सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

National Mission on Sustainable Habitat

2021-2030

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हरदीप एस पुरी
HARDEEP S PURI

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

आवासन और शहरी कार्य मंत्री
पेट्रोलियम एवं प्राकृतिक गैस मंत्री
भारत सरकार
Minister of
Housing and Urban Affairs; and
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MESSAGE

Climate change is the biggest challenge facing humanity today. Cities are at the forefront of this global crisis as they have become indispensable nodes in an increasingly interconnected world order. As the recently released IPCC report suggests, climate change is intensifying and cities are the major contributors. Cities are also the worst-affected by the changing micro-climates and ecological infrastructure. Given the increasing urban footprint and demands made on energy and resources in cities, urban and environmental phenomenon go hand in hand, and will require combined policy solutions.

Through the two-pronged approach of "mitigation" and "adaptation", the Union Government is augmenting capacity to ensure that we build climate resilience on an unprecedented scale. I am happy to know that the Ministry of Housing and Urban Affairs (MoHUA) is anchoring a revision of the National Mission on Sustainable Habitat (NMSH), which is one of the eight National Missions under the National Action Plan for Climate Change (NAPCC).

With the objective of making sustainable habitats through improvements in energy efficiency of buildings, management of solid waste, and modal shift to public transport, NMSH is a vital cog in India's thrust towards reducing CO_2-equivalent emissions in the country. Considering the recent global and national commitments, I believe this was a necessary revision of the Mission's strategies and core operational framework.

I am confident that the revised NMSH document will prove to be an important building block in addressing the challenges of climate change and achieving the targets of SDG 11 for India. I extend my compliments to the NMSH team for this accomplishment.

(Hardeep S Puri)

New Delhi
08 October 2021

कौशल किशोर
KAUSHAL KISHORE

आवासन और शहरी कार्य राज्य मंत्री
भारत सरकार
Minister of State, Housing & Urban Affairs
Government of India

MESSAGE

Consistent rise in average temperature of our planet since late 19th century has become a cause of serious concern, both at national as well as international level. The rise in global temperature has been attributed to significant increase in Green House Gas (GHG) emissions. Globally, urban areas contribute around 75 per cent of total greenhouse gas emissions. As our country witnesses rapid urbanization, these emissions are likely to increase further in the future. Moreover, the resultant change in climate has also rendered our cities susceptible to various climate related hazards and vulnerabilities.

In order to address the threat posed by climate change in a holistic manner, Government of India launched the National Action Plan for Climate Change (NAPCC) with eight sub-missions in 2008 with the prime objective of fulfilling India's developmental goals along with a focus on reducing the emission intensity of our economy. The National Mission for Sustainable Habitat (NMSH) is one of the eight missions under NAPCC which is being implemented by the Ministry of Housing and Urban Affairs. The first version of NMSH, which was released in 2010, has now been revised in the light of various global and national commitments such as New Urban Agenda, Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) within the Paris Agreement.

NMSH 2.0 enlists several enabling climate actions pertaining to Urban Governance, Capacity Building, Data, Technology and Innovation for the mission which are intended to address the overarching framework to facilitate adoption and implementation of sector-wise climate action strategies. I am confident that the adaptation and mitigation strategies spelt out in NMSH 2.0 would play a significant role in addressing the problem of climate change in urban areas.

I would also like to acknowledge here the efforts of all the officers which have been involved in preparation of this revised version of NMSH.

(Kaushal Kishore)

दुर्गा शंकर मिश्र
सचिव
Durga Shanker Mishra
Secretary

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MESSAGE

Urbanisation coupled with unplanned growth adds complexity in socio-economic and ecological challenges in urban areas, i.e., waste management, housing shortage, water crisis, traffic congestion, degradation of natural resources, environmental pollution, urban flooding, etc. With a view to address these challenges, Prime Minister's Council on Climate Change developed National Action Plan for Climate Change (NAPCC) through eight National Missions. National Mission on Sustainable Habitat (NMSH) is administered by Ministry of Housing and Urban Affairs with the objective to make habitat sustainable through improvements in energy efficiency in buildings, management of solid waste and modal shift to public transport, promote energy efficiency as an integral component of urban planning and urban renewal.

The vision of NMSH is to address climate change impacts and minimise the risks through various mitigation and adaptation strategies. The objectives of the Mission are to promote sustainability of habitats, bring efficiency in service delivery, protect and conserve national resources, reduce environmental degradation and mitigating their effects to improve ability of habitats by building disaster-resilient urban infrastructure to bring synergy in inter and intra departmental coordination, handholding and capacity building, strengthening institutional capacities of the city and State Departments, appropriate integration of climate change adaptation measures through relevant policies, plans and associated processes to cater to the local needs through various rules/ regulations.

The NMSH document is a result of untiring efforts of the Committee formed under the Chairmanship of Shri K. Sanjay Murthy, then Additional Secretary and thereafter by Shri Shiv DasMeena and Shri Kamran Rizvi, Additional Secretaries. I thank all Divisional Heads in the Ministry of Housing and Urban Affairs, including Advisers in the Technical Arm of the Ministry, including CPHEEO and TCPO, who had provided valuable inputs. I express my sincere complements to Shri Anupam Mishra, then Economic Adviser who anchored this work initially and Shri Dinesh Kapila, Economic Adviser and Shri Ashwini Kumar, Addl. Economic Adviser whose continued efforts brought out this Document in its present form. C-Cube Team (NIUA) has contributed in aligning the verticals with ClimateSmart Cities Assessment Framework. I take this opportunity to express my complements to GIZ Team for their valuable inputs and contribution in bringing out the printed version of the Document.

I am pleased to commend the National Mission on Sustainable Habitat 2020 document to all the stakeholders involved in this auspicious step to protect the Mother Earth by ensuring sustainability of our habitat. I hope that the NMSH Document will be useful to policy makers at Central, State and City Level Officers in bringing about a paradigm shift in sustainability of our Habitat and thereby decisively contribute to fulfil National and International commitments of our Country in overcoming the ill-effects of global warming and climate change.

(Durga Shanker Mishra)

New Delhi
01st October, 2021

Contents

Abbreviations

4R	Reduce, Reuse, Recycle, and Recovery
AJAY	Atal Jyoti Yojana
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BRTS	Bus Rapid Transit System
BUR	Biennial Update Report
C&D	Construction and Demolition
CAGR	Compound Annual Growth Rate
CapEx	Capital expenditure
CCAP	City Climate Action Plan
C-Cube	Climate Centre for Cities
CNG	Compressed Natural Gas
CPCB	Central Pollution Control Board
CSCAF	ClimateSmart Cities Assessment Framework
CSR	Corporate Social Responsibility
DAY-NULM	Deendayal Upadhyay Antyoday Yojana - National Urban Livelihoods Mission
DRR	Disaster Risk Reduction
ECBC	Energy Conservation Building Code
EESL	Energy Efficiency Services Limited
EV	Electric Vehicles
FAME	Faster Adoption and Manufacturing of Electric/Hybrid
FSSM	Faecal Sludge and Septage Management
FSTP	Faecal Sludge Treatment Plant
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GHTC - India	Global Housing Technology Challenge - India
GIS	Geographical Information System
GoI	Government of India
GRIHA	Green Rating for Integrated Habitat Assessment
ICCC	Integrated Command and Control Centre
IEC	Information, Education and Communication
IPCC	Inter-governmental Panel on Climate Change
ITS	Intelligent Transportation System
JJM-U	Jal Jeevan Mission - Urban
JSA	Jal Shakti Abhiyan
LAP/TPS	Local Area Plan/Town Planning Scheme
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LHP	Light House Project
MBBL	Model Building Bye-laws
MEEP	Municipal Energy Efficiency Programme
MNRE	Ministry of New and Renewable Energy
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MoP	Ministry of Power
MRF	Material Recovery Facility
MSWM	Municipal Solid Waste Management
NAPCC	National Action Plan for Climate Change
NCMC	National Common Mobility Card
NDC	Nationally Determined Contribution
NDMA	National Disaster Management Authority
NGO	Non-Governmental Organisation
NITI	National Institution for Transforming India
NIUA	National Institute of Urban Affairs
NMMU	National Mission Management Unit
NMSH	National Mission on Sustainable Habitat
NMT	Non-Motorised Transport

NRW	Non-Revenue Water
NULP	National Urban Learning Platform
NUTP	National Urban Transport Policy
O&M	Operation and Maintenance
ODF	Open Defecation Free
PBS	Public Bicycle System
PMAY-U	Pradhan Mantri Awas Yojana - Urban
PPP	Public Private Partnership
PWD	Public Works Department
RCA	Recycled Concrete Aggregate
RDF	Refused-Derived Fuel
RWA	Resident Welfare Association
SBM-U	Swachh Bharat Mission – Urban
SCF-S	Segregated Combustible Fraction
SCM	Smart Cities Mission
SDG	Sustainable Development Goal
SECI	Solar Energy Corporation of India
SLNP	Street Lighting National Programme
SPV	Special Purpose Vehicle
STP	Sewage Treatment Plant
SWD	Storm Water Drainage
SWM	Solid Waste Management
TCPO	Town and Country Planning Organisation
TNA	Training Needs Assessment
TOD	Transport Oriented Development
TTRO	Tertiary Treatment Reverse Osmosis
UDA	Urban Development Authority
ULB	Urban Local Body
UMTA	Unified Metropolitan Transport Authority
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
URDPFI	Urban and Regional Development Plans. Formulation and Implementation guidelines
USGBC	US Green Building Council
UTF	Urban Transport Fund
VCF	Value Capture Financing
VGF	Viability Gap Funding
WHO	World Health Organisation
WRI CAIT	World Resources Institute Climate Analysis Indicators Tool

Executive Summary

India is witnessing rapid urbanisation. According to Census 2011, about 377 million people comprising 31.14% of the total population lived in urban areas. The urban population is projected to grow to about 600 million by 2031. While cities are engines of growth, they also contribute to more than 70% of India's greenhouse gas (GHG) emissions.

There has been a perceptible increase in number as well as intensity of extreme weather events in recent times in India, which can be directly attributed to climate change. India has unique geo-climatic and socio-economic conditions, and is vulnerable, in varying degrees, to rising sea levels, floods, droughts, cyclones, landslides, avalanches, storms, and heat waves. Indian cities are especially susceptible to the effects of climate change due to limited access to basic services, infrastructure, livelihood, and health. It is estimated that India will experience a decline of about 2-6% in its GDP under the carbon-intensive scenario by 2050, which could pose a serious threat to its development goals and investments.

National Action Plan for Climate Change (NAPCC), launched in 2008, outlines multi-pronged, long term strategies to address climate change and its impacts. As a part of NAPCC, National Mission on Sustainable Habitat (NMSH) aims at (i) Promoting low-carbon urban growth towards reducing GHG emissions intensity for achieving India's NDC, and (ii) Building resilience of cities to climate change impacts and strengthening their capacities to 'bounce back better' from climate related extreme events and disaster risks. The first version of NMSH released in 2010 has now been revised in the context of Nationally Determined Contributions (NDCs) under the Paris Agreement, Sustainable Development Goals (SDGs), and New Urban Agenda (NUA).

"Sustainable Habitat" is defined in NMSH 2.0 as "an approach towards a balanced and sustainable development of the ecosystem of habitat which offers adequate shelter with basic services, infrastructure, livelihood opportunities along with environmental and socio-economic safety including equality, inclusiveness and disaster-resilience".

The revised NMSH has identified five thematic areas, namely (i) Energy and Green Building, (ii) Urban Planning, Green Cover and Biodiversity, (iii) Mobility and Air Quality, (iv) Water Management, and (v) Waste Management. Key mitigation and adaptation strategies to facilitate the development of sustainable habitat have also been recommended under each thematic area.

The first thematic area "Energy and Green Buildings" focuses on reducing the energy consumption for lighting, heating, and cooling, etc. in India's real estate sector and shifting to cleaner renewable energy sources through adoption of green building technologies. Key mitigation and adaptation strategies recommended under this area include undertaking energy audit of all municipal services, including water supply, sewage, and storm water management on an annual basis and promoting renewable energy, and 100% installation of energy-efficient streetlights.

The second thematic area on "Urban Planning, Green Cover and Biodiversity" lays emphasis on integrated urban and regional planning approaches to climate-sensitive development and preservation and rejuvenation of water bodies, green spaces, and eco-sensitive areas. Key mitigation and adaptation strategies include mapping of all eco-sensitive zones, biodiversity rich areas, natural assets in the city, and promoting maintenance of green cover using an ecological approach, specifically focusing on native tree species and sustaining urban biodiversity.

The third thematic area on "Mobility and Air Quality" highlights the need to formulate and implement strategies focusing on inclusive and multi-modal mobility options in order to arrest the rapid growth of private motor vehicles, which has led to traffic congestion and increasing air pollution levels in metro cities. Key mitigation and adaptation strategies recommended under this thematic area include adopting cleaner and environment-friendly technologies, such as Electric Vehicles (EVs), Compressed Natural Gas (CNG), biofuels, etc. and creating incentives to attract and enable public-private partnership (PPP) in setting up charging infrastructure, shared mobility, first and last-mile connectivity and the use of clean renewable energy sources.

The fourth thematic area on “Water Management” lays emphasis on augmenting existing water resources by adopting rain-water harvesting (RWH), rejuvenation of waterbodies, recycling/ reuse of treated sewage, water conservation, and promoting circular economy of water through development of City Water Balance Plan (CWBP). Key mitigation and adaptation strategies recommended include publishing Rapid Flood Risk Assessment Report to understand the reasons of flooding/water stagnation as well as flooding/water stagnation hotspots in the city, implementing an end-to-end urban flood early warning system, efficient distribution of piped water supply, and encouraging 100% recovery of Operation and Maintainance (O&M) charges by water supply authorities and wastewater management.

The fifth thematic area on “Waste Management” focuses on the need for cities to prioritise actions for waste reduction and waste management, and promote waste-to-energy and waste-to-compost plants. Key mitigation and adaptation strategies include segregating waste and 3R (Reduce, Reuse, and Recycle) principles for better waste management, and facilitating setting up Material Recovery Facility (MRF) with provision for sorting recyclables and facility for sorting SCF Segregated Combustible Fractions/Refuse Derived Fuels (RDF) as per the Solid Waste Management (SWM) Rules 2016 in cities with over 0.5 million population.

NMSH 2.0 also lists out enabling climate actions, which are intended to address the overarching framework to facilitate adoption and implementation of the sector-wise climate action strategies mentioned above. These include strategies pertaining to Urban Governance, Capacity Building, Data, Technology and Innovation for the mission. ClimateSmart Cities Assessment Framework (CSCAF), a first-of-its-kind assessment framework with 28 climate-relevant parameters across the five thematic areas, will serve as a tool for cities to assess their present situation vis-à-vis objectives and targets of NMSH 2.0.

The implementation period of NMSH 2.0 is from 2020-21 till 2030. The goals of NMSH 2.0 are envisaged to be achieved through various other Missions and programmes of MoHUA, which are already being financed through budgetary and extra-budgetary resources.

Bird's-eye view of Udaipur City, Rajasthan

1

Introduction

Since the late 19th century, earth's surface temperature has risen by 1.14 °C (National Aeronautics and Space Administration, 2020), which is primarily attributed to anthropogenic-induced climate change, leading to widespread impacts on natural and human systems. It is estimated that human activities have contributed to almost 78% of GHG emissions (Pachauri & Meyers, 2014) between 1970 and 2010. As per SR 1.5 of Inter-Governmental Panel on Climate Change (IPCC), the impacts of the average temperature warming by more than 1.5 °C are manifold: human death and illness are expected to increase in pathways with warming greater than 1.5 °C due to risks directly attributable to climate change, such as exacerbated urban heat islands, amplification of heat waves, extreme weather volatility, floods, droughts, coastal inundation and an increase in vector-borne diseases, like malaria and dengue fever (IPCC, 2018).

India is the 3rd largest emitter of GHG globally. While the per capita emissions are much lower - less than half compared to the global average, more than 70% (Sethi, 2015) of India's emissions are generated from urban areas. As per Census 2011, the urban population in India accounted for 31.16% of the total population (37.7 crores). The country has 53 city agglomerations with over a million people, and 6 city agglomerations with over 10 million population. By 2030, the country's urban population is expected to rise to about 600 million, and cities would generate 70% of India's GDP (MGI, 2011).

As India undergoes rapid urbanisation and economic growth, GHG emissions from urban areas are likely to increase further. Therefore, as hubs of population, economic activities, and infrastructure, cities are uniquely positioned when seen through the climate lens. On one side, cities are key contributors to climate change; on the other, they also experience the severe impact of climate change with varying degrees of risk to essential services, infrastructure, housing, livelihoods, and health. Urbanisation and unplanned growth have led to complex social, economic, and ecological challenges that the urban areas need to address, along with catering to the current demand for essential infrastructure services and resource allocation towards better urban management.

Urban Development in New Town Kolkata, West Bengal

2

Climate Change: Hazards and Vulnerabilities

According to IPCC, rise in the global average temperatures leads to increase in precipitation, extreme rainfall, cyclonic storms, coastal flooding and heatwaves. As per the Ministry of Environment, Forest and Climate Change (MoEFCC) Third Biennial Update Report (BUR) to United Nations Framework Convention on Climate Chnage (UNFCCC), the diverse geography of India manifests varied climate regimes, ranging from continental to coastal, heat and cold, aridity and negligible rainfall, to excessive humidity and torrential rainfall (MoEFCC, 2021). India has unique geo-climatic and socio-economic conditions and is vulnerable, in varying degrees, to floods, droughts, cyclones, landslides, avalanches, storms, and heatwaves. According to the National Disaster Management Authority (NDMA 2019), out of the 36 states and Union Territories (UTs) in the country, 27 are disaster-prone. 12% of the land area is prone to floods and river erosion; out of the 7,516 km coastline, around 5,700 km is prone to cyclones and tsunamis; 68% of the cultivable land is vulnerable to droughts, hilly areas are at risk from landslides and avalanches, and 15% of the landmass is prone to landslides. A total of 5,161 Urban Local Bodies (ULBs) are prone to urban flooding .

The recently released Global Climate Risk Index 2021 (David Eckstein, 2020) ranks India as the 7th most-affected country from climate-related extreme weather events (storms, floods, heat waves, etc.). This is based on the recorded data for loss and damages during 2000- 2019 in terms of fatalities per 100,000 inhabitants and losses per unit GDP as percentage. Besides, in 2019, India recorded its maximum rainfall since 1994, with the most number of cyclones and 'severe cyclones'. However, the impact of climate change and climate hazards is not uniform country-wide, and varies across regions due to differences in the exposure and vulnerability of various systems (O'Brien, 2008).

According to IPCC, the vulnerability of cities is linked with several economic, social, cultural, institutional, political, and psychological factors

Table 1: Loss and damages due to urban flooding in Indian cities (during 2000-20)

Sr. No.	Name of city	Year(s) of occurrence	Loss and damages
1	Bengaluru, Karnataka	2005, 2009, 2013, 2016	2005: 100 homes damaged and 54 collapsed, 10 persons died. Urban flood disrupted essential services in the city became non-functional. The flood inundated all arterial roads.
2	Chennai, Tamil Nadu	2004, 2015	2015: Essential transit services were disrupted during the megaflood; It claimed 280+ lives, and more than 0.1 million people were rescued.
3	Mumbai, Maharashtra	2005, 2007, 2015	2005: 1,094 lives lost; all essential services including major transits operations were suspended. INR 550 crores loss was estimated in two days.
4	Sri Nagar, Jammu & Kashmir	2014	2014: Flood affected the entire Kashmir valley, halted all services (transport, telecommunication, city administration, hospitals) within the city. The estimated damage was INR 5,000-6,000 crores.
5	Hyderabad, Telangana	2001, 2002, 2006, 2008	2000: Urban floods damaged 35,693 homes and affected 0.2 milion people 2008: Floods affected 0.15 million people.
6	Delhi	2010, 2013, 2016	2016: Heavy rainfall created havoc conditions
7	Vadodara, Gujarat	2005, 2013, 2019	2019: Major transport operations were suspended; natural habitats affected
8	Kochi, Kerala	2018, 2019	2018: Airport closed for 2 weeks with over INR 220 crores of loss and damages; floods were followed by drought, water scarcity, and public health issues.

that determine and affect the coping capacities of institutions, communities, and infrastructure systems. The current projected increase of global temperature by 1.5 to 2 °C is expected to increase the frequency and intensity of extreme weather events, and give rise to new vulnerabilities with differential spatial and socio-economic impacts on communities. This will further impact the hydrological cycle and existing water resources, leading to droughts, floods, water scarcity, and food insecurity. In addition, extreme events cause loss of life, and adversely impact the standards of living, economic growth, and poverty reduction measures. The impact would be particularly disastrous for India and will lead to differential impact on poor and vulnerable communities, which constitute between one quarter and one half of the population across most Indian cities. It is estimated that, by 2050, under the carbon-intensive scenario, India will experience a decline of about 2-6% in its GDP (Mani, Bandyopadhyay, Chonabayashi, Markandya, and Mosier, 2018). Thus, climate change can pose a severe threat to India's development goals and investments.

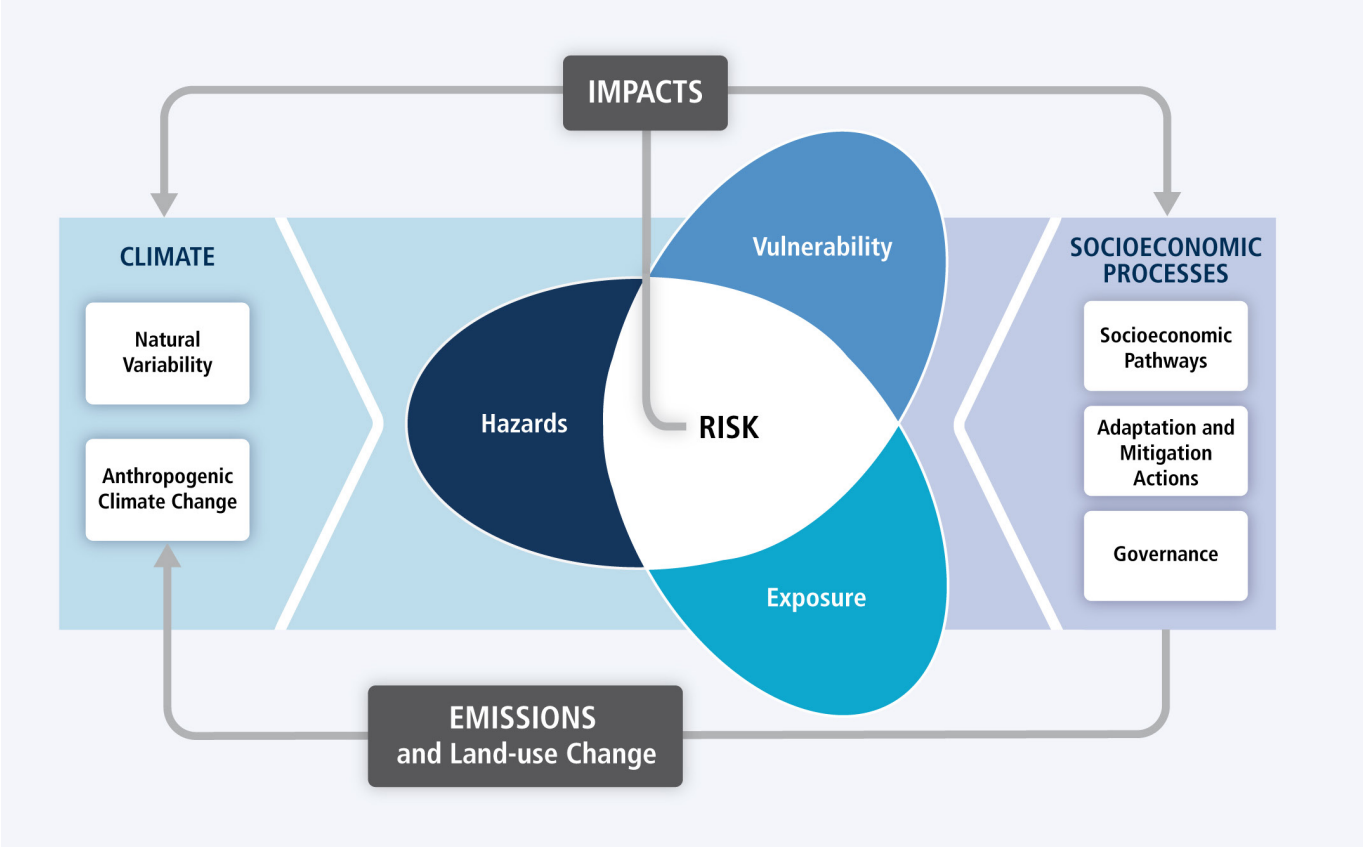
Heat waves

Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent globally due to climate change. Further, the decrease in the Diurnal Temperature Range (DTR) due to urbanisation is leading to human mortality and discomfort. Also, increased minimum temperatures in summer do not allow the necessary nocturnal cooling to neutralise the high maximum temperature during a heatwave, increasing its intensity and period. As per NDMA, India is witnessing the impact of climate change, which is increasing in intensity with each passing year and having a devastating impact on human health, which is evident from increasing number of heatwave casualties.

Cyclones

India has a coastline of about 7,516 km, which is exposed to nearly 10% of the world's tropical cyclones (NDMA, 2019). A recent study by the Indian Institute of Tropical Meteorology (IITM) indicates that frequency of cyclones in the Arabian Sea has increased by 52% between 2001 and 2019 (Deshpande, M., Singh, V.K., Ganadhi, M.K. et al., 2021). On average, about five or six tropical cyclones form in the Bay of Bengal and Arabian sea, and hit the coasts every year. About 71% of the coastal areas across ten states (Gujarat, Maharashtra,

Figure 1: Climate Risk Management Framework (IPCC, 2014)



Goa, Karnataka, Kerala, Tamil Nadu, Puducherry, Andhra Pradesh, Odisha, and West Bengal) and islands of Andaman, Nicobar, and Lakshadweep are prone to cyclones (Ministry of Home Affairs (MHA), 2011). In 2020 alone, nine cyclonic disturbances had their landfall in India, adversely impacting cities and coastal communities.

Droughts and water scarcity

The primary cause of drought is the deficiency of rainfall, including the timing, distribution, and intensity of deficiency. A prolonged period of relatively dry weather leading to drought is a widely recognised climate anomaly. Drought can be devastating as water supplies dry up, crops fail, animals die, and malnutrition and ill health become widespread. The environmental effects of drought include increase in soil aridity and salinisation, depletion in groundwater levels, and increased pollution of freshwater ecosystems.

According to MHA, a staggering 68% of India is prone to drought of variable degrees. 35% of the country receives rainfall between 750 mm and 1,125 mm, thereby falling in the drought-prone category, while 33% receives less than 750 mm and is categorised as chronically drought-prone (MHA, 2011). India has about 17% of the global population, but it has only 4% of total freshwater resources. About 0.2 million people die every year in the country due to inaccessibility to water, sanitation, and hygiene (NITI Aayog, 2019). Cities with high population density are more prone to the impacts of drought, leading to acute water scarcity.

Floods

In India, about 40 million hectares of the country's geographical area are flood prone (National Institute of Disaster Management (NIDM), 2014). There has been an increase in the intensity of urban floods over the past years, whereby major cities have been severely affected. While increasing frequency of extreme rainfall events (Pachauri & Meyers, 2014) is one of the critical factors responsible for the 'urban floods', increased paved surfaces affecting run-off, lack of adequate stormwater drainage, poor SWM systems leading to choking of the drains, etc. have also aggravated the vulnerability. In the last two decades, urban India has experienced unprecedented high intensity floods and flash floods in several cities, including Mumbai, Surat, Kolkata, Chennai, Kochi, Srinagar, Hyderabad, and Bangalore among others (Table 1). In 2019 alone, floods led to more than 1,800 deaths across 14 states. United Nations Children's Fund (UNICEF) estimates that around 2.4 million children were impacted by floods in India.

Climate change has led to increased occurrences of irregular and high intensity short duration rainfall events, which have rendered the cities more vulnerable to inundation and frequent flooding. The problem of urban flooding has been further compounded due to increase in impervious areas, absence of systematic approach to formulate and implement stormwater drainage systems, their inadequate O&M, and encroachment of drainage pathways in towns and cities (Central Public Health and Environmental Engineering Organisation (CPHEEO), 2019).

Landslides

National Landslide Risk Management Strategy, NIDM (2019) has indicated that landslide hazards in India rank high among the hydrogeological hazards, as they pose threat to life and livelihood, ranging from disruptions of routine activities to widespread loss of life, property, and destruction in large parts of the mountainous regions.Himalayan and other hilly regions are affected by landslides and landmass movement activities. Some of the significant landslide incidents that occurred in the past are Katropi - 2017 (Himachal Pradesh), Laptap Pampare - 2017 (Arunachal Pradesh), Mirik - 2015 (West Bengal), Malin - 2014 (Pune), Dasalgaon - 2007 (Maharashtra), Varunavat Parvat - 2003 (Uttarakhand), Amboori - 2001 (Kerala), Malpa - 1998 (Uttarakhand), Kalimpong - 1993 (West Bengal), Kohima - 1993 (Nagaland).

Rising sea levels and storm surges

According to India's Third BUR, sea level along the Indian coast is estimated to be rising at about 1.7 mm/year and at different rates along various parts of the coast. As per Census 2011, the total population of coastal districts is 171 million, which accounts for 14.1% of India's population. Several urban areas with considerable wealth in the form of assets and infrastructure, including the megacities of Mumbai and Chennai, with high population density, are located along the coast. Further, the urban slum population in these coastal cities is especially susceptible to be affected by regular flooding. Rising sea level can aggravate the flooding of low lying areas during extreme events, such as storm surges, while leading to increased coastal erosion. Coastal areas are vulnerable to the threat of rising sea-level, and can experience increased exposure to coastal hazards, such as storm surges during cyclones and related hazards.

3

National Mission on Sustainable Habitat

3.1 Paris Agreement and India's NDC

India is a party to the Paris Agreement, a legally binding international treaty on climate change adopted by 196 countries at the Conference of Parties (COP) 21 held in Paris. Its goal is to limit global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels. To that end, countries aim to reach global peaking of GHG emissions as early as possible to achieve a climate-neutral world by mid-century. In order to achieve these ambitious goals, the Paris Agreement has provisions for providing financial assistance to vulnerable and less-endowed countries as well as development and transfer of technology for improving resilience to climate change and reducing GHG emissions. The Agreement also lays great emphasis on strengthening climate-related capacity building in developing countries, and calls for conservation and enhancement of GHG sinks and reservoirs. The Agreement requires all countries to determine their NDCs, and also report regularly on emissions and their implementation efforts (UNFCCC, 2016).

India has committed to its NDCs (2021-30) and is on track to achieve the same (Economic Survey 2019-20). The NDCs for India are as follows:

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate-friendly and cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emission intensity of its GDP by 33-35% by 2030 from the 2005 level.
4. To achieve about 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of transfer of technology and low cost international finance, including from Green Climate Fund (GCF).
5. To create an additional carbon sink of 2.5-3 billion tonnes of CO_2 equivalent through additional forest and tree covers by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health, and disaster management.
7. To mobilise domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, create a domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and for joint collaborative R&D for such future technologies.

Floating Solar PV System at Kailasagiri Reservoir, Tirupati, Andhra Pradesh

3.2 National Action Plan on Climate Change

The Prime Minister's Council on Climate Change, GoI, launched NAPCC in 2008 with 8 sub-missions representing the multi-pronged, long-term, and integrated strategies to mitigate and adapt to the adverse impacts of climate change. The plan aims at fulfilling India's developmental objectives with a focus on reducing the emission intensity of its economy. Eight missions under NAPCC are as follows:

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

NAPCC is being guided by the following principles to achieve sustainable development while advancing the economic and environmental objectives:

1. Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change.
2. Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of GHG emissions.
3. Devising efficient and cost-effective strategies for end-use Demand Side Management (DSM).
4. Deploying appropriate technologies for both adaptation and mitigation of GHG emissions extensively at an accelerated pace.
5. Engineering new and innovative forms of market, regulatory, and voluntary mechanisms to promote sustainable development.
6. Effective implementation of programmes through unique linkages, including with civil society and local government institutions and through PPP.
7. Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global Intellectual Property Rights (IPR) regime that facilitates technology transfer to developing countries under the UNFCCC.

Riverfront Development in Indore, Madhya Pradesh

3.3 Overview: National Mission on Sustainable Habitat

India's GHG emissions grew from 1,311.29 $MtCO_2$ eq in 1994 to 3,202 $MtCO_2$ eq in 2014, an overall increase of 144% (WRI CAIT). The anticipated growth in urban population will require the construction of additional as well as re-construction of existing urban infrastructure and buildings, which will increase demand on land for habitation and other purposes. Managing the carbon footprint of urban habitats and ensuring their climate and disaster resilience are an important and challenging task for governments across countries, including India. To foster sustainable development, mainstreaming climate change mitigation and adaptation measures in urban planning and policy frameworks is critical. With this vision, GoI launched NMSH 2010 under NAPCC, which highlights strategies and guidelines to mitigate GHG emissions and adapt to climate change impacts by building resilience in infrastructure assets and communities, measures for improving disaster risk management, and warning systems for extreme weather events.

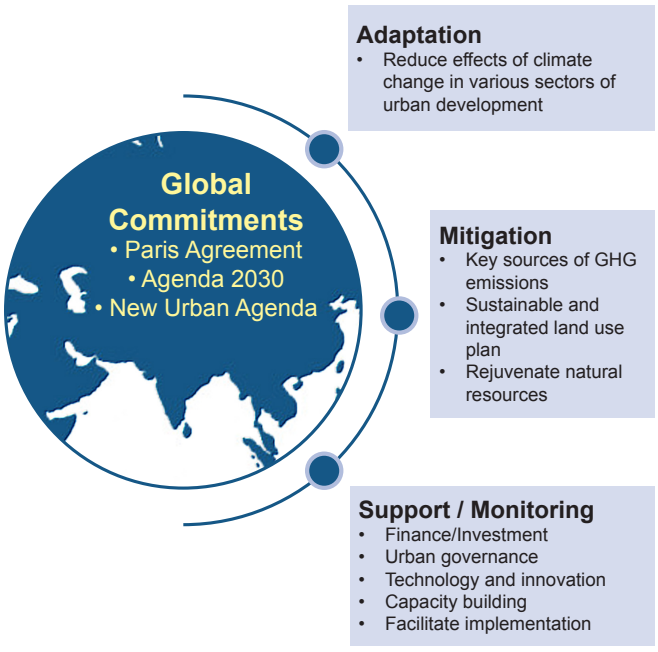
In 2015, GoI further adopted various strategies to mainstream sustainable development and climate actions in all urban investments and development activities as part of its various urban missions and programmes. These include the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Pradhan Mantri Awas Yojana - Urban (PMAY-U), Deendayal Upadhyay Antyoday Yojana - National Urban Livelihoods Mission (DAY-NULM), Swachh Bharat Mission - Urban (SBM-U), and the Smart Cities Mission (SCM). The missions focus on creating 'lighthouses of replicable models of sustainable urban development and providing a high quality of life to citizens'.

National Urban Policy Framework (NUPF) outlines an integrated approach for urban planning by analysing key challenges and priorities for managing urban habitats. Further, MoHUA has introduced CSCAF - a first-of-its-kind assessment framework on climate-relevant parameters that will serve as a tool for cities to assess their present situation and will facilitate cities to adopt, implement and disseminate best practices. It will also set standards compared to the international efforts towards green, sustainable, and disaster-resilient urban habitats. Aligning with these missions and initiatives, Indian cities have been actively working towards promoting sustainable urban development.

The 'Ease of Living Index' launched in 2018, aiming to improve institutional, social, economic, and physical urban systems to enhance the livability of cities, includes various indicators aligned to climate mitigation and adaptation targets.

With the new global urban agenda, the SDGs, and India's NDCs towards the Paris Agreement and paradigm shift in India's urban discourse, this revised version of the NMSH intends to align India's national programs and initiatives with international goals and commitments. This requires a closer review of the approaches and mechanisms for urban policy and planning, programs and investments, infrastructure development, and governance (Figure 2). The planning of cities needs to be envisioned with an integrated and holistic approach – making habitats that are sustainable, smart, low carbon, resilient, and promote quality living for all. In order to develop integrated strategies that promote sustainable habitat, NMSH 2.0 envisages to incorporate and address the growing needs and concerns that have emerged in the past decade.

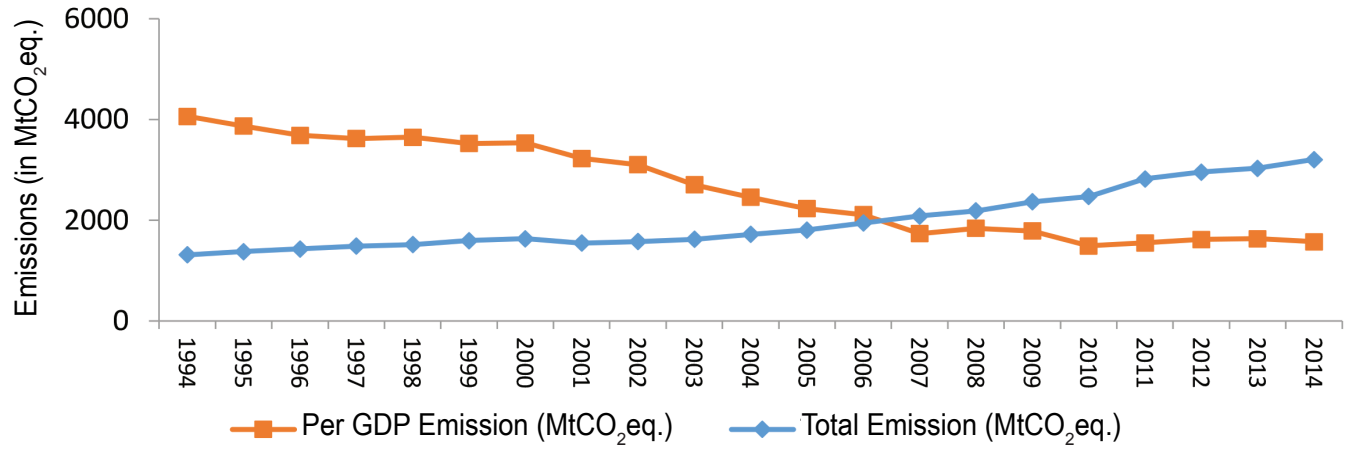
Figure 2: Strategy for Global Commitments



GHG Emissions Scenario

India's GHG emissions grew from 1,311.29 $MtCO_2$ eq in 1994 to 3,202 $MtCO_2$ eq. in 2014, indicating an overall Compound Annual Growth Rate (CAGR) of 4.5%. Although India's annual carbon footprint increased in 2014 compared to previous years, the country is on track to meet its global climate action pledges of reducing the emission intensity of its GDP (emission per unit of GDP). India's emission intensity reduced from 2,231.56 $MtCO_2$/million $ GDP in 2005 to 1,573.31 $MtCO_2$ eq/million $ GDP in 2014. Consistent time series information on GHG emissions per GDP from 1994 to 2014 are presented in Figure 3.

Figure 3: India's reduction of emission intensity CO_2/million $ GDP (2005 to 2014)



India GHGs: Sectoral analysis

According to the World Resources Institute Climate Analysis Indicators Tool (WRI CAIT), India's 2014 GHG profile was dominated by emissions from the energy sector, which accounted for over 63% of the total emissions, of which 49% of the emissions was from electricity and heat generation, and 24% from manufacturing and construction sectors. Agriculture was the second highest source with 20.3% of the total emissions, Industrial processes, transport, and waste contributed 7.0%, 6.2%, and 1.9% respectively emissions, as represented in Figure 4.

Figure 4: Sector-wise GHG emission (2005-14); source: WRI CAIT

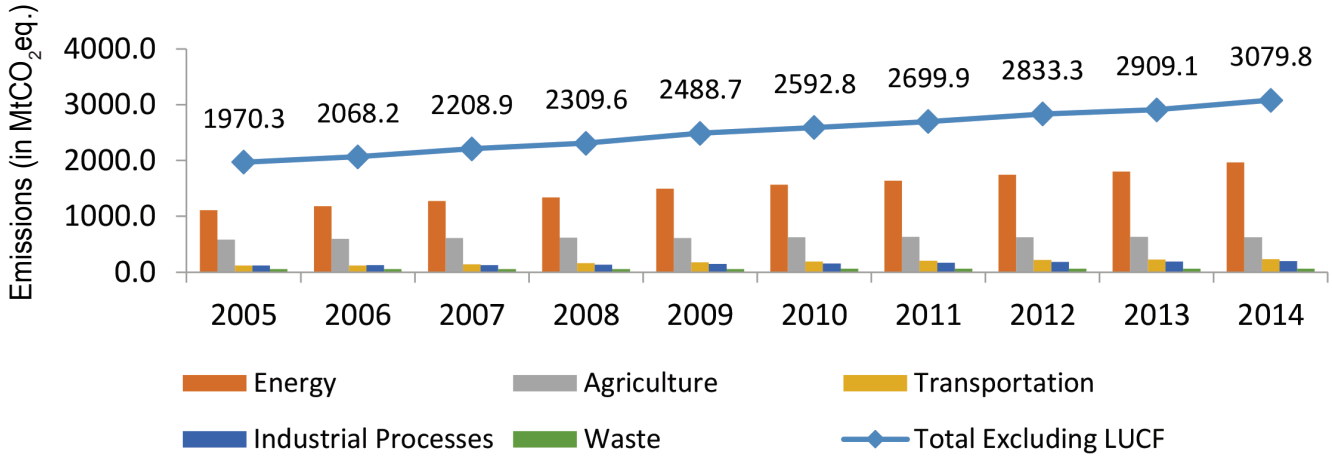
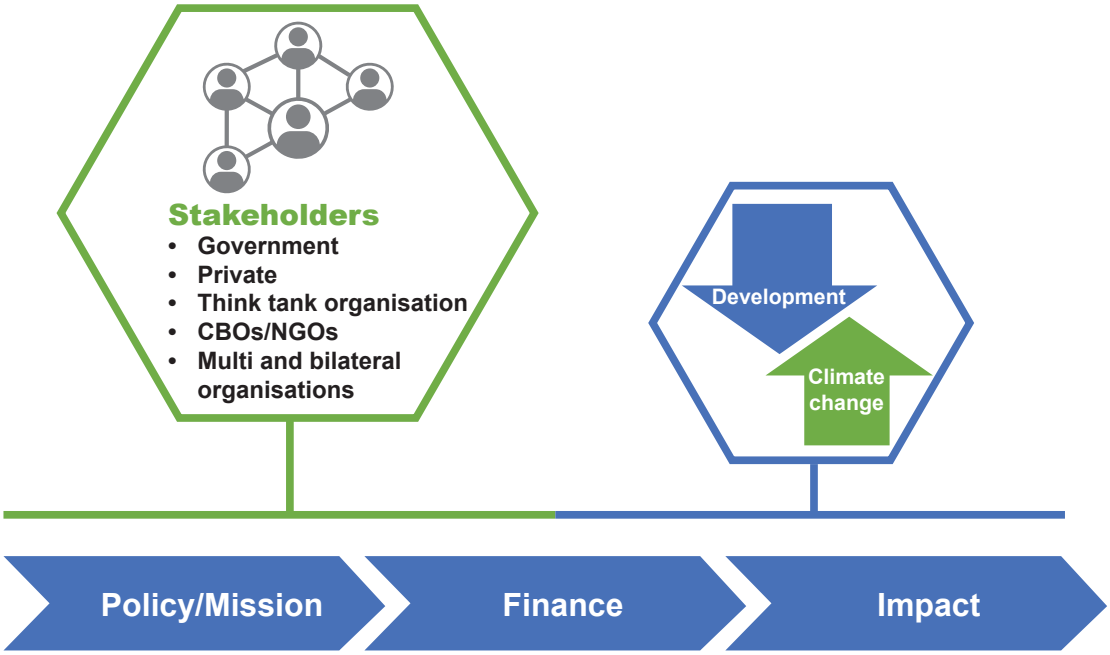


Figure 5: Interlinkage between development and climate change



3.3.1 Definition

A central principle of sustainable development is a holistic view of life, where all objects and activities are interconnected and mutually affect one another. Further, sustainable development aims to strike a balance between economic development, environmental conservation, and promotion of equity, known as the economy, efficiency, and effectiveness of sustainable development.

NMSH 2010 defined sustainable habitat as "achieving a balance between the economic and social development of human habitats together with the protection of the environment, equity in employment, shelter, basic services, social infrastructure, and transportation." However, in the context of various global and national commitments, i.e. NUA, SDGs, NDCs within the Paris Agreement, it was decided to review/revise NMSH in 2019.

NMSH 2.0, through this Mission document, adopts the following definition of sustainable habitat:

"An approach towards a balanced and sustainable development of the ecosystem of habitat which offers adequate shelter with basic services, infrastructure, livelihood opportunities along with environmental and socio-economic safety including equality, inclusiveness, and disaster resilience."

3.3.2 Objectives

The objectives of the NMSH 2.0 are as follows:

1. **Promote low-carbon urban growth towards reducing GHG emissions intensity for achieving India's NDC.**

2. **Build resilience of cities to climate change impacts and strengthen their capacities to 'bounce back better' from climate-related extreme events and disaster risks.**

3.3.3 Key Priorities

To achieve the objectives of NMSH, the subsequent sections provide a roadmap for realising the key priorities of building a sustainable and climate-resilient urban India under five thematic areas: Energy and Green Building; Urban Planning, Green Cover and Biodiversity; Mobility and Air Quality; Water Management; and Waste Management. These thematic areas are broad buckets of interventions to be undertaken and may be merged, in the local context, as required.

3.3.4 Linkages with SDGs

While all the SDGs are important, the cities can focus on the following SDGs as per the thematic areas in Table 2.

Table 2: Mapping of SDGs with NMSH thematic areas

Energy & Green Building	SDG 7: Affordable and Clean Energy SDG 11: Sustainable Cities and Communities
Urban Planning, Green Cover, and Biodiversity	SDG 13: Climate Actions SDG 15: Life on Land
Mobility and Air Quality	SDG 7: Affordable and Clean Energy SDG 11: Sustainable Cities and Communities
Water Management	SDG 6: Clean Water and Sanitation
Waste Management	SDG 12: Responsible Consumption and Production

4

Energy and Green Building

4.1 Key Priorities

Housing and buildings (residential and non-residential) are essential sectors of a country's economy and known as growth escalators, which directly impact the quality of life. The construction sector of India, including housing accounts for 8% of GDP and employs 12% of the total workforce (Source: India Habitat III National Report, 2016). Buildings consume 1/3rd of the global energy output and produce around 20% of the total GHG emissions (WBCSD 2016).

In the wake of increasing frequency of extreme events, such as floods, heatwaves, coastal flooding, storm surges, etc., it is critical to mainstream and implement retrofitting of climate adaptation measures in the building sector. While there are various guidelines and regulations in this sector to promote sustainability and address climate change impacts, there is a need for structured mainstreaming of various approaches and mechanisms in the existing city-level frameworks with appropriate implementation, monitoring, and verification protocols. Further, the challenges prevailing in the sector include knowledge gaps at various levels, issues related to enforcement and implementation, high upfront cost of green technology, and limited technological development.

With 50% of the building stock that is expected to be constructed by the year 2030 yet to be built, electricity consumption in residential and commercial buildings is bound to increase. Further, 80% of GHGs in India are generated from the present energy demand in fossil fuels, such as coal, natural gas, and oil. The Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, GoI, estimates that electricity consumption in the commercial building sector alone in India is expanding at a rate of over 9% per year. Similarly, as per the National Institution for Transforming India (NITI Aayog), GoI, the electricity consumption in the residential sector is expected to increase 6-13 times by 2047. Therefore, India's real estate sector will play a crucial role in addressing the climate-related challenges, especially in reducing energy demand and other resource requirements in terms of electricity consumption for heating and cooling, land and material requirement, and other infrastructural demands. Energy production must shift to cleaner, renewable energy sources (such as, solar photovoltaics (PV), solar thermal, wind energy, hybrid-hydel power, small hydro, geothermal energy, tidal energy, biogas, waste-to- energy, etc.).

There are several programmes designed by MoHUA, Ministry of Power (MoP), Ministry of New and Renewable Energy (MNRE) through the Bureau of Energy Efficiency (BEE) and its State Nodal Agencies, Energy Efficiency Services Limited (EESL), Solar Energy Corporation of India (SECI) and others, to develop energy efficiency in cities and shift to renewable energy sources. For example, MNRE has a Solar Cities program that is designed to support cities to prepare a roadmap to transform to 'renewable energy cities' or 'solar cities'. Similarly, BEE has a Municipal Demand Side Management (MuDSM) program for reducing electricity consumption in municipal services, promoting energy-efficient appliances, and a Green Building Star Rating program that the cities can take advantage of to achieve energy and cost savings in providing various municipal services. EESL has Municipal Energy Efficiency Programme (MEEP), Street Lighting National Programme (SLNP), and Unnat Jeevan by Affordable LEDs and Appliances for All (UJALA), that the ULBs can implement for promoting energy-efficient technologies in their cities. Under AMRUT, over 6.2 million streetlights were replaced with energy-efficient LED street-lighting. SNLP has been instrumental in replacing over 5 million street lights in over 500 cities in India, leading to 1.35 billion kWh of energy savings and cost saving of INR 7.42 billion every year. The cities can also take advantage of the solar street-lighting program through Atal Jyoti Yojana (AJAY) - an initiative of MNRE.

It is important to note that, even though the upfront costs for green building technologies are high, over long term, the life cycle cost, including O&M, is considerably lower. It is evident from research that the life cycle cost of green buildings is 24-28% less compared to conventional buildings (Weerasinghe et al, 2017).

Similarly, the building sector has implemented policies and codes, which elaborate on energy efficiency in residential and commercial building sector - Model Building Bye Laws (MBBL), 2016, National Building Code (NBC), 2016; the Energy Conservation Building Code (ECBC); the Eco- Niwas Samhita, 2018, and the schemes deployed by BEE. During the last decade, these policies and guidelines have been revised to address and incorporate the emerging needs of the sector. MBBL 2016 has provided guidelines for sustainable buildings to reduce energy and water consumption to 50% of the present consumption in conventional buildings. NBC developed by the Bureau of Indian Standards (BIS) was updated in 2016 to include a chapter on 'Approach to Sustainability'. ECBC 2007 document developed for commercial buildings was revised in 2017 to address the energy performance of the buildings at three levels. In 2018, ECBC for residential buildings "Eco Niwas Samhita 2018" was also launched. However, the ECBC document applies only for new construction and does not apply to existing buildings and renovation projects. For existing buildings, BEE has launched a scheme 'Star Rating of commercial buildings' with the objective of building a foundation for enhancing energy efficiency in buildings. Besides, the Green Rating for Integrated Habitat Assessment (GRIHA) stipulates green building guidelines for both new and existing buildings.

4.2 Key Strategies

The impact of the energy & buildings sector is critical from climate mitigation, adaptation and resilience perspective. Following strategies are recommended to facilitate the development of sustainable habitats.

1. Undertake energy audit of all municipal services, including water supply, sewage, and storm water management, on an annual basis.
2. Promote 100% installation of energy-efficient streetlights and use of renewable energy operated streetlights.

Roof-top Solar PV System in Jaipur, Rajasthan

3. Promote installing renewable energy systems in buildings (premises), including all municipal corporation buildings, to reduce the dependency on fossil fuels.
4. Integrate ECBC 2017 for all new municipal buildings and Eco-Niwas Samhita 2018 for residential buildings.
5. Green building guidelines should be integrated into development control regulations and building rules/bye laws and made mandatory for all new constructions of more than 20,000 sq.m area.
6. Promote roof cooling techniques within new developments in peri urban areas for all new constructions of more than 20,000 sq. m area.
7. Rating systems notified in Development Control Regulations (DCRs)/ General Development Control Regulations and building rules/ bye laws to be made mandatory for all new constructions of more than 20,000 sqm. area.
8. Integrate norms and standards to address climate risks (heat, floods, extreme rainfall, cyclones & storm surges, water scarcity, etc.) in Model Building Bye- laws, 2016 and National Building Code, 2016 for adoption by cities. Develop promotional/penalty schemes available for code compliance, pre-certification, certification of green buildings.
9. All Municipal Corporations with a 10 lakh plus population should Institute a green building action cell for knowledge creation, public awareness, empanelling green building vendors, designing green building schemes and their promotions, verification, and faster approvals for green buildings in the city. Develop a high-level green building committee/equivalent comprising ex-officio members from municipal corporation, smart city SPV, UDD, PWD, Green building certification agencies, and civil engineering/architect's membership association. The committee will provide strategic advice to promote and adopt energy efficient buildings and green buildings in the city.
10. Water harvesting should be mandated to reduce surface runoff and reduce water scarcity.

4.3 Linkages with Policies and Programmes

Initiatives of MoHUA

MoHUA has been promoting new and emerging technologies in the construction sector to reduce the overall pollution and emissions. Further, they are also promoting energy efficiency, resource management, and recovery through green building initiatives. Further, it is also promoting the uptake of renewable energy and reducing reliance on fossil fuels. The Ministry has spearheaded several initiatives, including the PMAY-U, AMRUT, SCM, and Model Building Bye-Laws, 2016.

Global Housing Technology Challenge (GHTC) under PMAY-U

- The objective of the GHTC (launched in January 2019) is to identify new emerging proven construction technologies, replacing conventional construction practices and building materials that are polluting, consume higher energy, and use natural resources.
- Fifty four new emerging construction technologies were identified for construction of mass housing.
- Six Light House Projects (LHPs) of about 1,000 houses each with necessary infrastructure in six regions of the country have been planned using six distinct technologies identified under GHTC. Funds for these projects have been allocated.
- Future evolving technologies will be supported to foster an environment of research and development in the country through Incubation and Acceleration Support at the Indian Institute of Technology (IIT) Madras, IIT Mumbai, IIT Kharagpur, IIT Roorkee, and the Council of Scientific & Industrial Research (CSIR) lab at Jorhat to help technology initiators.

Model Building Bye-Laws (MBBL), 2016

- Rainwater Harvesting (RWH) is mandatory for buildings on plot size of 100 sq. m or more.
- Rooftop solar photovoltaic (PV) system is mandatory for buildings on plot size of more than 500 sq. m.
- Waste water recycle is mandatory for all buildings having a minimum discharge of 10,000 litres per day.
- Processing of MSW should ensure implementation of the 4R rule of 'Reduce, Reuse, Recycle, and Recovery' through promotion of waste-to-compost and segregation of dry and wet waste.
- All buildings on plot sizes above 100 sq.m. to comply with the green norms and conform to the mandatory requirements for sanction as per Green Rating systems to reduce energy and water consumption to 50% of the consumption in conventional buildings.
- 20% of the recreational space to be left unpaved for green space.

AMRUT

- Replacement of conventional lights with LEDs: 6.2 million streetlights replaced with LED lights out of targeted 9.8 million lights. This is estimated to save around 1.35 billion kWh units of energy per year and reduce about 1.1 million tonnes of CO_2 emission per year.
- Energy audit of water pumps and replacement of inefficient pumps: MoUs were signed with 446 cities (29 states/UTs), and field survey for energy was completed in 413 cities (28 states/UTs), out of which energy audit was completed in 370 cities (27 states/UTs). 11,567 pumps (26 states/UTs) have been identified for replacement.

Smart Cities Mission (SCM)

- In case of redevelopment and greenfield models of Smart Cities, at least 80% of the buildings should be energy-efficient and green buildings.
- Renewable energy is to be promoted to ensure that a minimum of 10% of the city's energy needs are met by solar power.

Smart Sustainable Campus

Infosys Pune (Phase 2) is the largest campus in the world to earn Leadership in Energy and Environmental Design - Existing Building Operation and Maintenance (LEED-EBOM) - Platinum Certification from the US Green Building Council (USGBC), which is a globally accepted benchmark for design, construction, and operation of high-performance existing green buildings. LEED is one of the most stringent green rating tools for existing buildings, which verifies whether a building is performing sustainably.

The campus started operations in 2004 with 114 acres in Hinjewadi, wherein efficiency improvements were achieved through large-scale retrofit projects in 10 office buildings, three food courts, employee training centre, guest house, and sports complexes across the campus that can accommodate 34,000 people. A two-pronged strategy was adopted in 2008, which were:

- Designing new buildings to meet the highest efficiency standards
- Implementing deep retrofits in old buildings to increase energy efficiency.

The details of measures taken for efficient design in 6 years (2008 to 2014) and their impact is as under:

- 663 million units (kWh) saved.
- 0.56 million Tons of CO_2 emissions reduced.
- 80 million USD spend on electricity, saved.
- Ensuring that 90% of occupied space should be naturally lit (impact of day lighting i.e., employee health, work productivity, pleasant work space).
- Re-engineering of chiller plants reduced energy consumption by 30%, number of equipments by 45% and space requirement by 25%.
- Replacement of electric heaters with heat pumps is 3.5 times more efficient (1 kW electricity required for electric water heaters of 0.95 kW heating whereas 1 kW can heat 3.5 kW through heat pump). This led to a reduction of 4 MW of connected load across the campus.
- 2.6 million sq. ft area covered with white roofs across Infosys campuses. reduced building heat gain and urban heat island effect.
- 2000 street light retrofits, high-pressure sodium vapour luminaire of 250 W replaced with 90 W LED, migrated from yellow to white light for improving night vision, retrofit through replacement of standalone UPS systems with modular type high-efficiency UPS which improved efficiency by 15% as a result of a reduction in the number of UPS and annual maintenance costs.
- Smart operations through Command and Control Centre to monitor, manage and optimise resources, data driven building operations through energy-saving algorithms, provide data to optimise future building designs, demystifying solar by publishing live data, ground level weather data, 2020 goal for corporates allow solar funding as part of home loan etc.

According to a study, traditional “dark roofs” absorb significant sunlight - around 100 watts per sq. ft. While white roofs absorb less sunlight than either green or black roofs, they offset a portion of the warming effect from the GHG emissions. Both white and green roofs do a good job at cooling the building and cooling the air in the city. However, white roofs are three times more effective at countering climate change than green roof, and white roof is the most cost-effective over 50 years. The high installation cost of green roof, their environmental benefits may at least partially mitigate their financial burden (Source: Laurence Berkeley National Laboratory, California, USA).

5

Urban Planning, Green Cover, and Biodiversity

5.1 Key Priorities

Urban areas in India are expected to house more than 40% of the country's total population, and will contribute to over 75% of the national GDP by 2030 (Source: MoHUA, SCM). However, as the cities expand, the energy demand is expected to increase dramatcally, resulting in high GHG emissions and thereby contributing to the climate change. Since much of India's future development is centred around cities and urban areas, consistent with the objectives of the Paris Agreement, cities urgently need to plan and implement climate actions in an integrated and inclusive way. This would include mitigation of GHG emissions and adaptation to climate change impacts to foster comprehensive social, cultural, economic, and environmental benefits.

The cost of poor planning of Indian cities is estimated between 1.2% and 6.3% of the GDP by 2050 (Mani, Bandyopadhyay, Chonabayashi, Markandya & Mosier, 2018). Therefore, there is an urgent need for urban planning reforms that can facilitate integrated urban and regional planning approaches to climate-sensitive development, with active public participation in a time bound manner. At the same time, adoption and enforcement of existing mechanisms and guidelines, such as the revised URDPFI guidelines 2014 on preservation and rejuvenation of water bodies, green and eco-sensitive areas, need to be strengthened by the Urban Development Authorities (UDAs) and Urban Local Bodies (ULBs).

As of July 2019, out of the 7,933 cities and towns, 2,843 have statutory Master Plans. The disaggregation of Master Plans in the form of Zonal Development Plans/ Local Area Plans /Layout Plans are rarely available for most cities and towns, leading to haphazard and unplanned growth. Moreover, a review of existing plans suggests that many towns and cities that have Master Plans or Development Plans, which do not match with the growing infrastructural requirements and emerging challenges arising out of climate change, environmental and infrastructure requirements. Besides, lack of data to enable risk-informed planning, fund scarcity, and lack of qualified human resources (urban/town planners) pose serious challenges in formulation, implementation, and monitoring of climate actions at the city level. Spatial and temporal data loss and damage due to disasters remain a gap. In addition, timely implementation and monitoring of various spatial plans and provision for revision, need to be enabled with the use of the latest technological tools, such as Geographical Information System (GIS) and Remote Sensing techniques.

Urban environment consists of many aspects, including waterbodies, open spaces, and built-up areas. The waterbodies and open spaces help people adapt better to the adverse impacts of extreme climate events besides combating the urban heat island effect. These also combat water crisis, acting as reservoirs for draining, retention for groundwater recharge, for protection in case of floods, and for maintaining biodiversity. Further, local sources of freshwater decrease the dependence on energy for pumping purposes.

Similarly, sufficiently large and protected green spaces reduce the impact of human activities on climate, while biodiversity helps in carbon sequestration, air and water purification, mitigation of impacts of environmental pollution, noise reduction, and microclimate regulation. The effects of climate change and disasters (natural and man-made) are faced by urban inhabitants, and impact urban infrastructure. As effects of climate variability leading to extreme events are becoming more severe and frequent, the incidents of damage to urban infrastructure are also increasing. Therefore, all cities should be able to identify their potential hazards, vulnerabilities, and risk as well as be prepared for a prompt response mechanism to combat any disaster situations, including robust plans for recovery, reconstruction, and rehabilitation to 'build back better'.

5.2 Key Strategies

The following strategies are recommended for Urban Planning, Green Cover and Biodiversity to facilitate sustainable habitat development:

1. Map all eco-sensitive zones, biodiversity hotspots, natural resources in the city including waterbodies/drinking water sources, along with their catchments, open spaces/wetlands, and forest areas. Further, prepare a heat island map to inform mitigation actions to regulate micro-climate and reduce GHG emissions locally.
2. Take appropriate disaster mitigation and management measures in vulnerable areas as identified in the Vulnerability Atlas of India (Source: Building Materials and Technology Promotion Council (BMTPC)), which contains digitised state/UT-wise Hazard Maps with respect to earthquakes, wind, and floods.
3. Protect and prevent the construction of roads and buildings on wetlands/waterbodies and flood zones to maintain channels for surface runoff.
4. Promote maintaining of green cover using an ecological approach, specifically focusing on native tree species and sustaining urban biodiversity that provides important ecosystem services contributing to climate change mitigation and adaptation, such as carbon sequestration, air and water purification, mitigation of impacts of environmental pollution, noise reduction, and regulation of microclimate.
5. Develop a plan of action for city preparedness to tackle natural and man-made disasters in alignment with the Sendai Framework for the Disaster Risk Reduction (DRR), NDMA guidelines (2010, 2014, 2019), and MoHUA's Standard Operating Procedure (SOP) on Urban Flooding (2017). State/city level development controls/ codes should address multi-hazard risks in line with the Vulnerability Atlas of India to enable disaster resilient urban planning.
6. Carry out rejuvenation and conservation of urban waterbodies as envisaged under the Jal Jeevan Mission (JJM-Urban).
7. Enforce existing guidelines to preserve and protect river floodplains, banks, river beds, natural drainage canals, and open areas.
8. Digitise the city drainage network, and used the information to prepare drainage master plans, which include locations of storm water system, waterbodies, streams, natural canals, invert levels, terrain, land use, and land cover.
9. Ensure that 10-12% of city area is earmarked as recreation spaces, including the green and blue infrastructure of the total developed area following the URDPFI guidelines.
10. Develop green belt buffer zones around the industries situated within the Master Plan limit.
11. Prepare and implement City Climate Action Plan (mitigation and adaptation) for Million-plus cities, and integrate with the Master Plan, Local Areas Plans, and Town Planning Schemes, as applicable.
12. Apart from the focus on land use and land cover aspects, Make provisions for proper planning of water supply, sewerage, and storm water drainage networks in the Master Plans.
13. Reduce impervious surfaces and encourage construction of permeable sidewalks and pavements to reduce the intensity of surface runoff during monsoons and contribute to increased recharge of the groundwater, thereby helping to address stresses, such as droughts and water scarcity.
14. Take effective steps to increase green cover in urban areas, which prevents soil erosion (during run-off) and help manage the surface and ground water hydrology. Eg. Maintain vegetation and trees to stabilise soil and and reduces the risk of landslides in hilly/mountainous areas.

Rejuvenation of City Greens by Gwalior Smart City, Madhya Pradesh

5.3 Linkages with Policies and Programmes

Initiatives of MoHUA

Rejuvenation of waterbodies is critical to combat urban water stress. Waterbodies are essential, as they cater to drinking water needs, act as retention basins for groundwater recharge, protect during floods, and help to maintain biodiversity. Having local sources of fresh water decreases the dependence on energy used for pumping purposes. Open spaces play a critical role in climate mitigation and adaptation aspects by improving the microclimate and enabling groundwater recharge.

AMRUT

- INR 176.8 billion has been allocated by MoHUA for development and restoration of green spaces and parks.
- 1,770 parks have been developed at a cost of INR 9.9 billion, and creation of another 650 green spaces and parks worth INR 5.2 billion is under progress. The development of green space and parks with special provision for child-friendly components has ensured access to amenities, reduction in carbon footprints, increase in groundwater level, and improvement in quality of life of citizens.
- Local Area Plans/Town Planning Schemes (LAP/TPS) worth INR 0.5 billion has been launched as a pilot scheme in 25 cities @ INR 0.02 billion per city to catalyse planned and sustainable urban growth. The scheme will enhance the public realm (public spaces, areas under roads, etc.) by enabling the redevelopment of the existing built environment, preparing a new layout with enhanced infrastructure provision, and providing for planned urban expansion.
- Formulation of GIS-based Master Plans for 500 cities is one of the crucial reforms under AMRUT. It is a 100% centrally-funded sub-scheme with a total outlay of INR 5.15 billion, having three components, i.e., geo-database creation, GIS-based master plan formulation, and capacity building.

URDPFI Guidelines, 2014

- The URDPFI guidelines provides detailed methodology and framework for preparing various types of spatial plans, such as Metropolitan Regional Plan, Regional Plan, Master Plan, Zonal Development Plan, and Local Area Plan.
- It advocates for the development of compact cities, ensuring the use of public transport, and facilitating non-motorised transport (NMT). Norms for charging infrastructure in DCRs with a vision to implement ‘electric mobility’ and emphasis on Transport Oriented Development (TOD) for a span of the next 30 years have also been incorporated.Guidelines.

Smart Cities Mission (SCM)

- A key feature of SCM is preservation and development of open spaces - parks, playgrounds, and recreational facilities.

Park for citizens in Diu, UT of Daman and Diu

6

Mobility and Air Quality

6.1 Key Priorities

Urban India has experienced unprecedented growth of private motor vehicles during the last decade, resulting in traffic congestion and increase in air pollution levels. The average growth of vehicle registration in the country during 2001-16 was 9.4%. Five metro cities have a vehicle registration rate of over 500 per 1,000 people, and account for over 54% of the total vehicles in the metropolitan cities as of 2011 (Source: Indian Institute for Human Settlements, 2015). The public bus services are also limited to large cities, and most cities lack road safety measures for pedestrians and cyclists. It is estimated that the transport sector alone contributes to almost 13% (Source: International Transport Forum - Organisation for Economic Co-operation and Development, 2019) of carbon dioxide emissions in India, more than three times compared to what it emitted in 1990. Therefore, cities need to formulate and implement strategies focusing on inclusive and multi-modal mobility options that will not only address the problems related to the high consumption of non-renewable energies, but also promote health and user safety, and equal mobility options for all.

The development of urban transport is guided by the National Urban Transport Policy (NUTP), 2006, which emphasises planning for people rather than vehicles by providing sustainable mobility and accessibility to all citizens to place of work, education, social services, and recreation at affordable cost and within a reasonable time. This articulates the importance of incorporating urban transport as an integral component of land use plans under the Urban Planning component. Further, SCM, AMRUT, Automotive Mission Plan 2026, and Faster Adoption and Manufacturing of Electric/Hybrid (FAME) India are playing a key role in promoting sustainable mobility. Studies show that bus systems supported by quality pedestrian and cycling networks for first and last-mile connectivity form the most cost-effective public transport solution. The Metro Rail Policy, 2017 has also supported the construction of metro networks across various cities to reduce private vehicle ownership. The missions have enabled several cities to improve their bus systems, footpaths, and cycling networks.

6.2 Key Strategies

The folllowing strategies are recommended to address the issues related to urban mobility and air quality to facilitate the development of sustainable habitat:

1. Municipal Corporations should prepare action plans to promote the use of clean technology-based shared vehicles. Adoption of cleaner and environment-friendly technologies, such as Electric Vehicles (EV), Compressed Natural Gas (CNG), bio-fuels, etc., and provision of necessary infrastructure. Cities should also encourage the shift of goods vehicles to cleaner fuels to reduce air pollution.

Traffic Management at Sursadan Junction, Agra, Uttar Pradesh

2. Incentives should be provided to attract and enable PPP to set up charging infrastructure, shared mobility, first and last-mile connectivity, and the use of renewable energy sources.

3. Mixed use of walking, cycling within the city should be promoted in line with the National TOD Policy 2017. NMT plans should be developed to include no-car zones, docking stations, public bicycle sharing networks, etc. These facilities should be designed with safety aspects for pedestrians and cyclists for better uptake.

4. In order to decongest cities and discourage the use of private vehicles, Municipal Corporations, in collaboration with the Traffic Department, should introduce and monitor strategies, like higher parking charges, congestion charging, charges on low occupancy vehicles, and higher registration charges on the purchase of a second vehicle, mandatory parking requirement certification for private vehicle ownership, mandating private parking spaces for registering new cars, etc. They should encourage usage of public transport by providing an affordable, safe, comfortable, quick, reliable, and environment-friendly mode of public transport. Cities should establish quality-focused multi-modal public transport systems that are well-integrated, providing seamless travel across modes and encourage greater use of public transport and non-motorised modes.

5. ULBs should promote NMT by improving pedestrian safety, comfort, and convenience on all streets. All cities shall implement the Ministry's guidelines on NMT (2016) in coordination with UDAs, and shall design and implement green cover and open spaces along the walking and cycling paths. Cool pavements with good water absorption pavement technologies should be used in all walking and cycling paths.

6. Cities should complement the Pollution Control Board's existing monitoring system to collect and analyse data on localised pollution hot-spots. To implement the same, Municipal Corporations should adopt affordable technologies by introducing low- cost air quality sensors and linking the latter to the Integrated Command and Control Centres (ICCCs).

7. All million-plus cities should develop city-level clean air action plans, which should also include detailed monitoring of air pollution and its impact based on the CPCB guidelines.

8. The choice of public transport should be assessed according to the corridor demand, terrain, financial capacity, and affordability level. Typically, Metro Rail Systems form the high-capacity systems and are suited for high demand corridors. Buses, Light Metro Rail Systems (Metro Lite and Metro Neo), and Bus Rapid Transit System (BRTS), etc. typically constitute the medium and low-capacity public transport systems. Additionally, other modes such as cable cars, trolley buses, and water transport etc., may be explored as per requirements.

Public Transport System in Chennai, Tamil Nadu

6.3 Linkages with Policies and Programmes

Initiatives of MoHUA

An increase in the availability of public transport can promote the modal shift from private to public transport. This, in turn, helps tremendously to reduce carbon emissions by the transport sector.

- **National Urban Transport Policy, 2006**
- **Metro Rail Policy, 2017**
- **National Common Mobility Card (NCMC)**
- **Integrated Command and Control Centre (ICCC)**
- **Transit Oriented Development (TOD) Policy, 2017**
- **Guidance documents UMTA & UTF Operations, Urban Bus Specification, Operation of City Bus Service, Non-Motorised Transport (NMT), Public Bicycle System (PBS), Value Capture Finance (VCF) Framework, CMP Toolkit, etc.**

Metro Rail

- A total of about 721 km of the metro rail line is operational in 18 cities, and approximately 1,000 km of metro rail, including 82 km of Regional Rapid Transport System (RRTS) is under construction in 27 cities.
- Standards for Light Urban Rail Transit System named “Metrolite” has been issued by the Ministry in July 2019. This system is suitable for cities with a lower projection of ridership. It can also be used as a feeder system to the metro system.
- 42 MW of Rooftop Solar PV system in metro depots and station buildings has led to reduction of CO_2 emissions of 67,500 tonnes during 2019-20.

Bus Rapid Transit System (BRTS)

Presently, 400 km of BRTS is operational across the country, and 180 km of the same are under construction.

National Common Mobility Card (NCMC)

NCMC is an inter-operable transport card that runs on a RuPay card, and will enable people to pay multiple kinds of transport charges, including metro services, bus travel, toll taxes, parking charges, retail shopping, and even withdraw money across the country.

AMRUT

Central Government has allocated INR 14.36 billion for NMT in urban areas, of which 149 projects worth INR 2.37 billion to develop footpaths/walkways/skywalks, sidewalks, foot over-bridges, facilities for NMT, and multi-level parking have been completed. 184 projects worth INR 7.87 billion are under progress. These projects will enhance the zero-carbon public mobility for all. In order to facilitate the availability of charging infrastructure for EVs, MBBL 2016 and URDPFI guidelines 2014 have been amended in February 2019 to facilitate states/cities to make provisions in their bye-laws for providing EV charging infrastructure.

SCM

ICCC projects under SCM includes some of the Intelligent Transport System (ITS) components, like camera- based city surveillance, smartstreet lights, smart parking, traffic management, environmental sensors, Bus Intelligent Transport System, common mobile apps, etc., to strengthen the urban transport system. More than 60 cities across India are in the process of establishing ICCCs. Ministry’s support to ‘Streets for People and Cycle for Change’ initiatives further help in promoting NMT.

7

Water Management

7.1 Key Priorities

The increase in urbanisation and the resultant economic activities have increased the demand for water by many folds in cities. NITI Aayog estimates (2019) suggest that India will become water-stressed by 2025. More than 20% of India's groundwater has dried up or is in a critical state, emphasisng the need to augment existing water resources through recharge, rejuvenation, and storage, including RWH. With climate change expected to cause variation in precipitation patterns and affect water availability, there is an urgent need for cities to adopt integrated water and waste water management systems.

Cities are currently managing different water cycle components, including surface water, rainwater, groundwater, storm water, and wastewater. However, the ability of these isolated management systems to deliver services is increasingly jeopardised due to rapid population growth, spatial expansion of cities/towns, as well as climate variability.

As per Census 2011, 70.6% of the urban households (HHs) have access to piped water sources, whereas 26.9 % HHs depend upon non-piped sources, such as wells, hand pumps, tube wells/bore wells. The remaining 2.5% depend on unimproved sources, such as springs, rivers/canals, tanks/ponds/lakes, etc. Poor availability of water (i.e., 0.5 - 5 hrs a day) and inefficiency in water supply (i.e. unaccounted-for-water up to 50%) are the major shortcomings in the urban water supply. Besides, large inequities exist in both the quality and quantity of water supplied.

Urban water supply service, at present, is fraught with myriad challenges. On one hand, local water resources (surface and groundwater) are getting exhausted/ polluted, and cities are reaching much beyond their catchment area to source surface water. On the other hand, due to operational and management challenges, the water distribution systems are suffering from substantial physical losses. The existing challenges faced today by the water sector include inefficient supply and demand management, absence of equity in water distribution, financial and institutional issues and leakage management, limited metering, and archaic billing and collection systems.

Urban water management is now on the verge of a revolution in response to rapidly escalating urban demand for water and the need to make urban water systems resilient to climate change. Growing competition, conflicts, shortages, waste, and degradation of water resources make it imperative to rethink conventional concepts - to shift from an approach that attempts to manage different aspects of the urban water cycle in isolation to an integrated approach supported by all stakeholders.

The recently launched Jal Jeevan Mission (Urban) intends to promote the circular economy of water by developing CWBPs, focusing on recycle/reuse of treated sewage, rejuvenation of waterbodies, and water conservation. Further, 20% of the water demand is to be met by reused water with the development of institutional mechanisms.

MoHUA published the 'Manual on Water Supply and Treatment' in May 1999 to assist ULBs in managing urban water supply. It has also published a 'Manual on O&M of Water Supply Systems' in January 2005 to assist ULBs in execution and O&M of urban water supply. The manual provides detailed guidelines and methodology for planning, designing, execution, and O&M of water supply systems. It also provides information on the recent technical advances and trends in developing protected water supply systems.

In order to address the problem of urban sanitation, SBM-Urban was implemented to cover all cities and make the country 'Open Defecation Free' (ODF). Besides, the mission aims to provide universal coverage of sewerage system, including faecal septage management in 500 Mission cities.

The Ministry has released the 'Manual on Sewerage and Sewage Treatment Systems, 2013' in three parts: Part A: Engineering, Part B: O&M, and Part C: Management. The manual provides information on the recent technical advances and trends in the planning, designing, execution, O&M, and asset management, which all the ULBs refer to in urban areas. It also provides the technological interventions to prevent untreated discharge of sewage to avoid groundwater contamination.

Providing safe, reliable, and affordable water supply through efficiently managed arrangements is a crucial goal for the water supply sector. MoHUA has issued a Guidance Note for Continuous Water Supply (24/7 supply) in 2009. These guidelines intends to sensitise state governments, ULBs, and service providers to the policy and operational issues that need to be addressed. The guidelines are under the process of revision. A paradigm shift is required to consider stormwater as a resource instead of waste, and leverage stormwater to address the problem of water crisis. Within the existing urban development framework, particularly AMRUT, initiatives are taken up for implementation and monitoring of existing Stormwater Drainage (SWD) systems. MoHUA has prepared a 'Manual on SWD Systems, 2019' to provide necessary guidance to all the stakeholders towards aspects of sustainable design, planning, and management of SWD systems across towns and cities.

Water Management System in Dehradun, Uttarakhand

7.2 Key Strategies

In alignment with India's vision and ongoing programmes, the following water management strategies are recommended to ensure sustainable habitats:

1. City administrations should implement supply side management for efficient distribution of piped water supply. Water supply departments and Jal Nigams should adopt 100% water metering, and develop an appropriate water tariff structure, considering the water usage and income levels of the consumers. This could be achieved through practising escalating tariff, i.e., the consumption level of 20 lpcd (as per WHO and UNICEF) should be subsidised, and at 135 lpcd, full cost recovery should be built into the tariff. The tariff should be increased for consumption levels above the set benchmarks, which will not only help in sustainable consumption of water, but also augment revenues.

2. Full recovery of O&M charges should be encouraged by Jal Nigams and Water supply departments/authorities through rationalising user charges and improving the efficiency of water tax collection. For conventional underground sewerage systems, the user charges could be linked to the water consumption of the relevant property. O&M subsidies should be phased out in the short term for moving towards 100% O&M cost recovery. Capital Expenditure (CapEx) recovery should be aimed for in the long run. Energy-efficient equipments for wastewater pumping should be promoted, as it leads to a reduction in GHG emissions (CO_2 emissions) per kWh of electricity consumed, thereby reducing O&M costs.

3. ULBs should map the significant ground and surface water sources (catering to 5% or more of a city's water needs), and prepare a plan for augmenting existing water resources through recharge, rejuvenation, and storage. ULBs should make GIS-enabled urban plans for water supply and sewerage systems. RWH should be made mandatory within all buildings to replenish and recharge the groundwater.

4. Continuous (24x7) water supply should be adopted by relevant authorities, which will prevent the contamination of drinking water and optimise the use of fresh and treated water. Reduction of the non-revenue water (NRW) should be ensured by identifying illegal water connections through water audits and community involvement.

5. Municipal Corporations should develop Integrated Urban Water Resource Plans, which includes strategies for prevention of encroachments and rejuvenation of waterbodies. All ULBs should protect and prevent the construction of roads and buildings on wetlands/waterbodies and flood zones to maintain existing channels for surface water runoff.

6. City administrations should mandate treatment, recycle and reuse of at least 20% of the wastewater in alignment with the guidelines of JJM(U), and promote circular economy of water through the development of CWBPs. Decentralised wastewater management approach should be promoted for areas where there is a possibility for localised reuse of treated wastewater (as compared to all sewage being treated in one far corner), which will reduce the usage of fresh water. Building and construction projects, having an area of more than 20,000 sq. m (or as per latest norms) should install treatment plants within their premises to treat 100% of the generated wastewater. Building and construction projects with an area of more than 5,000 sqm. (or as per latest norms) should install treatment plants within their premises in case of unavailability of municipal sewage network.

7. All Municipal Corporations should conduct water and energy audits for water supply systems and wastewater management, especially treatment plants and pumping stations. All ULBs should undertake NRW assessments and put in place Reduction Strategy and Action Plan, incorporating options for active leakage control (at distribution mains, storage tanks, and service connection points). Cities should aim to achieve the target of NRW below 20%.

8. While strategising (planning) the wastewater management approach for an urban area, administrative authorities should shift their focus (end objective) from the conventional 'disposal-oriented' approach to the 'recycle and reuse-oriented' approach. Relevant authorities should develop advisories/standards for safe use of wastewater, greywater, and sludge in various activities, with special focus on managing associated health risks. This includes, but not limited to, the following: (a) Integration of stormwater management systems with wastewater recycling systems shall be made, wherever possible, (b) Reuse of greywater, after primary treatment, in flush toilets should be encouraged, ensuring no human contact, (c) Authorities are encouraged to develop regulations for new development to reuse greywater, minimising impacts on freshwater,

(d) Develop plans/agreements with industries situated within/nearby to use the treated wastewater in their manufacturing process, based on the quality of the treated wastewater, (e) Mandate use of recycled wastewater in cooling towers of commercial and institutional buildings, and (f) Develop plans/agreements to utilise the treated wastewater from STPs in thermal power plants.

9. All ULBs should publish a rapid flood risk assessment report to analyse the reasons for flooding/water stagnation, the hotspots, level, and frequency. All Municipal Corporations should implement an end-to-end urban flood early warning systems and link the same with ICCC, where possible.

10. Rejuvenation and conservation of water bodies should be promoted, as they act as essential reservoirs for drinking water, retention basins for groundwater recharge and risk prevention in case of floods.

11. Recycling and reuse of wastewater should be promoted, as it reduces the stress on the existing water resources, which are adversely affected by climate change.

7.3 Linkages with Policies and Programmes

Initiatives of MoHUA

Considering that climate change is expected to create additional pressure on the existing water resources, reducing NRW is considered a robust climate smart solution. Further, it can also be used as a demand management instrument to decrease additional stress on existing water resources. NRW reduction will cater to the reduction in energy consumption required for pumping water, thereby reducing GHG emissions.

AMRUT

- The Mission focuses on sustainable water management, comprising universal water supply coverage, reducing NRW (universal water supply, water meters, and leakage detection technologies), double piping systems in group housing societies, and water conservation interventions.
- The central government has allocated INR 390 billion (50% of the total budget) to the water supply sector. 553 water supply projects worth INR 76.83 billion have been completed, and 759 projects worth INR 338.6 billion are under progress.
- Water tap connections have been provided for 9.5 million HHs, and additional 4.42 million water tap connections will be provided under the Mission to achieve universal coverage.
- Energy audit of water pumps and replacement of inefficient pumps is another essential milestone. MoUs have been signed with 474 cities (30 states/UTs) , and field survey for energy audit has been completed in 420 cities (29 states/UTs), out of which energy audit has been completed in 396 cities (27 states/UTs) and 13,051 pumps (26 states/UTs) have been identified for replacement.
- In order to address water scarcity, Jal Shakti Abhiyan (JSA) was launched by the Ministry of Jal Shakti in 754 water-stressed ULBs on 01 July 2019. MoHUA under AMRUT has participated actively in the Mission and issued guidelines for urban water conservation to undertake conservation, restoration, recharge, and reuse of water. It aims to create 'Jan Andolan' through asset creation and communication campaigns to ensure interventions in the four major thrust areas for urban water conservation, namely: RWH, reuse of treated wastewater, rejuvenation of waterbodies, and plantation. During JSA, 239,847 RWH structures have been installed till date; 420 MLD wastewater have been treated, 1,480 water bodies covering 6,082 acres of land have been rejuvenated; 7.5 million saplings have been planted, providing green cover to 893.15 sq.km area, and 3.4 million citizens have registered their participation.
- In order to ensure sewerage and septage management, besides laying underground sewerage systems and installing septic tanks, the Mission promotes recycle and reuse of wastewater to improve water use efficiency and reduce dependence on drinking water for non-potable uses. The target of the Mission is to provide 14.5 million sewer connections to enhance substantial sewerage network coverage. INR 324.56 billion (42% of the Mission budget) has been allocated for sewerage and septage projects.

- Under the Mission, 257 projects on networked underground sewerage systems, augmentation and rehabilitation of old sewerage systems, STPs, Tertiary Treatment Reverse Osmosis (TTRO) plants, Faecal Sludge Treatment Plants (FSTPs), and mechanical and biological cleaning of sewers/septic tanks worth INR 52.64 billion have been completed. Another 548 projects worth INR 265.7 billion are under progress.
- So far, about 6 million sewer connections have been provided, leading to treatment of wastewater and its reuse in industries, thermal power plants, horticulture, etc. It has led to improved hygiene conditions, cleaner environment, and better quality of life.
- Ministry has brought out the 'Faecal Sludge and Septage Management Policy (FSSM), 2017', wherein detailed guidance/approach to roll out FSSM policy is provided which, inter alia, emphasises on the objectives, septage collection, and transportation, treatment and disposal, specific milestones, and leveraging FSSM to achieve 100% access to safe sanitation.
- Construction and improvement of stormwater drains while adhering to guidelines contained in 'Manual on Stormwater Drainage Systems (2019)' has been taken up in order to reduce flooding. INR 29.6 billion has been allocated towards drainage projects. So far, 475 projects worth INR 7.0 billion have been completed, and another 297 projects worth INR 21.4 billion are under progress.
- SOP on urban floods was issued in 2017 to mitigate and manage floods in cities.
- AMRUT 2.0 is a step towards 'AatmaNirbharBharat' with aim of making the cities 'water-secure' and providing functional water connections to all HHs.

8

Waste Management

8.1 Key Priorities

Urban India generates about 55 million tonnes of municipal solid waste (MSW) annually (Source: Planning Commission Report, 2014). As per a 2009 report of the Department of Economic Affairs (DEA), per capita waste generation is increasing by about 1.3% annually. It is estimated that 10-25% of the total MSW generated in Indian cities is Construction and Demolition (C&D) waste, of which only 5% is recycled and reused. The total quantum of waste from the construction industry was estimated to be around 100 million tonnes per annum in 2018 (NITI Aayog, 2019). According to MoEF&CC, MSW generation is expcted to reach 0.45 million tonnes per day (TPD) by 2031, and 1.19 million TPD by 2050. The relationship between solid waste and GHG emissions is well established. GHGs can be avoided through scientific management of waste. The first principle of the integrated waste management hierarchy is reduction of waste generation at source. Therefore, it is essential for cities to prioritise actions for waste reduction and accordingly plan their future waste management operations and infrastructure requirements.

On 2nd October 2014, SBM-U was launched by MoHUA, with the objectives of making the country Open Defecation Free (ODF) and promoting scientific SWM. With this vision, India has embarked on the journey of cleanliness, duly advocating compliance with the SWM Rules 2016, C&D Waste Rules 2016, and the Plastic Waste Management Rules 2016, among others. At the time of the launch of SBM-U, 26,000 TPD of waste was being treated, which has been enhanced substantially in the last 6 years of the Mission to approximately 96,000 TPD (as reported by the states/UTs in November 2020). The total waste generated is about 0.15 million TPD. About 98% of the total municipal wards have door-to-door collection, 68% of the total waste generated is processed, and 77% of the total wards practice source segregation. In order to enhance the progress and sustain the achievements, the proposal to continue the Mission under SBM 2.0 is under examination by the government.

Since 2016, in order to create healthy competitiveness and to evaluate the performance of ULBs, the Annual Swachh Survekshan (cleanliness survey) is carried out, under which the ULBs are ranked based on various parameters of cleanliness. In the first round of Swach Survekshan, 73 million-plus cities were evaluated. Similarly in 2017, the survey was conducted among 434 cities. Swachh Survekshan 2018 and 2019 covered 4,203 and 4,237 ULBs respectively. The Swachh Survekshan 2020 covered 4,242 cities, and introduced the concept of 'Continuous Survekshan' to ensure that the Mission outcomes are sustained through a continuous quarterly monitoring and verification.

SWM Rules 2016 emphasises on source segregation of waste into three streams (i.e., bio-degradable, non-bio-degradable, and domestic hazardous waste) and proper transportation and treatment of solid waste. The Rules insist that all industrial units, located within 100 km from the refused-derived fuel (RDF) and waste-to- energy plants based on solid waste, shall make arrangements within six months from the date of notification of these Rules to replace at least 5% of their fuel requirement by refused derived fuel so produced. As per the latest amendment to the Electricity Tariff Policy 2006 by the Ministry of Power, it is mandatory for the state electricity distribution companies (Discoms) to purchase all power generated from MSW at the rate determined by the appropriate authority. Further, as per the Policy on Promotion of City Compost, the Ministry of Chemicals & Fertilisers will provide a fixed market development assistance of INR 1,500/metric tonne of city compost for scaling up and consumption of the product. Initially, the marketing and promotion of city compost will be done through the existing fertiliser companies.

As a part of capacity building, MoHUA has conducted 130 workshops on various components of SBM-U, including municipal SWM, covering more than 2,400 ULBs and 5,000 officials across the country. Additionally, MoHUA has brought more than 20 advisories on various components of the SBM.

8.2 Key Strategies

Cities are advised to follow the suggested strategies for developing sustainable habitat:

1. Segregation of waste and 4R principles for efficient waste management should be implemented. State/city authorities should establish targets and promote replacement of virgin materials with recycled materials (linear to circular economy).
2. Resource efficiency of cities with more than 0.5 million population should be maximised by facilitating set-ups for Material Recovery Facility (MRF), with provision for sorting recyclables and facility for sorting segregated combustible fractions (SCF)/RDF as per the SWM Rules 2016.
3. State governments should promote the use of RDF in cement factories to reduce coal consumption and control GHG emissions.
4. All major cities with a population of more than 0.5 million should develop a mechanism to collect and process/reuse C&D waste as per the C&D Waste Management Rule 2016.
5. City administration should plan and implement strategies for onsite processing of wet waste and segregation of dry waste, and provide incentives to reduce waste generation at the source. They should promote technology integration for efficient collection and processing of waste. Residents and RWAs should be incentivised to collect wet waste and process them into compost on-site, as far as possible.
6. City administration should prepare a remediation plan for legacy dumpsites in the city to avoid/ mitigate GHG emissions. Cities need to scientifically operate and manage their landfills as per the SWM Rules 2016.
7. City administration should maintain the drains and prevent clogging due to waste disposal in order to reduce the risk of flooding and other associated health hazards.

Sewage collection in Devanahalli, Karnataka

8.3 Linkages with Policies and Programmes

Initiatives of MoHUA

The relationship between solid waste and GHG emissions is well established. Generation of GHGs can be avoided through scientific waste management of waste. The first principle of the integrated waste management hierarchy is the reduction of waste generation at the source. C&D waste is a significant component of city waste. To reduce the pressure on the exploitation of natural resources, cities need to focus on finding greener ways to produce concrete, encouraging reuse of recycled materials to replace virgin materials.

SBM-U

- **Waste to Compost**
  - The assessed capacity of compost that can be generated in India from MSW is about 5.5 million TPA.
  - Current production is around 1.75 million TPA from 635 operational centralised compost plants.
  - Another 206 plants of 0.68 million TPA capacity are under construction.

- **Waste to Energy**
  - The assessed capacity of power that can be generated from MSW is around 511 MW.
  - 7 plants are currently in operation, with a combined capacity of 88.4 MW.
  - Another 56 plants are coming up with the capacity of 415 MW

SCM

Waste management projects under the mission include distribution of bins, development of IT solutions for monitoring of trucks, among others.

CPWD Guidelines for Sustainable Habitat, 2014

- The amount of C&D waste in India is estimated to be around 10-12 million tonnes annually, and the proportion of concrete is estimated to be about 23-35% of the total waste.
- The total available recycled concrete aggregate (RCA) in India is about 1.8 million tonnes annually.
- A plan for systematic approach towards demolition of a building shall be developed to minimise the generated waste and maximise its use.
- Various agencies/sub-contractors shall be involved and linked up with the steps for C&D waste reuse and recycling.
- All C&D waste information shall be collected by contractors/waste management companies to ensure effective and efficient reuse of C&D waste (e.g. use of recycled aggregates).

Segregated waste collection by battery-operated vehicle, Tirunelveli, Tamil Nadu

9

Cross-Cutting Strategies for enabling Climate Actions

The enabling climate actions intend to address the overarching framework to facilitate the adoption and implementation of the sector-wise climate action strategies discussed in this Guidelines. These include strategies pertaining to the following: urban governance; capacity building; data, technology and innovation; and financing mechanism for the mission.

9.1 Urban Governance

Urban governance in climate change context refers to the ability and capacity of local/municipal governments to make decisions and implement plans/programmes and strategies across a range of responsibilities and services for achieving a better quality of life, especially for the vulnerable citizens' group irrespective of the changes in the environment, climate, or weather patterns. Overall, it requires adequate legal and policy frameworks, efficient institutional and administrative processes to enable the government response to the needs of citizens in the context of climate change. At the city level, ULBs play a vital role in providing access to basic services, grievance/concern redressal, etc. It is to be noted that most of the urban missions in India are being implemented and converged at the ULB level. Therefore, it is vital to address the issues and challenges of urban governance in a meaningful way. Some of the recommended strategies are listed below:

1. The centre will constitute a National Mission Management Unit (NMMU) to take up regular activities and handhold states/cities in implementing the Mission. NMMU also has to take up capacity building (for ULB and state officials on climate change related aspects) activities, along with developing Information, Education and Communication (IEC) materials, which will play an important role towards mass awareness generation and behaviourial change aspects.
2. Cities shall promote principles of sustainable neighbourhood planning and climate resilience to address climate mitigation and adaptation in the ongoing and proposed activities, such mixed and specialised land use, TOD, risk-informed land use, and infrastructure planning.
3. City administration should analyse the local climate risks and consider the same within all policies, plans, and projects. Cities need to develop CCAPs in line with the NMSH guidelines and CSCAF. CCAPs will also have to indicate proposed actions and budgetary requirements to carry out various activities under each thematic area till 2030.
4. Municipal Corporations will institutionalise monitoring and implementation of climate actions by establishing 'Environment & Climate Change Cell'. The Cell will closely coordinate with the city-level multi-stakeholder committee on climate change as instituted under CSCAF. This committee should include participants from various stakeholders at the city/state level, such as industry, civil society, sector experts, academia, and scientific institutions.
5. ULBs will conduct regular monitoring of critical climate and environment parameters to mainstream and improve the existing situation. This mechanism includes and addresses CSCAF indicators.
6. States/Cities shall implement existing institutional and policy guidelines towards low-carbon and climate-resilient cities. For instance, setting up of the Unified Metropolitan Transport Authority (UMTA) and Urban Transport Fund (UTF) while enabling coordinated and integrated urban transport planning and management.

9.2 City Level Monitoring Mechanism

At the city level, ULB will be responsible for the implementation of the Mission. The District Magistrate/ Municipal Commissioner will chair the city-level monitoring committee with the following members:

District Magistrate/Municipal Commissioner	Chair/Member-Secretary
CMO	Member
Chief Engineer (CE) (Water supply and sanitation)	Member
CE (Buildings)	Member
CE (Roads)	Member
CE (Electrical)	Member
Commissioner - Transport	Member
Town Planner, UDA	Member

The terms of reference for the city-level monitoring committee are mentioned below:

1. The ULBs are responsible for the implementation of the Mission in the city.
2. Monitoring day-to-day activities related to the Mission.
3. Undertake and review capacity building activities at local levels under various missions/ schemes/ programmes of the Ministry.
4. Submit quarterly progress reports on the implementation of mission to State Level Committee.
5. The ULB will also be responsible for building coordination and collaboration among stakeholders.
6. The City level committee should meet every three months.

Mitigation strategy

- City inventory on GHG emissions, identification of sources, and opportunities for reduction of emissions under various thematic areas
- Analysis of collected data, estimatation of future emissions based on the socio-economic profile of a city, and setting of targets and proposed actions
- Assessment of the local capacity to converge with existing policies/missions/schemes, etc.
- Setting of goals to reduce emissions (short/mid/long term) and consensus building on CCAPs.
- Prioritisation of activities proposed as part of CCAP under each thematic area and its institutionalisation.
- Implementation plan with clear roles, responsibilities, and timeline.

Adaptation strategy

- Climate change vulnerability assessment with present and future risks to community and environment, with respect to physical and socio-economic aspects, including identification of vulnerable segments.
- Analysis of different scenarios of climate impact and risk levels (low/mid/high) on people, infrastructure, and investments.
- Assessment of the local capacity to address climate change with an inventory of existing resources, local knowledge, policies, schemes, missions, etc., which will complement the actions proposed under CCAPs.
- Planning and implementation to enhance resilience towards physical, environmental, economic, and social impacts of climate change.

Cycle-for-Change, Bilaspur, Chhattisgarh

ClimateSmart Cities Assessment Framework (CSCAF)

MoHUA launched CSCAF under SCM in February 2019. This first-of-its-kind city level framework on climate-relevant parameters, including those of the National Clean Air Programme, is intended to drive climate-resilient and low carbon development across urban India, in alignment with SDGs and India's NDCs towards addressing global climate change.

With 28 progressive indicators across five thematic areas (refer to figure below), CSCAF provides an overarching monitoring framework for assessing the progress made in alignment of the NMSH guidelines. CSCAF serves as a tool for cities to assess their performance on an annual basis, and provides an incremental roadmap to adopt and implement relevant climate actions. Results from CSCAF is used to monitor the progress, and inform NMSH. In addition, the framework also facilitates the dissemination of context-specific best practices adopted by Indian cities, and assess the required skills and resources for scaling the same through its Secretariat at the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA).

Climate Centre for Cities

MoHUA, under SCM, has established the 'C-Cube' at NIUA to anchor climate actions across urban India. The Centre ensures continuity of ongoing initiatives under CSCAF, including building capacity and knowledge retention for mainstreaming climate change action in all 500 Class-I cities. This includes, but not be limited to, municipal services, such as water supply, SWM, infrastructure, urban planning, land development, transportation, air quality, and energy. Through climate smart development, cities will be able to respond to the changing climatic conditions and foster sustainable actions, thereby increasing the ease of living of citizens. At present, 126 cities, including the 100 Smart Cities, housing more than 140 million people, are reporting on climate actions. C-Cube is facilitating access to the required knowledge, training, project development, and financial support to achieve sustainable climate actions on the ground.

9.3 Capacity Building

Capacity building - for strengthening both individual and institutional capacities at the city level - is an integral component of all the urban missions of the Ministry. Implementing NMSH will require applying a climate change lens and addressing local priorities towards climate mitigation and adaptation in the capacity building programmes. It is intended that the individual training will enhance functional knowledge, improve job-related skills, and focus on bringing an attitudinal change in state and municipal functionaries. Institutional capacity building will enable institutional outcomes and bring about more significant sustainable and transformative change.

Capacity building initiatives should be targeted towards college students, professional architects, engineers, planners, ULBs, and government organisations. These initiatives should specifically help the stakeholders understand various technologies, methods, and processes to develop sustainable cooling, waste and water management/recycling, use of sustainable materials, etc. to develop green infrastructure and its potential cost benefits.

Recommended strategies for individual and institutional capacity building are as follows:

1. Strategic training plans for ULB officials should be carried out based on the Training Needs Assessment (TNA) on various issues, particularly climate change related aspects. Nodal officers from the Environment and Climate Change Cell and other relevant departments are to be identified for participation, including training programmes implemented under CSCAF. This may also include exposure visits.
2. Nodal officers should be encouraged to enroll in both online and offline training programmes with various recognised institutions and the National Urban Learning Platform (NULP) of MoHUA. This will aim at building a dedicated team of climate practitioners within the ULBs.
3. Suitable staff should be encouraged to participate in various workshops, seminars, etc. on regular basis.
4. Individual capacity building shall focus on coaching and task-related assistance from peers and mentors.

Institutional capacity building

1. Relevant authorities should develop advisories/ standards for safe use of wastewater, greywater and sludge in agriculture and aquaculture, focusing on managing health risks associated with such use. Authorities should also develop advisories on reuse of wastewater for farm forestry, urban forests, horticulture, watering public parks, public gardens, road medians, green belts, industrial use, road washing, dust control, building construction, and other uses as deemed appropriate without compromising on the health risks associated with such uses.
2. Capacity building programmes and modules are being developed and implemented by MoHUA under CSCAF to train ULB officials, city level experts and practitioners. ULBs, relevant city level departments, and state line departments are to be trained to refer the various tools and guidelines while implementing various Missions. Periodic review of the progress of capacity building and training activities shall be mandatory at national and state/UT level. Each state/UT shall submit an annual action plan on capacity building to the Ministry at the beginning of the financial year.
3. Annual IEC plans and materials should be prepared and disseminated through various events (offline/online) to increase public awareness and participation on issues related to climate change, sanitation, public health, and environment, among others.
4. Research and development on climate change and related aspects should be encouraged with support from various research and training organisations, NGOs, civil society, and international agencies. To that end, cities can leverage the ClimateSmart Cities Alliance instituted by MoHUA in partnership with C-Cube at NIUA.

9.4 Data, Technology and Innovation

The cities must use the transformational force of data and emerging technologies for holistic urban development. Urban managers and administrators require tools and early warning indicators that can provide them with objective insights on routine civic activities using advanced predictive capabilities to plan for future challenges. The significance of urban data to capture the growing and changing needs of the public

is well documented. The advantage of interconnected technology and platforms sourcing data from all civic services and functions is possible in real-time, and the possibilities for urban impact are significant (Richard Barkham, 2018). The significance of data to track and implement climate action measures has gained attention in recent times. Alongside the above possibilities, utilising the urban data ecosystem can put the cities' thinking and agenda on climate change on the national and global policymaking platforms. With data insights giving a more accurate picture of resources, capabilities, and aspirations, Indian cities can effectively position themselves to strategise and negotiate policies and support provided by national governments and global organisations. In essence, with data-backed decision-making, cities will not just be able to tackle the effects of climate action, but also identify and anticipate the root causes, for advocating climate-responsive policies. Recommended strategies are as listed below:

1. ULBs should start using spatial/non-spatial decision support tools, such as big data analytics, including visual representations of results using GIS technologies.

2. Collection and management of data on various urban development and climate parameters at the city level is key to informed planning and decision-making for urban climate actions. The data collection should be standardised to enable easy comparison across cities over time. For example, the lack of urban transport statistics has severely constrained the ability to formulate sound urban transport plans and reliably assess the impact of the different initiatives that have been taken. Therefore, cities should collect regular data on public and private transport patterns to formulate sound urban transport plans. The use of Intelligent Transportation System (ITS) to enable real time tracking and information of public transport should be encouraged. Developing digital platform/apps to ensure end to end route planning, booking, electronic ticketing, and easy payment methods to make public transport attractive and enable safety measures to improve ridership, universal design for better access to public transport.

3. In case of Smart Cities, where ICCCs have been established, the same should be integrated with end-to-end early warning systems to predict and manage extreme events and risks due to climate change.

9.5 Financing

The implementation of NMSH will begin from 2021 till 2030 in alignment with the SDGs and India's NDCs. The goals of NMSH are envisaged to be achieved through various Missions and programmes of MoHUA. Therefore, no separate financing is sought for implementing NMSH. However, the following financing strategies are recommended:

1. In view of investment required to take up various activities, states/UTs need to mobilise resources (technical/financial) from other sources, such as own revenue sources (user fees, beneficiary charges, impact fees, etc.), municipal bond markets, private sector investments, pool finance, PPP, Viability Gap Funding (VGF), Corporate Social Responsibility (CSR) funds, bilateral and multi-lateral agencies (such as World Bank, Asian Development Bank, KfW, etc.), concessional loans, carbon markets, Green Bonds, among others. An incentive mechanism is to be devised by the states/UTs to encourage ULBs to adopt climate-friendly measures.

2. ULBs should find appropriate financing options, including innovative mechanisms that tap land as a resource for investments in urban infrastructure. VCF policy framework will assist states/cities in assessing the scope of resource mobilisation, identifying the area of influence of proposed projects, and optimising resource mobilisation.

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Annexure I

Case studies on various thematic areas

Chandigarh: Construction and Demolition (C&D) waste plant

Background

The Goverment of India has notified the C&D Waste Management Rule, 2016, which is applicable to everyone who generates construction and demolition waste (building materials, debris, rubble waste resulting from construction, re-modelling, repair and demolition of any civil structure of individual or organisation or authority). The Rules address the scientific disposal of C&D waste to enable reuse and recycling. All local government institutions are responsible for proper management of C&D waste within its jurisdiction, including placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal. Chandigarh Municipal Corporation (CMC) has installed a C&D waste processing plant and a cement concrete products factory to use recycled aggregates.

Project objectives

- Develop a C&D waste processing unit in the industrial area of Chandigarh.
- Comply with the waste management policy of the city and C&D Waste Management Rules, 2016.

Project location

- Industrial Area Phase I, Chandigarh implemented during December 2018 – May 2019.

Approach

CMC has set up the C&D waste processing plant in its industrial area for stacking, crushing, processing, and manufacturing of various C&D products. The plant has the following characteristics:

1. It is set up with a capital cost of about INR 23 million and plant capacity of about 120 MT per day (8 hr shift) for crushing construction waste.
2. It produces materials that can be utilised for cement concrete works, such as washed sand, crushed aggregates of 10, 20, and 40 mm.
3. The plant also manufactures road material (PCC kerbs, PCC channels, PCC tiles, paver blocks, etc.) at a relatively low cost. It reduces the in-house cost of construction by approximately 10%.
4. Fees charged for collection and transportation are INR 396 + GST for recycled aggregate and sand, INR 198 + GST for silt per cu. m.
5. It provides facility for the residents of Chandigarh to dump their construction waste in an authorised manner.
6. CMC has also come up with a C&D waste management policy, which has penalty provisions of INR 1,000 for residential and INR 5,000 for commercial buildings, in case they are involved in indiscriminate dumping of C&D waste.
7. The policy also talks about provisions for C&D waste management while issuing new/ reconstruction of building permits. Amounts of INR 20/sq. m for new construction, and INR 160/ sq.m for re-construction are charged .

Achievements

1. Till date, 5,000 MT C&D waste has been processed into recycled products from the date of commissioning of the plant (15 May 2019), which has resulted in natural resources savings, reduction in the quantum of waste reaching landfills, and reduction in carbon footprints with numerous environmental benefits.
2. Economic benefits include reduction of transportation costs of the construction materials, job creation.

Limitations

The minimum land required for setting up a C&D waste plant in Chandigarh is 3-4 acres. In future, stacking of recycled materials will require extra land and environmental clearance.

Thane: Energy and Green Buildings

Background

Thane city, Maharashtra, is rapidly growing due to extensive immigration and urbanisation. Thane Municipal Corporation (TMC) is continuously undertaking environment-oriented projects to reduce GHG emissions. TMC, with support from ICLEI South Asia, under the project of Urban Low Emission Development Strategies, undertook a feasibility assessment of the streetlight infrastructure.

Project objectives

- Establish a baseline of 8,000 plus street-lights, performance contracting with involvement of private participation.
- Optimise power consumption of LEDs.

Approach of LED Street Lighting Initiative

A systematic approach for execution of LEDs was carried out, which is as follows:

- Numerous stakeholders, including energy experts, lighting experts, techno-commercial experts, political and administrative heads, and local residents, etc. were consulted to execute LED street-lighting projects across the city.
- Sites were selected across the city based on various parameters, like electrical infrastructure, road type, road width, geographical location, project visibility, etc.
- An investment grade audit was carried out at different locations to establish the baseline and electrical infrastructure assessment of the site.
- Market assessment for best available technology with upgradability and compatibility was conducted.
- Financial modelling was conducted to arrive at a feasible payback mechanism, and to develop a PPP structure around the estimated capital and expenditure.
- Bids were invited through public competitive bidding.
- The streetlight replacement was carried out, demand reduction was recorded, and a new baseline established.
- TMC has appointed a third-party expert to verify the energy saving and ensure transparent transactions to the technology provider.

Financial structure of the initiative

The project was based on a PPP arrangement with multiple stakeholders. Benefits and co-benefits of energy savings LED ESCO project has achieved maximum energy savings, i.e., 5.33 million kWh per year, and energy consumption for street lighting reduced by more than 60%, which helped in mitigating GHG emissions of 4,385 tonnes CO_2 eq. annually. On the operational level, the share of GHG emissions from municipal services in Thane has reduced from 35% in 2012-13 to 11.7% in 2017-18. Connected load of streetlight infrastructure has reduced by 70%.

The citizens have reported that white light provides better visibility and a heightened sense of safety. Conventional technology was high maintenance prone, whereas higher life of lamps (50,000 hrs against 15,000 hrs) implies lesser downtime and higher reliability. The lighting optics as designed resulted in optimum lux levels with uniform spread across the roads and hence ensuring improved visibility.

LED lights fitting in Thane, Maharashtra

Thanjavur: Rejuvenation and conservation of urban environment

Background

Rejuvenation of a park (area 1,282 sq.m), situated on the west side of ADB area of Thanjavur city in Tamil Nadu was completed. The park is one of the prominent public spaces of the neighbourhood, with amenities, such as children park, open spaces used for informal parking of four wheelers, trucks, and buses, which restrict the residents from using the park. This has led to the proposal for rejuvenating other neighbourhood parks.

Project objectives

- To improve the facilities in the park for an enhanced ease of living.

Approach

An integrated approach involving pre-assessment and redevelopment was adopted to improve the condition of the park. The key activities included:

- Assessment of the existing condition and scope of improvement of the park.
- Extensive involvement of the local residents to identify the facilities that need to be provided in the park.
- Development of a comprehensive plan of action incorporating all the aspects identified through pre-assessment as well as residents' consultations.
- The total project cost was INR 13 million, and the proposed plan was implemented through active participation of the city Municipal Corporation and residents. This park is service-oriented, and revenue generation is not expected.

Benefits

- Increased green cover leading to improvement in the overall aesthetics and quality of environment.
- Installation of various play equipments for kids, which resulted in increased attractiveness.
- Enhancement in the park infrastructure, i.e., park furniture, water fountains etc.
- Improvement of lighting facilities in and around the park.
- Reduction in cases of garbage dumping.
- Reclamation of the encroached portion of land

Rejuventaion of park in progress, Thanjavur, Tamil Nadu

Annexure II

Indicative list of proposed cities under NMSH

Sl. No.	List of proposed cities under NMSH						Cities covered under	
	State	UA/City	Million-plus cities	Coastal cities	Hilly cities	Other cities	Smart cities	AMRUT
1	Andaman & Nicobar Island	Port Blair		✓			✓	✓
2	Andhra Pradesh	Vishakhapatnam	✓	✓			✓	✓
3		Vijayawada	✓					✓
4	Arunachal Pradesh	Pasighat			✓		✓	
5	Assam	Guwahati			✓		✓	✓
6	Bihar	Patna	✓				✓	✓
7	Chandigarh	Chandigarh	✓				✓	✓
8	Chhattisgarh	Raipur	✓				✓	✓
9		Durg-Bhilainagar	✓					✓
10	Dadar & Nagar Haveli	Silvassa					✓	✓
11	Daman & Diu	Diu		✓			✓	
12		Daman		✓				✓
13	Goa	Panaji		✓			✓	✓
14	Gujarat	Ahmedabad	✓				✓	✓
15		Surat	✓	✓			✓	✓
16		Vadodara	✓				✓	✓
17		Rajkot	✓				✓	✓
18		Porbandar		✓				✓
19	Haryana	Faridabad	✓				✓	✓
20	Himanchal Pradesh	Dharamshala			✓		✓	
21	Jammu & Kashmir	Srinagar	✓		✓		✓	✓
22	Jharkhand	Jamshedpur	✓					
23		Dhanbad	✓					✓
24		Ranchi	✓				✓	✓
25	Karnataka	Bengaluru	✓				✓	✓
26		Mangaluru		✓			✓	✓
27		Udupi		✓				✓
28	Kerala	Kochi	✓	✓			✓	✓
29		Kozhikode	✓	✓				✓
30		Malappuram	✓					
31		Thiruvananthapuram	✓	✓			✓	✓
32		Kannur	✓	✓				✓
33		Kollam	✓	✓				✓
34		Thrissur	✓	✓				✓
35		Calicut		✓				
36		Ernakulam		✓				

Sl. No.	List of proposed cities under NMSH						Cities covered under	
	State	UA/City	Million-plus cities	Coastal cities	Hilly cities	Other cities	Smart cities	AMRUT
37	Lakshadweep	Kavaratti		✓			✓	✓
38	Madhya Pradesh	Bhopal	✓				✓	✓
39		Jabalpur	✓				✓	✓
40		Gwalior	✓				✓	✓
41		Indore	✓				✓	✓
42	Maharashtra	Mumbai	✓	✓				✓
43		Pune	✓				✓	✓
44		Nagpur	✓				✓	✓
45		Nashik	✓				✓	✓
46		Vasai Virar City	✓					✓
47		Aurangabad	✓				✓	✓
48	Manipur	Imphal			✓		✓	✓
49	Meghalaya	Shillong			✓		✓	✓
50	Mizoram	Aizawl			✓		✓	✓
51	Nagaland	Kohima			✓		✓	✓
52	NCT of Delhi	Delhi	✓				✓	✓
53	Odisha	Puri		✓				✓
54		Paradip		✓				
55	Puducherry	Puducherry		✓			✓	✓
56		Karaikal		✓				✓
57	Punjab	Ludhiana	✓				✓	✓
58		Amritsar	✓				✓	✓
59	Rajasthan	Jaipur	✓				✓	✓
60		Jodhpur	✓					✓
61		Kota	✓				✓	✓
62	Sikkim	Namchi			✓		✓	
63	Tamil Nadu	Coimbatore	✓				✓	✓
64		Madurai	✓				✓	✓
65		Tiruchirappalli	✓				✓	✓
66		Kanyakumari		✓				
67		Chennai	✓	✓			✓	✓
68		Tuticorin		✓			✓	✓
69	Telangana	Hyderabad	✓					✓
70	Tripura	Agartala			✓		✓	✓
71	Uttar Pradesh	Kanpur	✓				✓	✓
72		Lucknow	✓				✓	✓
73		Ghaziabad	✓					✓
74		Agra	✓				✓	✓
75		Varanasi	✓				✓	✓
76		Meerut	✓					✓
77		Prayagraj	✓				✓	✓
78	Uttarakhand	Dehradun			✓		✓	✓
79	West Bengal	Kolkata	✓				✓	✓
80		Asansol	✓					✓
Total		**80**	**53**	**23**	**11**		**55**	**70**

Sources: *Million Plus Cities: Census of India*
Coastal Cities: Centre for Coastal Zone Management and Coastal Shelter Belt
Hilly Cities: Only smart city mission cities have been selected
Other Cities: TBD

Annexure III

Key Deliverables and Timelines (2021-2030)

Energy and Green Buildings			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Undertake energy audit of all municipal services, including water supply, sewage and storm water management on an annual basis			
Promote 100% installation of energy-efficient streetlights and use of renewable energy-operated streetlights			
Promote installation of renewable energy systems in buildings (premises), including all Municipal Corporation buildings			
Integrate ECBC 2017 for all new municipal buildings and Eco-Niwas Samhita 2018 for residential buildings	In all million+ cities and state capitals based on the adoption of MBBL 2016 and NBC 2016	In all AMRUT cities with a population of more than 0.1 million	In all statutory cities
Integrate green building guidelines into development control regulations (DCRs) and building rules/bye-laws, and made mandatory for all new constructions of more than 20,000 sq. m area	In all million+ cities and state capitals based on the adoption of MBBL 2016 and NBC 2016	In all AMRUT cities with a population of more than 0.1 million	In all statutory cities
Promote roof cooling techniques within new developments in peri-urban areas for all new constructions of more than 20,000 sq. m. area			
Rating systems notified in DCRs/GDCRs and building rules/bye-laws to be made mandatory for all new constructions of more than 20,000 sq. m. area	In all million+ cities and state capitals based on the adoption of MBBL 2016 and NBC 2016	In all AMRUT cities with a population of more than 0.1 million	In all statutory cities
Integrate norms and standards to address climate risks (heat, floods, extreme rainfall, cyclones and storm surges, water scarcity, etc.) in MBBL 2016 and NBC 2016 for adoption by cities	In all million+ cities and state capitals based on the adoption of MBBL 2016 and NBC 2016	In all AMRUT cities with a population of more than 0.1 million	In all statutory cities
All Municipal Corporations to set up a green building action cell and a high-level green building committee	In all million+ cities and state capitals based on the adoption of MBBL 2016 and NBC 2016	In all AMRUT cities with a population of more than 0.1 million	In all statutory cities

Urban Planning, Green Cover, and Biodiversity			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Map all eco-sensitive zones, biodiversity hotspots, natural assets in the city, and prepare a heat island map to inform mitigation actions to regulate micro-climate and reduce GHG emissions locally	All million-plus cities	All AMRUT cities	
Protect and prevent the construction of roads and buildings on wetlands/waterbodies and flood zones to ensure channels for surface runoff	All million-plus cities	All AMRUT cities	
Promote maintaining of green cover using an ecological approach, specifically focusing on native tree species and sustaining urban biodiversity	All million-plus cities	All AMRUT cities	
Develop a plan of action for city preparedness to tackle natural and man-made disasters, and check for its alignment with the Sendai Framework for DRR, NDMA guidelines (2010, 2014, and 2019) and MoHUA's SOP on Urban Flooding (2017). State/city level development controls/codes should address multi-hazard risks in line with the Vulnerability Atlas of India to enable disaster resilient urban planning	City level plans for all million-plus cities	All AMRUT cities	
Rejuvenate and conserve urban waterbodies in line with the Jal Jeevan Mission	All million-plus cities	All AMRUT cities	
Enforce existing guidelines on preservation and protection of river floodplains, river banks, river beds, natural drainage canals, and open areas	All million-plus cities	All AMRUT cities	
Digitise city drainage network and prepare the drainage master plan	All million-plus cities	All AMRUT cities	
Ensure 10-12% of the total developed area under recreation spaces, including green and blue infrastructure, in line with the URDPFI guidelines	All million-plus cities	All AMRUT cities	
Develop green belt buffer zones around industries situated within the ULB limit	All million-plus cities	All AMRUT cities	
Prepare and implement the Climate Action Plans (mitigation and adaptation) for million-plus cities, which is integrated with the Master Plan, local area plans, and TP schemes	100% Master Plans in all million-plus cities 100% Local Area Plans (25 cities) CCAP for all million-plus cities	Master Plans for all AMRUT cities 100% Local Area Plans in all million-plus cities CCAP for all AMRUT cities	

Mobility and Air Quality			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Municipal Corporations should prepare action plan and promote the use of clean technology-shared vehicles			
Create incentives to attract and enable PPP in setting up charging infrastructure, shared mobility, first and last-mile connectivity, and the use of renewable energy sources for clean renewable energy sources			
Promote mixed-use and NMT plans to facilitate walking, cycling within the city in line with the National TOD Policy, 2017	In all million-plus cities and state capitals	In all cities with a population of more than 0.5 million	
Introduce strategies to decongest cities and discourage the use of private vehicles	In all million-plus cities and state capitals	In all cities with a population of more than 0.5 million	
Promote NMT by improving infrastructure for pedestrian safety, comfort and convenience on all streets; all Municipal Corporations are to implement the NMT guidelines, 2016	In all million-plus cities and state capitals	In all cities with a population of more than 0.5 million	
Complement the Pollution Control Board's existing monitoring system to collect and analyse data on localised pollution hot-spots			
Develop city-level clean air action plans for all million-plus cities, which include detailed monitoring of air pollution and its impact based on the CPCB guidelines			
Increase share of public transport, and implement metro network and rapid rail transit system (RRTS)		Enabling increase in overall public transport share to 30 % by expanding metro network Metro network in 50 cities Operationalisation of 82 km of RRTS network	

Water Management			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Implement supply side management for efficient distribution of piped water supply. Water supply departments and Jal Nigams should adopt 100% water metering and develop appropriate water tariff structure taking into consideration the water usage and income levels of its users		100% in all cities & towns	
100% recovery of O&M charges should be encouraged by Jal Nigams and water supply departments/authorities through rationalising user charges and improving the efficiency of water tax collection		100% in all cities	
ULBs should undertake mapping of major ground and surface water sources (catering to 5% or more of city's water needs)and preparation of a plan for augmentation of existing water resource through recharge, rejuvenation, and storage. ULBs should make GIS-enabled urban plans, including water supply and sewerage systems. RWH should be made mandatory, based on area of the building, to replenish and recharge the groundwater		In all Class-I cities	
Continuous (24x7) water supply to the cities should be adopted by water supply authorities		100% in all cities & towns	
Municipal Corporations should develop Integrated Urban Water Resources Plan, including rejuvenation of urban waterbodies. All ULBs should protect and prevent construction of roads and buildings on wetlands/waterbodies and flood zones to ensure channels for surface runoff		In all Class-I cities	
Mandate treatment, recycling, and reuse of wastewater in line with the guidelines of JJM-U, and promote circular economy of water through development of city water balance plans		City water balance plan for all the cities and towns Treatment of waste water: 100% in all Class-I cities and 50% in Class-II and below towns Reuse at least 20% of treated waste water in all Class-I cities	
Conduct water and energy audits for water supply systems and wastewater management, especially treatment plants and pumping stations. All ULBs should undertake NRW assessments and put in place a NRW Reduction Strategy and Action Plan		NRW less than 20% in all cities Audits in at least Class – I cities	
Relevant authorities should develop advisories/standards for safe use of wastewater, greywater, and sludge in various activities with special focus on managing health risks associated with such use		In all the cities & towns	
All ULBs should publish rapid flood risk assessment report to understand the reasons of flooding/water stagnation as well as flooding/water stagnation hotspots, level, and frequency. All Municipal Corporations should implement an end-to-end urban flood early warning system and link the same to ICCCs		In at least Class – I cities	

Waste Management			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Segregation of waste and 4R principles in the city to better manage waste management. Further promote and establish targets to replace virgin materials with recycled materials		100% in all cities & towns	
Resource efficiency of cities with more than 0.5 million population can be maximised by facilitating setups for MRF with provision for sorting recyclables and facility for sorting SCF/ RDF as per the SWM Rules, 2016			
State governments should promote use of RDF in cement factories to reduce the coal consumption and control GHG emissions			
Develop a mechanism to collect and process/reuse C&D waste as per C&D Waste Management Rule, 2016		100% in all Class-I cities	
City administration should plan and implement strategies for on-site processing of wet waste and segregation of dry waste, and provide incentives to reduce the waste generation at source		100% in all cities & towns	
Prepare a remediation plan for legacy dumpsites to avoid GHG emissions. Cities need to scientifically operate and manage their landfills as per SWM Rules, 2016		100 % in all cities & towns	
City administration should maintain the drains and prevent clogging of the same due to waste disposal in order to reduce the risk of flooding and other associated health hazards		100 % in all cities & towns	

Annexure IV
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