level programmes (*e.g. JnnURM, National Mission on Sustainable Habitat, Rajiv Awas Yojna*) and state government transfers to fund their infrastructural development projects. The examples of other cities that were able to access a large share from such national level urban development programmes show that the city needs to prioritize the development activities and build a readymade shelf of priority implementation projects (PIP) before such national programmes are launched. Incorporation of climate change resilience in these projects is an ideal strategy.

The above two problem statements can be better addressed through two parallel measures i.e. generating multi-sectoral information and shelf of project proposals. Firstly, inclusion of a broad perspective to sectoral projects can significantly improve the quality of planning process and develop cross learning mechanisms. The proposed resilience strategy is aimed to generate such critical information from climate change resilience perspective and can provide additional insight to the planning, design and implementation process. Secondly, developing a shelf of CC informed Detailed Project Reports (DPR) will aid the city administrators as well as informing national level decision makers. Studies and research for these DPRs will be one of the resilience building strategies. These DPRs will empower the cities to leverage funds for building CC resilience as well as develop capacities to appreciate the CC resilience. Inputs from international/national knowledge partners and best practices will be used for developing these DPRs.

5. Building synergy with state and national institutions

The ongoing and planned national and state level programmes provide opportunities to seek financial and technical support for resilience building process. The 74th amendment clearly mandates the State government to devolve funds, functions and functionaries to the ULBs. In spite of this amendment, the state government still prefers to be the key stakeholders and often has not devolved some of the functions. Further, since major parts of the city's finances are provided by the State government, the State still takes the liberty to fix the tariffs for specific services. Therefore building synergy with state and national stakeholders is critical.

The current resilience strategy includes plans to inform and influence the state and national level stakeholders through sharing of the lessons learnt from the city resilience interventions. Initiatives such as Peer Experiences and Reflective Learning (PEARL) will have to be incorporated to include networking, publishing experiences, sharing lessons and experiences through workshops/seminars. Such platforms can facilitate in building synergy across ULBs, State and National level actions and to incorporate the lesson learnt from one city to another

Some
Do's & Don'ts

Global Warming is a dramatically urgent and problem which requires an attention. We don't need to wait for governments to find the solutions for this problem; each individual can bring an important help by adopting a more responsible lifestyle: starting from little, everyday things. It's the only reasonable way to save our planet, before it is too late.

Here is a list of some simple things that everyone can do in order to fight against global warming and contribute to reduce the adverse effects of this phenomenon: some of these ideas are at no cost, some other require a little effort or investment but can help you save a lot of money, in the middle long term!

Encourage Others to Conserve

Share information about recycling and energy conservation with your friends, neighbors and co-workers, and take opportunities to encourage public officials to establish programs and policies that are good for the environment.

These following points, listed for important service sectors will take you a long way toward reducing your energy use and your monthly budget too. Thus, less energy use means less dependence on the fossil fuels that create greenhouse gases and contribute to global warming.

If there isn't a recycling program at your workplace, school, house or in your community, ask about starting one. By recycling half of your household waste, you can save huge amount of carbon dioxide annually.

Plant a Tree

If you have the means to plant a tree, start digging. During photosynthesis, trees and other plants absorb carbon dioxide and give off oxygen. They are an integral part of the natural atmospheric exchange cycle on Earth, but there are too few of them to fully counter the increases in carbon dioxide caused by automobile traffic, manufacturing and other human activities. A single tree will absorb approximately one ton of carbon dioxide during its lifetime. Using both sides of the paper and recycling it can save 2.5 kg of green house gases for every kilogram of paper used.

Do’s & Don’ts referred here are based on www.unep.org and web research.

Water

It's also a good idea to turn off the tap when you're not using it. While brushing your teeth, shampooing or washing your car or other vehicles, turn off the water until you actually need it for rinsing. You'll reduce your water bill (electricity bill) and also help to conserve this vital resource. The regions dependent on the groundwater can save it by using only when required.

Take Shorter Showers

Did you know that showers account for 2/3 of all water heating costs? So cut your shower short and save emission of the carbon dioxide isn't it interesting?
Set your water heater at 49^0 C. to save energy, and wrap it in an insulating blanket if it is more than 5 years old. Buy low-flow showerheads to save hot water . Wash your clothes in warm or cold water to reduce your use of hot water and the energy required to produce it. That change alone can save at least 250 kg of carbon dioxide annually in most households. Use the energy-saving settings on your washing machines or other gadgets.

Install a Low-flow Shower Head

Using less water in the shower not only conserves this precious resource, but it also means less energy is used to heat the water.

Wash your Clothes on the Cold Water Cycle

You'll save energy because the water isn't being heated, and your clothes will last longer.

Air Dry Your Clothes

Weather in our country is very generous and most of the time uniform in the seasons. how about putting your laundry on the line to dry? You'll save plus, there's no better stain remover than the sun.

Transportation

Drive Less and Drive Smart

Less driving means fewer emissions. Besides saving petrol, walking and cycling are great forms of exercise. Explore your public mass transit system, and check out options for carpooling to work or other purposes of your daily work.

When you do drive, make sure your car is running efficiently. Every liter of petrol or kilogram of gas you save not only helps your budget, it also keeps some amount of carbon dioxide out of the atmosphere.
Walk, bike, carpool, or take public transit. You'll save CO2 for every kilometer you don't drive!

Inflate Your Tires

Keeping your tires adequately inflated can save you significant amount of money per year and also keep carbon dioxide out of the air! Check them monthly to be sure and enjoy the rides of your vehicles. Keeping your tires properly inflated can improve your average by more than 3 percent.

Change Your Car's Air Filter

Check your car's air filter at least once a month.

Carpool When You Can

Carpooling with friends saves fuel, and you have the added perk of having all your talks in one car. Even better, you can save some carbon dioxide and hundreds of rupees per year.

Don't Idle In the Car

How many times have you seen someone sitting in a car while it's running? Are you guilty of this? Idling wastes money and petrol or gas, and generates pollution and contribute in some way to the global warming-causing emissions. Turn your engine off if you have to wait for more than 30 seconds- except of course when in traffic. Observe the traffic lights indicating the count down timers to turn engine off.

Energy

Use Less Heat and Air Conditioning

Adding insulation to your walls and upper floor, and installing weather stripping around doors and windows can lower your cooling costs more than 25 percent, by reducing the amount of energy you need cool your home.

Change a Light Bulb

Wherever practical, replace regular light bulbs with compact fluorescent light (CFL) bulbs. Replacing just one 60-watt incandescent light bulb with a CFL will save you about Rs. 1000 over the life of the bulb. CFLs also last 10 times longer than incandescent bulbs, use two-thirds less energy, and give off 70 percent less heat.
If every family replaced one regular light bulb with a CFL, it would eliminate 70 to 80%.
Save electricity and reduce global warming by turning off lights when you leave a room, and using only as much light as you need. and remember to turn off your television, video player, stereo and computer when you're not using them.

Buy Energy-Efficient Products

When it's time to buy a new home appliances, choose one that offers good energy efficiency. Home appliances now come in a range of energy-efficient models. Avoid products that come with excess packaging, especially molded plastic and other packaging that can't be recycled. If you reduce your household garbage by 10 percent, you can save considerable emissions of carbon dioxide annually.

Change the AC Filter

Clean or replace dirty air conditioner filters. That'll reduce the emission of carbon dioxide and also save the money.

Put on a Sweater

Instead of turning up the heater, put on another layer of clothing in winter. You can save electricity by adopting the easy way to beat the winter.

Turn Off Your Computer

Shut it off ,when you're not using it and save electricity.

City Resilience Strategy (CRS) document is result of the in-depth studies carried out during capacity and vulnerability assessment projects undertaken in the city of Indore during ACCCRN phase II. The results produced during the study would have not been possible without the constant encouragement from the City Advisory Committee constituted of IMC officials, academia, various NGO's , range of stake holders including architects, urban planners and many individuals.

At last but not the least every citizen of the city has contributed in one or the other way to make Indore more resilient towards the possible climate changes.

I sincerely acknowledge one and the all in brining out this document.

G,K.Bhat
Director, TARU Leading Edge

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Mr. V.V.Rajwade
Mr. Vivek Shrotriya
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1. Photograph showing the participation of city stake holders during CAC meeting.
2. Patron (In center), Chairman (right) & Secretary (left) during the city advisory committee meeting.

3. Monitoring mission member interacting with the community during field visit.
4. Photograph showing discussion of water user group during the pilot project of conjunctive water management.

IMC officials, Stake holders and representatives from NGO's participating in Risk to Resilience Workshops

About the Rockefeller Foundation

The Rockefeller Foundation was established in 1913 by John D. Rockefeller, Sr., to "promote the well-being" of humanity by addressing the root causes of serious problems. The Foundation supports work around the world to expand opportunities for poor or vulnerable people and to help ensure that globalization's benefits are more widely shared. The Rockefeller Foundation believes that there is a current opportunity to catalyze attention, funding, and action in building climate change resilience globally. The goal of the Climate Change Resilience Initiative is to build resilience to climate change risks for poor and vulnerable people, especially through targeted investments in developing, demonstrating and replicating resilience strategies, and through leveraging policy opportunities to support and fund resilience building measures.

The Asia region is the strategic geographic focus for the Foundation's urban climate change resilience work. More than 60 percent of the increase in the world's urban population in the next 30 years will occur in Asia, the continent with the largest urban population, and the largest population at risk to climate related impacts. Decisions made in cities today will either amplify climate change impacts or reduce them, and thus there is a narrowing window of opportunity to ensure that the cities of tomorrow are developed in a climate resilient manner. Addressing urban growth and climate trends in tandem in the Asia region provides the opportunity to create urban resilience strategies that will benefit the largest urban population of the world, and will develop models that can be exported to other regions. Through the development of the Asian Cities Climate Change Resilience Network, the Rockefeller Foundation works with city governments, academic centers, non- profits and the private sector to collectively improve the ability of the cities to withstand, prepare for, and recover from the projected impacts of climate change. Cities will develop a replicable model to assess climate risks, assess vulnerabilities, identify, prioritize and implement resilience building measures. These interventions will span health, infrastructure, water, disaster, urban planning/development issues, and will include leveraging policy incentives and investment funds to improve infrastructure, services, disaster management and preparedness strategies.

www.imagineindore.org

An initiative taken under ACCCRN to create an awareness about climate change and to understand it's possible impacts on the Indore city.

Asian Cities Climate Change Resilience Network

Indore Municipal Corporation

TARU Leading Edge

Institute for Social and Environmental Transition