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
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सत्यमेव जयते

आवासन और शहरी कार्य मंत्री
पेट्रोलियम एवं प्राकृतिक गैस मंत्री
भारत सरकार
Minister of
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Government of India

आज़ादी का अमृत महोत्सव

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

3R	Reduce, Reuse & Recycle
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 & Demolition
CAGR	Compound Annual Growth Rate
CAPEX	Capital expenditure
CCAP	Climate Action Plans
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	Fecal Sludge & Septage Management Policy
FSTP	Fecal Sludge Treatment Plants
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	Intergovernmental Panel on Climate Change
ITS	Intelligent Transportation System
JDI	Joint Declaration of Intent
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 Projects
MBBL	Model Building Byelaws
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 Organization
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-Motorized Transport
NRW	Non-Revenue Water
NULP	National Urban Learning Platform
NUTP	National Urban Transport Policy
O&M -	Operations 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	Refuse Derived Fuels
RWA	Resident Welfare Association
SBM-U	Swachh Bharat Mission – Urban
SCF - S	Segregated Combustible Fractions
SCM	Smart Cities Mission
SDG	Sustainable Development Goals
SECI	Solar Energy Corporation of India
SLNP	Street Lighting National Program
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 Authorities
ULB	Urban Local Body
UMTA	Unified Metropolitan Transport Authority
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
URDPFI	Urban and Regional Development Plans. Formulation and Implementation
USGBC	US Green Building Council
UTF	Urban Transport Fund
VCF	Value Capture Financing
VGF	Viability Gap Funding
WHO	World Health Organization
WRI CAIT	World Resources Institute Climate Analysis Indicators tool

Executive Summary

India is witnessing rapid urbanization. According to Census 2011, about 377 million Indians comprising 31.14% of the country's 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 our greenhouse gas (GHG) emissions.

There has been a perceptible increase in number as well as intensity of extreme weather events in recent times in our country 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. Our 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 our 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 for 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 Paris Agreement, SDGs and New Urban Agenda.

"Sustainable Habitat" has been 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 Buildings, (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 & 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 operated 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 & rejuvenation of water bodies, green spaces and eco-sensitive areas. Key mitigation and adaptation strategies recommended under this thematic area include mapping all eco-sensitive zones, biodiversity hotspots, 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, CNG and biofuels etc. and creating incentives to attract and enable public-private partnership in setting up charging infrastructure, shared mobility, first and last-mile connectivity and the use of clean renewable energy sources.

The fourth thematic area i.e. "Water Management" lays emphasis on augmenting existing water resources by adopting rain-water harvesting, rejuvenation of water bodies, recycle / reuse of treated sewage & water conservation and promoting circular economy of water through development of city water balance plan for each city. Key mitigation and adaptation strategies recommended under this thematic area 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 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 & waste management, to promote waste-to-energy & waste-to-compost plants. Key mitigation and adaptation strategies recommended under this thematic area include segregating waste and 3R (Reduce, Reuse & 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)/RDF (Refuse Derived Fuels) as per the SWM Rules, 2016 in cities with over 5 lakh 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. Climate Smart 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

1.

Introduction

Since the late 19th century, Earth's surface temperature has risen by 1.14°C (National Aeronautics and Space Administration, 2020) and is primarily attributed to anthropogenic climate change and the widespread impacts on natural and human systems globally. It is estimated that human activities have caused an increase of almost 78% of GHG emissions (Pachauri & Meyers, 2014) between 1970 to 2010. As per SR1.5 of 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).

As of 2017, India is the 3rd largest emitter of GHG emissions (Sethi, 2015) globally. While the per capita emissions are much lower - less than half -compared to the global average, more than 70% (Sethi, 2015) of our emissions are from urban areas. At the time of the 2011 Census of India, 37.7 crores (31.16%) people were residing in urban areas across the country. The country had 53 city agglomerations with over a million people, and 6 city agglomerations with over 1 crore population. By 2030, the country's urban population is expected to be around 60 crores and cities would generate 70% of India's GDP (MGI, 2011). Currently, about a third of the country's population is residing in urban areas, which is estimated to increase to 40% by 2030 (MGI, 2011).

As India undergoes rapid urbanization and economic growth, GHG emissions from urban areas are likely to increase as well. Therefore, as hubs of population, economic activitiy, 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 has 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

2.

Climate Change: Hazards and Vulnerabilities

According to the Intergovernmental Panel on Climate Change (IPCC), globally, it is evident that whenever there is an increase in the global average temperatures, there has been an increase in precipitation, extreme rainfall, cyclonic storms, coastal flooding and heatwaves. As per MOEFCC's Third Biennial Update Report (BUR) to UNFCCC, the diverse geography of India manifests varied climate regimes ranging from continental to coastal, from extremes of heat to extremes of cold, from extreme aridity and negligible rainfall to excessive humidity and torrential rainfall (MoEFCC, 2021). India has unique geo- climatic and socio-economic

Table 1: Loss and Damage from Urban Flood events in a few Indian Cities (2000-2020)

Sr. No	City	Year of Occurrence (20002020)	Damages and Losses
1	Bangalore, Karnataka	2005, 2009, 2013, 2016	2005: 100 homes damaged and 54 collapsed, 10 persons died. During the 2016 urban flood, essential services in the city became non-functional. The flood inundated all arterial roads.
2	Chennai, Tamil Nadu	2004, 2015	Essential transit services were disrupted during the megaflood of 2015. It claimed 280+ lives in Chennai, and more than 1,27,580 people were rescued.
3	Mumbai, Maharashtra	2005, 2007, 2015	2005 urban floods: 1094 lives lost, all essential services including major transits operations were suspended. Rs 550 crores loss was estimated in two days.
4	Sri Nagar, Jammu & Kashmir	2014	2014 flood-affected all Kashmir valley, halt all service (transport, telecommunication, city administration, hospitals) of the city. The estimated damage was Rs 5000-6000 crores.
5	Hyderabad, Telangana	2001, 2002, 2006, 2008	2000 urban floods damaged 35,693 homes and affected 2 lakh people 2008 floods affected 1.5 lakh people
6	Delhi	2010, 2013, 2016	2016 – heavy rainfall created havoc conditions in the city
7	Vadodara, Gujarat	2005, 2013, 2019	Major transport operations were suspended for two days, 10000+ evacuat ed, natural habitats affected
8	Kochi, Kerala	2018, 2019	2018 - Airport shut down for 2 weeks in with over Rs. 220 crores of loss & damages, floods were followed by drought, water scarcity, and public health issues

conditions and is vulnerable, in varying degrees, to floods, droughts, cyclones, landslides, avalanches, storms, and heatwaves. Out of 36 States and Union Territories (UTs) in the country, 27 are disaster-prone. 12% of the land is prone to flood and river erosion; out of 7,516 km coastline, 5,700 km is prone to cyclones and tsunamis; 68% of the cultivable land is vulnerable to drought, 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 (NDMA, 2019).

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 damage during 2000- 2019 in terms of fatalities per 100,000 inhabitants and losses per unit GDP in percentage. Besides, in 2019, India recorded its maximum rainfall since 1994, with the most number of cyclones and 'severe cyclones' on record. However, the impact of climate change and climate hazards is not uniform countrywide. It 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 that determine and affect the coping capacities of institutions, communities, and infrastructure systems.

Therefore, with the current projected increase of global temperature by 1.5 to 2 degrees Celsius, climate change 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 likely further impact the hydrological cycle and existing water resources leading to droughts, floods, water scarcity, and uncertainty to food security. Further, extreme events and risks cause loss of life and 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, & Mosier, 2018). Thus, climate change can pose a severe threat to our 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, a decrease in the Diurnal Temperature Range (DTR) due to urbanization is leading to human mortality and discomfort. Also, increased minimum temperatures in summer do not allow the necessary nocturnal cooling to neutralize the high maximum temperature during a heatwave, increasing its intensity and period. As per the recent report from

National Disaster Management Authority (NDMA), India,

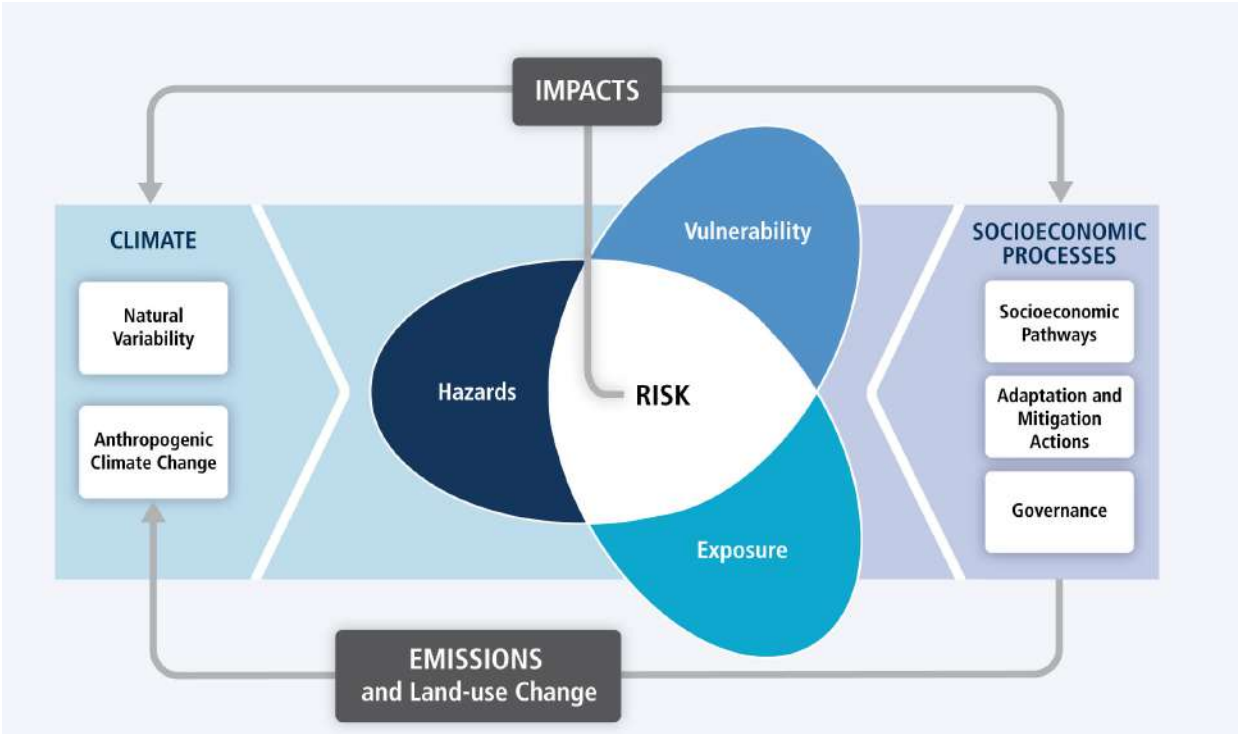


Figure 1: Climate Risk Management Framework (IPCC, 2014)

is witnessing the impact of climate change in terms of increased instances of heatwaves which are increasing in intensity with each passing year and are 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 and 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 Arabian Sea cyclone frequency 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 coast every year. About 71% of coastal area across ten states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Puducherry, Andhra Pradesh, Odisha, and West Bengal) and islands of Andaman, Nicobar, and Lakshadweep are also prone to cyclones (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 any drought is the deficiency of rainfall and in particular, the timing, distribution, and intensity of this deficiency in relation to the existing reserves. A prolonged period of relatively dry weather leading to drought is a widely recognized climate anomaly. Drought can be devastating as water supplies dry up, crops fail to grow, animals die, and malnutrition and ill health become widespread. The environmental effects of drought include an increase in soil aridity and salinization, depletion in groundwater level, and increased pollution of freshwater ecosystems.

According to the Ministry of Home Affairs (MHA) report, a staggering 68% of India is prone to drought of variable degrees (MHA,2011). 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 of rainfall and is categorized as chronically drought-prone (MHA, 2011). India has about 17% of the global population, but it has only 4% of total water resources. About two lakh people die every year in the country due to inadequate 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

40 million hectares of land in these states & UTs, i.e., roughly one-eighth of the country's geographical area is flood prone (NIDM, 2014). There has been an increase in the intensity of urban floods in India over the past years, whereby major cities in our country have been severely affected. While increasing frequency of extreme rainfall events (Pachauri & Meyers, 2014) is one of the critical factors responsible for the 'urban flood' events, increased paved surfaces affecting run-off, lack of adequate and efficient stormwater drainage, poor solid waste management systems leading to choking of the drains, etc. have also aggravated the vulnerability of cities. In the last two decades, urban India has experienced unprecedented high intensity floods and flash floods in several cities across the country, 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. UNICEF estimates that around 2.4 million children were impacted by floods in India (UNICEF, 2020).

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 operation & maintenance and encroachment of drainage pathways in towns and cities (CPHEEO, 2019).

Landslides

National Institute of Disaster Management in their National Landslide Risk Management Strategy (NIDM, 2019), has indicated that landslide hazards rank high among the hydrogeological hazards because they pose a 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 region of India. Himalayan and other hilly regions of India 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 landslide-1998 (Uttarakhand), Kalimpong-1993 (West Bengal), Kohima-1993 (Nagaland).

Rising Sea levels and Storm Surges

As per India's Third Biennial Update Report, 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 at present. As per Census 2011, the total population of coastal districts is 171 million which accounts for 14.1 per cent of India's population. Several urban areas, including the megacities of Mumbai and Chennai, with high density of population are located along the coast where considerable wealth of the country in the form of assets and infrastructure also exists. Further, the urban slum population in these coastal cities is especially susceptible to be affected by alluvial 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 area of India are, therefore, especially vulnerable to the threat of rising sea-level and can experience increased exposure to coastal hazards including storm surges during cyclones and related hazards.

3.

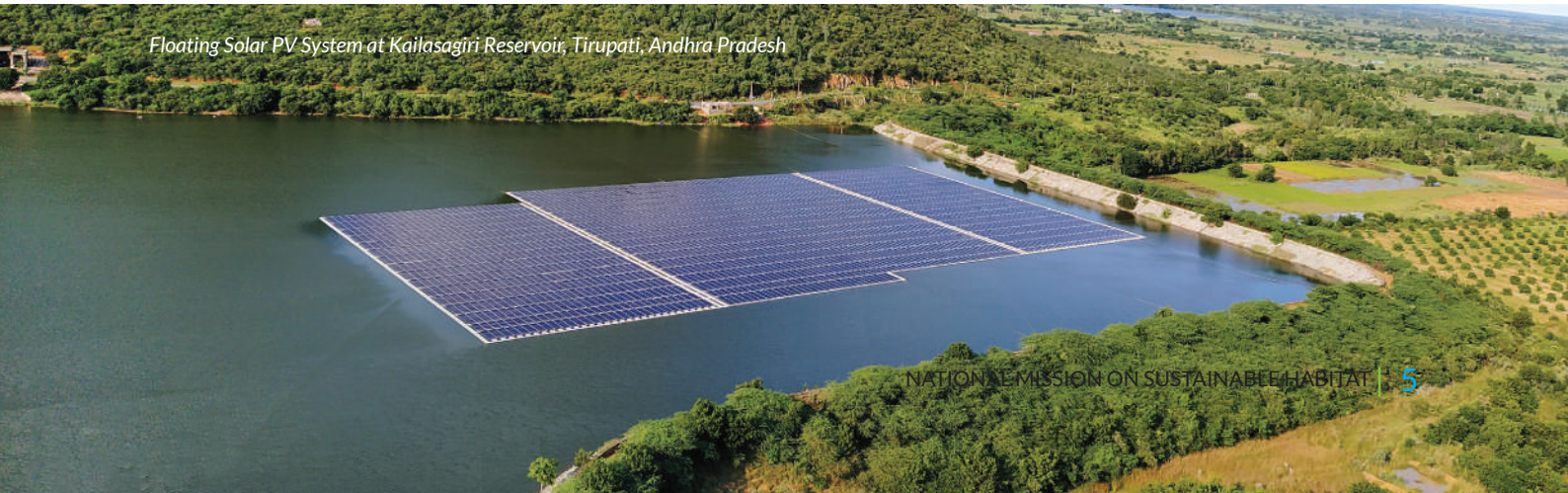
National Mission on Sustainable Habitat

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 in Paris. Its goal is to limit global warming to well below 2 degrees, preferably to 1.5 degree Celsius, compared to pre-industrial levels. To that end, countries aim to reach global peaking of greenhouse gas 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 more 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 sinks and reservoirs of GHGs. The agreement requires all countries to determine their "Nationally Determined Contributions" and also report regularly on emissions and on their implementation efforts (UNFCCC, 2016).

India has committed to its Nationally Determined Contributions (NDCs) and is already on track to achieve it (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 the corresponding level of economic development.
3. To reduce the emissions 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 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover 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 mobilize 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

National Action Plan on Climate Change

The Prime Minister's Council on Climate Change under the Government of India launched the National Action Plan for Climate Change (NAPCC) in 2008 with 8 sub-missions representing the multi-pronged, long-term, and integrated strategies to mitigate and adapt to the adverse impact 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 the 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 greenhouse gas emissions.
3. 3. Devising efficient and cost-effective strategies for end-use Demand Side Management.
4. Deploying appropriate technologies for both adaptation and mitigation of greenhouse gasemissions 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 public-private-partnerships.
7. Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global IPR regime that facilitates technology transfer to developing countries under the UNFCCC.

Riverfront Development in Indore

Overview: National Mission on Sustainable Habitat

India's Green House Gas (GHG) emissions grew from 1229 $MtCO_2e$ in 1994 to 2531 $MtCO_2e$ in 2016, an overall increase of 106% (MoEFCC, 2021). 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 is important and a 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, the Government of India launched the National Mission on Sustainable Habitat (NMSH), 2010, under the National Action Plan on Climate Change. NMSH highlights strategies and guidelines to mitigate GHG emissions and adapt to climate change impacts by building resilient in infrastructure assets and communities, measures for improving disaster risk management, and warning systems for extreme weather events.

In 2015, the Government of India 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 programs. 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), which outlines an integrated approach for urban planning by analysing key challenges and priorities for managing urban habitats, is being finalised. Further, the Ministry has recently launched the "Climate Smart Cities Assessment Framework (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.

Further, 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 to all. To that end, MoHUA is revisiting and revising the NMSH to develop an integrated strategy to promote sustainable habitats by incorporating the growing

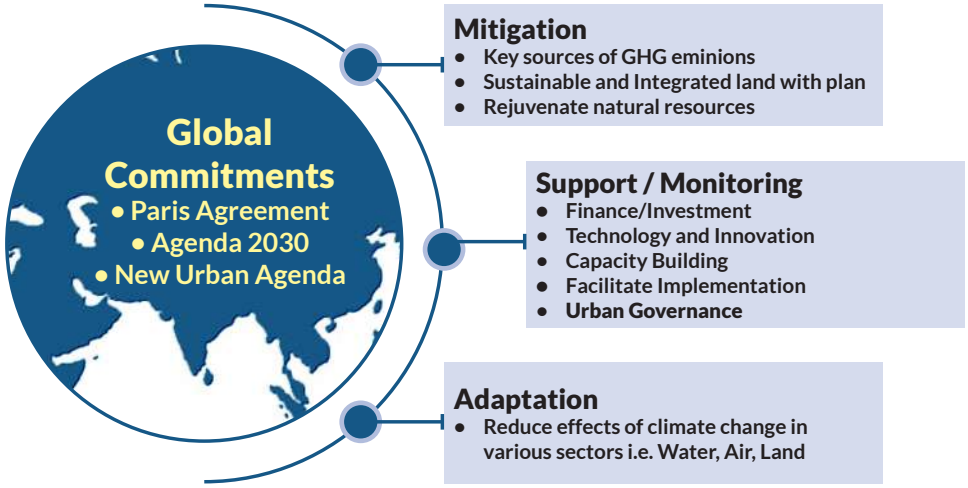
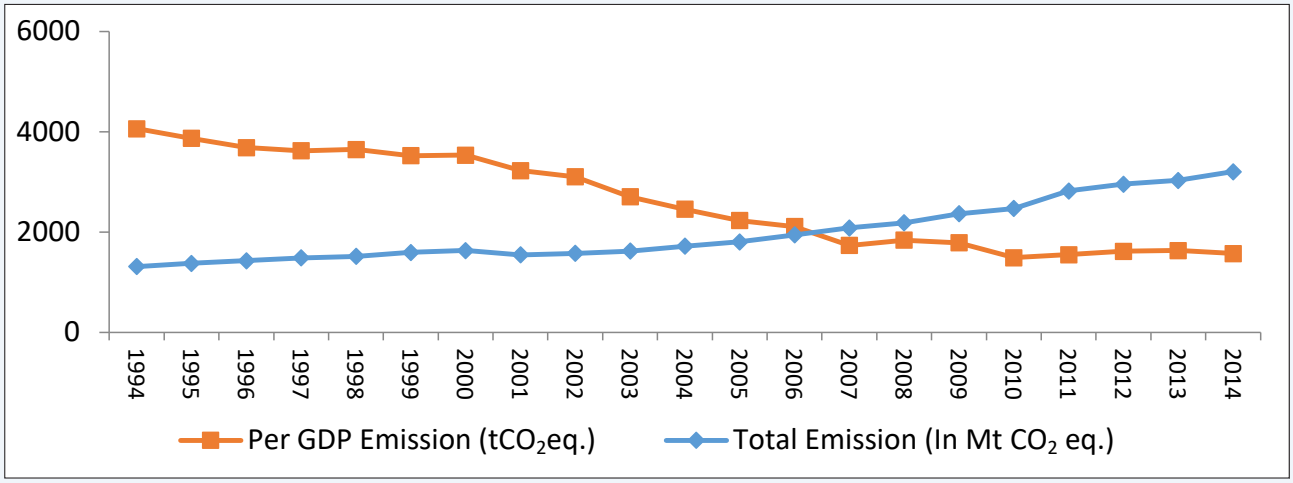


Figure 2: Strategy for Global Commitments

Green House Gas Emissions Scenario

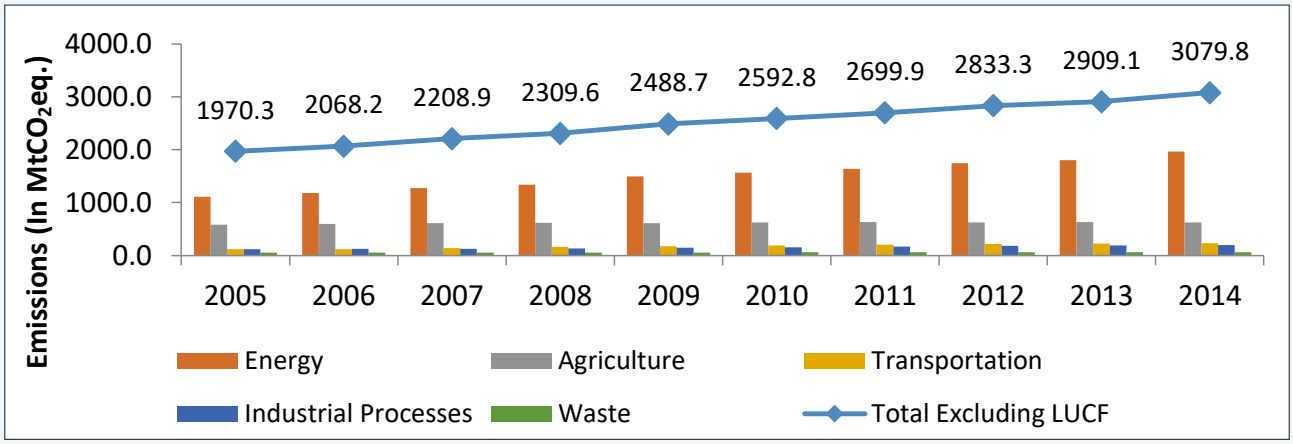
India's GHG emission grew from 1311.29 $MtCO_2$ eq in 1994 to 3202 $MtCO_2$ eq. in 2014, indicating an overall CAGR of 4.5% . Although India's annual carbon footprint increased in 2014 compared to previous years, the country is well on track to meet its global climate action pledges of reducing the emission intensity of its GDP (emission per unit of GDP) on time. India's emission intensity reduced from 2231.56 tCO_2/million $ GDP in 2005 to 1573.31 tCO_2eq/million $ GDP in 2014. Consistent time series information on GHG emissions and GHG emissions per GDP from 1994 to 2014 are presented in Graph (i).



Graph (i) India's reduction of emission intensity CO_2/million $ GDP (2005 to 2014)

India GHG: 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 emissions was from electricity and heat generation, 24% from manufacturing and construction. Agriculture was the second highest source with 20.3% of total emissions) Industrial processes (IP), transport, and waste contributed 7.0%, 6.2%, and 1.9% of 2014 total emissions, respectively (WRI CAIT) in Graph (ii).



Graph (ii) Sector wise GHG emissions (2005 - 2014)
Source: (WRI CAIT)

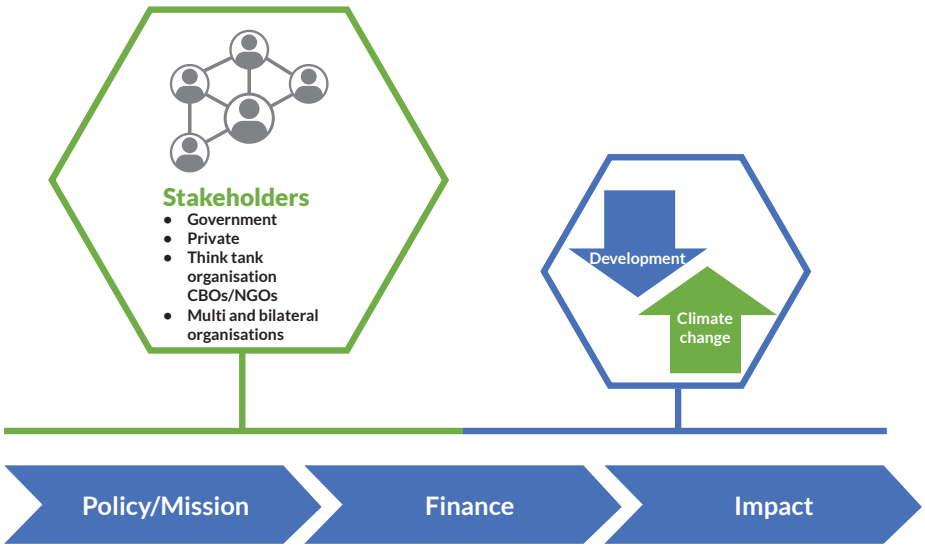


Figure 3: Interlinkage between development and climate change

needs and concerns that have emerged in the past decade.

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 3Es of sustainable development.

The first generation of the NMSH 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. New Urban Agenda, Sustainable Development Goals (SDGs), Nationally Determined Contributions (NDCs) within the Paris Agreement, it was decided to revise the 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."

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 strengthening their capacities to 'bounce back better' from climate related extreme events and disaster risks.

Key Priorities

In order 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 Buildings; 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.

Linkages with SDGs

While all the Sustainable Development Goals (SDGs) are important, the cities can focus on the following SDGs as per the thematic area 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 & Biodiversity	SDG 13: Climate Actions SDG 15: Life on Land
Mobility & 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

Key Priorities

Housing and buildings (residential and non-residential) are an essential sector 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% GDP and employs 12% of itspopulation. Buildings consume a third of global energy output and produce around 20% of total greenhouse gas emissions (WBCSD, 2016).

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

With 50% of the building stock that will exist in the year 2030 yet to be built, electricity consumption in residential and commercial buildings is bound to increase. Further, 80% of greenhouse gases in India are 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, Government of India, estimates that electricity consumption in the commercial building sector in India is expanding at a rate of over 9% per year. As per the National Institution for Transforming India (NITI Aayog), Government of India (GoI), the electricity consumption for the residential sector is expected to increase 6-13 times by 2047. Therefore, India's real estate sector will, have to play a crucial role in addressing climate-related challenges, especially in reducing energy demand and other resource requirements in terms of electricity consumption for heating & cooling, land & material requirement, and other infrastructural demands.

Also, the energy production will need a shift to cleaner renewable energy sources (solar PV, solar thermal, wind energy, hybrid-hydel power, small hydro, geothermal energy, tidal energy, biogas, waste to energy).

There are several programmes initiated and implemented to develop energy efficiency in cities and shift to renewable energy sources by the Ministry of Housing and Urban Affairs (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. For example, MNRE has a Solar Cities program that is designed to support cities to prepare a Road Map to guide their cities in becoming '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 to achieve energy and cost savings in their municipal services. EESL has Municipal Energy Efficiency Programme (MEEP), Street Lighting National Program (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 50 lakh street lights in over 500 cities in India, leading to 135 crore kWh of energy savings and cost-saving of INR 742 crore every year. The cities can also take advantage of the solar street-lighting program through Atal Jyoti Yojana (AJAY)- an initiative of the Ministry of New and Renewable Energy (MNRE).

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

Similarly, the Building sector has implemented policies and codes, which elaborate on energy efficiency in residential

and commercial building sectors, Model Building Bye Laws, 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. Model Building Bye Laws (MBBL) 2016 have provided for sustainable buildings to reduce energy and water consumption to 50% of the present consumption in conventional buildings. The NBC of India developed by the Bureau of Indian Standards (BIS) was updated in 2016 to include a chapter on 'Approach to Sustainability'. The ECBC 2007 document developed for commercial buildings was revised in 2017 to address the energy performance of the building 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.

Key Strategies

The impact of the energy & buildings sector is critical both 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.

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 & 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 SqM area.

6. Promote cool roofing techniques within new developments in peri urban areas for all new constructions of more than 20,000 SqM. area.

7. Rating systems notified in Development CRs/GDCRs 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.

Rooftop Solar PV System in Jaipur

Linkages with Policies & Programmes

Initiatives of MoHUA

The Ministry of Housing and Urban Affairs 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. The ministry is also promoting the uptake of renewable energy to facilitate peak load management and reduce reliance on fossil fuels. To enable the above, MoHUA 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 global search for identification of new emerging proven construction technologies, replacing conventional construction practices and building materials which are polluting and consume higher energy and use natural resources, which are fast depleting.
- Launched a Global Housing Technology Challenge-India (GHTC-India) in January 2019.
- 54 new emerging construction technologies identified for use in mass housing.
- Six Light House Projects (LHPs) of about 1000 houses each with necessary infrastructure in six regions of the country have been planned using six distinct technologies identified in GHTC-India. 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 IIT Chennai, IIT Mumbai, IIT Kharagpur, IIT Roorkee, and CSIR – lab at Jorhat to help technologies initiators.

Model Building Bye Laws (MBBL), 2016

- Rainwater harvesting: Mandatory for buildings on plot size of 100 sq. m. or more.
- Rooftop solar photovoltaic (PV) system: Mandatory for buildings on plot size of more than 500 sq. m.
- Waste water recycle: Mandatory for all buildings having a minimum discharge of 10,000 litres per day.
- Processing of Municipal solid waste 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.
- Green Building: 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.
- Green space: 20% of recreational space to be left unpaved.

AMRUT

- Replacement of conventional lights with LEDs: 62.8 lakh streetlights replaced with LED lights out of targeted 97.9 lakh light. This is estimated to save 137.5 crore units of energy per year and reduce 11 lakh tonnes of CO_2 emission per year.
- Energy audit of water pumps and replacement of inefficient pumps: MoU signed with 446 cities (29 States/UTs), and field survey for energy audit completed in 413 cities (28 States/UTs), out of which energy audit completed in 370 cities (27 States/UTs). 11,567 pumps (26 States/UTs) have been identified for replacement.

Smart City Mission

- In the case of redevelopment and greenfield models of Smart Cities, at least 80% of buildings should be energy efficient and green buildings.

- Promote renewable energy to ensure that a minimum of 10% of the city's energy needs are derived from solar power.

Smart Sustainable Campus

Infosys Pune: It is the largest campus in the world to earn LEED Platinum Certification from US Green Building Council (USGBC) which is a globally accepted benchmark for design, construction, and operation of high-performance existing green buildings and one of the stringent green rating tools for existing buildings that verifies that the building is performing sustainably.

- Powered by Data

- Driven by technology and

- Sustained by profit

The campus started operations in 2004 with 114 acres in Hinjewadi, efficiency improvements achieved through large-scale retrofit projects in 10 office buildings, three food courts, employee training center, guest house, and sports complexes across the campus that can accommodate 34,000 people. A two-pronged strategy was adopted n 2008 i.e., designing new buildings to meet the highest efficiency standards and implementing deep retrofits in old buildings to increase energy efficiency. The details of measures taken for efficient design of Infosys campus in 6 years (2008 to 2014) and their impact is as under:

- 663 Million units (kWh) avoided.

- 0.56 Million Tons of CO_2 emissions avoided.

- 80 Million USD spend on electricity, avoided.

- 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.

- 26 lakh sq ft area covered with white roofs across Infosys campuses. Installation of white roofs for existing buildings 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 optimize 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 square foot. While white roofs absorb less sunlight than either green or black roofs, they offset a portion of the warming effect from greenhouse gas emissions. Both white and green roofs do a good job at cooling the building and cooling the air in the city, but white roofs are three times more effective at countering climate change than green roof, and white roofs are the most cost-effective over 50-years. The high installation cost of green roofs, their environmental and amenity benefits may at least partially mitigate their financial burden (Source: Lawrence Berkeley National Laboratory (Berkeley Lab).

5.

Urban Planning, Green Cover and Biodiversity

Key Priorities

Urban areas in India are expected to house more than 40% of the country's total population and will contribute to 70% of the national GDP. With much of India's future development centred on cities, 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 greenhouse gas emissions and adaptation to climate change impacts to foster more comprehensive social, cultural, economic, and environmental benefits.

The cost of poor planning for 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 norms of Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines, 2014 on preservation and rejuvenation of water bodies, green and eco-sensitive areas, need to be strengthened by Urban Development Authorities (UDA) and Urban Local Bodies (ULB).

As of July 2019, out of 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, rarely available for most cities and towns, has resulted in haphazard and unplanned growth. Moreover, a review of existing plans suggests that many towns and cities that have their Master Plans or Development Plans which do not match the growing infrastructural requirements and emerging challenges arising out of climate change, environmental and infrastructure stresses. 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 data and temporal data on loss & damage from disasters for urban planning 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 water bodies, open spaces, and built-up areas. The water bodies and open spaces help people adapt better to the adverse impacts of extreme climate events besides combating the urban heat island effect. Water bodies are significant to combat water crises as they act as reservoirs for drinking, as retention basins 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 also be prepared for a prompt response during disaster situations and have robust plans in place to "Build Back Better", including recovery, reconstruction, and rehabilitation.

Key Strategies

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 assets in the city including water bodies/ drinking water sources, along with their catchments, open spaces/ wetlands and forest areas.. Further, prepare a heat island map of the city to inform mitigation actions to regulate micro- climate and reduce GHG emissions locally.

2. Appropriate disaster mitigation and management measures should be taken in vulnerable areas as identified in the Vulnerability Atlas of India (VAI) which contains digitized state/UT-wise Hazard Maps with respect to Earthquakes, Winds and Floods.

3. Protect and prevent the construction of roads and buildings on wetlands/water bodies and flood zones to ensure 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 and check for its alignment with the Sendai Framework for DRR, NDMA guidelines (2010,2014,2019), 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.

6. Rejuvenation and conservation of urban water bodies should be carried out in line with Jal Shakti Mission.

7. Existing guidelines should be enforced on preserving and protecting of river floodplains, river banks, river beds, natural drainage canals and open areas.

8. The city drainage network should be digitised, and the information should be used to prepare drainage master plan. The Drainage master plan should include locations of the storm water system, water bodies, streams, natural canals, invert levels, terrain, land use, and land cover.

9. Cities should ensure 10-12% area under recreation space, including the green and blue infrastructure of the total developed area following URDPFI Guidelines.

10. Green belt buffer zones should be developed around the industries which are situated within the ULB limit.

11. Climate Action Plan (mitigation and adaptation) should be prepared and implemented by cities with a million plus population. It should be integrated with the Master Plan, Local Areas Plans, and Town Planning Schemes of the city.

12. Apart from focus on the land use and land cover aspects, Masterplans should also make provisions for proper planning of water supply, sewerage, and storm water drainage networks.

13. Cities should reduce impervious surfaces and encourage the construction of permeable sidewalks and pavements to reduce the intensity of surface runoff during monsoons and contribute to increased recharge of the groundwater, thereby help in addressing stresses such as droughts and water scarcity.

14. Take effective steps to increase green cover in urban areas which has the potential to protect the soil against erosion (during run-off) and help manage the surface and ground water hydrology. When properly maintained, vegetation, including trees, helps in soil stabilisation and reduces the risk of landslides in hilly/ mountainous areas.

Rejuvenation of City Greens by Gwalior Smart City, Gwalior

Linkages with Policies & Programmes

Initiatives of MoHUA

Rejuvenation of water bodies is critical to combat urban water stresses. Water bodies are essential as they cater to drinking water needs, as retention basins for groundwater recharge, for protection in case of floods, and for maintaining 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 micro climate and help in groundwater rechare.

AMRUT

- INR 1,768 crore (2%) has been allocated by the Ministry of Housing and Urban Affairs for development and restoration of green spaces and parks.

- 1,770 parks are developed at a cost of Rs.997 crore and 650 green spaces & parks worth Rs. 523 crore is under progress. The development of green space and parks with special provision for child-friendly components has improved amenities in the community, reduced carbon footprints, increased groundwater table and raised citizens' quality of life.

- Local Area Plan/Town Planning Scheme (LAP/TPS) worth Rs 50 crore launched as a pilot scheme in 25 cities @ Rs 2.00 crore per city to catalyse planned & 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 provide for planned urban expansion.

- Formulation of GIS-based Master Plans for 500 AMRUT cities is one of the crucial reforms under AMRUT. It is a 100% centrally funded sub-scheme with a total outlay of Rs.515.00 crore. It has three components i.e., geo-database creation, GIS-based master plan formulation, and capacity building.

Urban and Regional Development Plan Formulation and Implementation (URDPFI) Guidelines, 2014

- The Urban and Regional Development Plan Formulation and Implementation (URDPFI) Guidelines, 2014 provides detailed methodology for preparing the various type of spatial plans viz., Metropolitan Regional Plan, Regional Plan, Master Plan, Zonal Development Plan, and Local Area Plan. I

- It advocates for the development of compact cities, ensuring the use of public transport, and facilitating non-motorised transport. Norms for charging infrastructure in Development Control Regulations with a vision to implement 'electric mobility and emphasis on Transport Oriented Development (TOD) for a span of next 30 years have also been incorporated in the URDPFI Guidelines.

Smart Cities Mission (SCM)

- A key feature of Smart Cities Mission is preserving and developing open spaces — parks, playgrounds, and recreational spaces.

Park for Citizens in Diu

6.

Mobility and Air Quality

Key Priorities

Urrban India has experienced unprecedented growth of private motor vehicles during the last decade, resulting in traffic congestion and increasing air pollution levels. The average growth of vehicle registration in the country from 2001 to 2016 was 9.4%. Five metro cities in India have a vehicle registration rate of over 500 per 1000 people and account for 54% of the total vehicles in the metropolitan cities as of 2011 (IIHS, 2015). The public bus services are also limited to large cities, and most of the cities lack road safety measures especially for the pedestrian and cycling. This trend has resulted in increased fuel consumption and emissions from the sector, increased traffic congestion and air pollution, and impacted residents' overall quality of life. It is estimated that the transport sector alone contributes to almost 13% (ITF-OECD, 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 income brackets.

The development of urban transport is guided by the National Urban Transport Policy (NUTP), 2006, which emphasizes 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, the Smart Cities Mission (SCM), Atal Mission for Rejuvenation and Urban Transport (AMRUT), Automotive Mission Plan 2026, and Faster Adoption and Manufacturing of Electric/Hybrid (FAME) India are playing an instrumental role in promoting sustainable mobility in the Indian cities. Studies show that bus systems supported by quality pedestrian and cycle 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 cycle networks.

Traffic Management at Sursadan Junction, Agra, Uttar Pradesh

Key Strategies

Following strategies are recommended for urban Mobility and Air Quality to facilitate the development of sustainable habitat.

1. Municipal Corporations should prepare an action plan to promote the use of clean technology based shared vehicles. Adoption of cleaner and environment-friendly technologies e.g., Electric Vehicles (EV), Compressed Natural Gas (CNG) and biofuels, etc. and provision of necessary infrastructure. Cities should also encourage the shift of goods vehicles to clean fuels like electric, CNG, and biodiesel to reduce air pollution.

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

3. Promote mixed-use of walking, cycling within the city in line with the National Transit Oriented Development Policy, 2017. Non Motorized Transport (NMT) plans should be developed for the cities and include no-car zones, docking stations, public bicycle sharing networks, etc. They 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. Encourage usage of public transport by providing an affordable, safe, comfortable, quick, reliable, and environment-friendly mode of public transport. Cities to 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-motorized modes.

5. Municipal corporations and 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 urban development authorities tand will 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.

7. All cities with million plus population should develop city-level clean air action plan. The action plans 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) 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 by cities as per their requirements.

Public Transport System in Chennai

Linkages with Policies & Programmes

Initiatives of MoHUA

An increase in the availability of public transport can promote the modal shift from private transport 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-Motorized
- 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 approx. 1000 km of metro rail, including 82 km. of RRTS is under construction in 27 cities.
- Standard Specification for Metrolite: 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 emission by 67,500 tons.

Bus Rapid Transit System (BRTS)

- Presently 400km 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 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.

Joint Declaration of Intent (JDI)

- Ministry signed a Joint Declaration of Intent (JDI) with the German Government on Green Urban Mobility on November 1, 2019, for a concessional loan of 1 billion Euros until 2023 through KfW for investments in improvements of urban mobility infrastructure and services with a special emphasis on low-carbon solutions.

AMRUT

- Central Government has allocated Rs. 1,436 crore (2%)for non-motorised urban transport. Of which, 149 projects worth Rs.237 crore to develop footpaths/walkways/skywalks, sidewalks, foot over-bridges, facilities for non-motorised transport, and multi-level parking have been completed, and 184 projects worth Rs.787 crore are under progress. These projects will enhance the zero carbon public mobility for all and improve the ease of living of citizens. To facilitate the availability of Charging Infrastructure for Electric Vehicles, Model Building Byelaws (MBBL) 2016 and Urban Regional Development Plans Formulation and Implementation (URDPFI) Guidelines 2014 have been amended in February 2019 to facilitate States/ Cities to make provisions in their Bye Laws for providing Electric Vehicle Charging Infrastructure.

SMART CITIES MISSION

- Integrated Command and Control Centre (ICCC) projects under the Smart Cities Mission includes some of the ITS components like Camera based City Surveillance, Smart Street Lights, Smart Parking, Traffic Management, Environmental Sensors, City 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 the use and NMT options within the cities.

7.

Water Management

Key Priorities

With increasing urbanisation and infrastructure demand, water has become one of the primary concerns for many Indian cities, including Chennai, Bengaluru, and Delhi, among others. NITI Aayog estimates suggest that India will become water-deficient by 2025 (NITI Aayog, 2019). More than 20% of India's groundwater has dried up or is in a critical state, emphasizing the need to augment existing water resources through recharge, rejuvenation, and storage including rain-water harvesting. 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 management systems.

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

As per the Census report 2011, household survey data indicates that 70.6% of urban households (HHs) have access to piped water sources whereas 26.9 % HHs depend upon non-piped improved sources such as well, hand pump, tube well/bore well, while the remaining 2.5% HHs of households (HHs) depend upon unimproved sources such as spring, river/canal, tank/pond/lake and other sources. Poor availability of water (i.e., 0.5 – 5 hrs. per 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 the quality and quantity of water supplied.

Urban water supply service , at present, is fraught with myriad challenges. While on one hand, local water resources (surface and groundwater) are getting exhausted and / or 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 demands for water and the need to make urban water systems more 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 a city water balance plan for each city focusing on recycle/reuse of treated sewage, rejuvenation of water bodies, and water conservation. Further, 20% of water demand is to be met by reused water with the development of institutional mechanisms.

The Ministry of Housing and Urban Affairs (MoHUA) published the Manual on Water Supply & Treatment, May 1999 to assist ULBs in managing urban water supply. MoHUA also published the Manual on Operation & Maintenance of Water Supply Systems, January 2005, to assist ULBs in execution and operation & maintenance of urban water supply. The Manual provides detailed guidelines/methodology for planning, designing, execution, and operation & maintenance of water supply systems. It also provides information on the recent technical advances and trends in developing protected water supply systems.

To address the problem of Urban Sanitation, Swachh Bharat Mission-Urban (SBM-U) was implemented to cover all cities make India Open Defecation Free (ODF). Besides, AMRUT 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 i.e, Part A: Engineering, Part B: Operation & Maintenance, and Part C: Management. The Manual provides information on the recent technical advances and trends in the planning, designing, execution, operation, maintenance, and asset management, which all the ULBs refer to in urban areas. It also provides the technological intervention to prevent untreated discharge from groundwater contamination.

Providing safe, reliable, and affordable water supply through efficiently managed arrangements is a crucial goal for the water supply sector. MoHUA has also published and released Guidance Note for Continuous Water Supply (24-7 supply), 2009. These guidelines will sensitize State Governments, Urban Local Bodies, and service providers to the policy and operational issues that need to be addressed as they reform urban water supply. The guidelines areunder 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 the water crisis in India. Within the existing urban development framework, particularly the AMRUT mission, initiatives are taken up for implementation and monitoring of existing Storm Water Drainage (SWD) systems. MoHUA has prepared a Manual on Storm Water Drainage Systems, 2019, to provide necessary guidance to all the stakeholders towards all aspects of sustainable design, planning, and management of stormwater drainage systems of towns and cities of the country.

Water Management System in Dehradun

Key Strategies

In alignment with India's vision and ongoing programs, 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 its users. This could be achieved through Practising Escalating Tariff, i.e., the Consumption level of 20 lpcd (as per WHO & UNICEF) should be subsidized, and at 135 lpcd, full cost recovery should be built into the tariff. The tariff should be increased for consumption levels above the benchmarks. This will help in sustainable consumption levels and revenue generation.
2. 100% recovery of operation and management (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, and CAPEX recovery should be aimed in the long run Energy efficient equipment for wastewater pumping in the city should be promoted as it leads to a reduction in Green House Gas emissions (CO_2 emissions) per kWh of electricity consumed, thereby reducing O&M costs.
3. ULBs should map the significant (catering to 5% or more of the city's water needs) ground & surface water sources and prepare a plan for augmentation of existing water resources through recharge, rejuvenation, and storage. ULBs should make GIS enabled Urban Planning for water supply and sewerage systems. Rainwater harvesting should be made mandatory within all buildings to replenish and recharge the groundwater.
4. Continuous (24x7) mode of water supply to the cities should be adopted by water supply authorities. This will prevent the contamination of drinking water and optimise the use of fresh and treated water. Reduction in the Non-Revenue Water (NRW) should be effected by identification of illegal water connections through water audits and community involvement.
5. Municipal Corporations should develop an Integrated Urban Water Resources Plan including rejuvenation of urban waterbodies. All ULBs should protect and prevent the construction of roads and buildings on wetlands/water bodies and flood zones to ensure channels for surface runoff.
6. City administrations should mandate treatment, recycle and reuse of at least 20% of the wastewater treated in line with the guidelines of Jal Jeevan Mission (Urban) and promote circular economy of water through the development of a city water balance plan. Decentralised wastewater management approach should be promoted for areas where there is a possibility for localized reuse of treated wastewater (as compared to all sewage being treated in one far corner in the case of centralized STPs) thereby reducing the usage of fresh water. Building and construction projects having an area of more than 20,000 sqm. (or as per latest norms) should install treatment plants in their premises to treat 100% of their wastewater. Building and construction projects having an area of more than 5,000 sqm. (or as per latest norms) should install treatment plants on their premises if there is no 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 Non-Revenue Water (NRW) assessments and put in place NRW 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 Non-revenue water (NRW) for the city below 20%.
8. While strategizing (planning) the wastewater management approach for a town, 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 the safe use of wastewater, greywater, and sludge in various activities with a special focus on managing health risks associated with such use. This includes but is not limited to (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 for reusing greywater, minimizing impacts on freshwater (d) Develop plans/agreements with industries situated within/nearby to use the treated wastewater in their manufacturing process, based on the requirement of the treated quality of wastewater (e) Mandate use of recycled wastewater in cooling towers of commercial and institutional buildings. 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 understand the reasons for flooding/water stagnation and their hotspots , level, and frequency in the city. All municipal corporations should implement an end to end urban flood early warning systems and link the same with the Integrated Command and Control Centres where possible.
10. Rejuvenation and conservation of Water bodies should be promoted as they are essential reservoirs for drinking, as retention basins for groundwater recharge, for protection 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 expected to be impacted by climate change.

Linkages with Policies & Programmes

Initiatives of MoHUA

Given 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 robust demand management instrument to decrease additional stress on existing water resources. NRW reduction will cater to the reduction in energy required for pumping water, thereby mitigating GHG emissions.

AMRUT

- The Mission focuses on sustainable water management comprising universal water supply coverage, reducing non-revenue water (universal water supply, water meters & leak detection technologies), double piping systems in group housing societies, and water conservation interventions.

- The central government has allocated Rs. 39,011 crores (50%) to the water supply. 553 water supply projects worth Rs.7,683 crores have been completed, and 759 projects worth Rs. 33,859 crores are under progress.

- Water tap connections have been provided for 94.6 lakh household,s and additional 44.2 lakh 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 task. MoU has been signed in 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). 13,051 pumps (26 States/UTs) have been identified for replacement.

- To address water scarcity, Jal Shakti Abhiyan (JSA) was launched by the Ministry of Jal Shakti in 754 water stressed Urban Local Bodies (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, Rain Water Harvesting, Reuse of Treated Wastewater, Rejuvenation of Water Bodies, and plantation. As per portal, in the Urban areas during the Abhiyan, 2,39,847 Rain Water Harvesting (RWH) structures have been installed; 420 MLD wastewater have already been treated, 1,480 water bodies covering 6,082 acres of land have been rejuvenated; 75,97,000 saplings have been planted, providing green cover to 8,93,15,000 sq. m. Area and 3,40,40,000 citizens have registered their participation in JSA.

- To ensure sewerage & septage management, besides laying underground sewerage systems and installing septic tanks, 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 145 lakh sewer connections to enhance substantial sewerage network coverage. Rs. 32,456 crores (42%) has also been allocated to sewerage & septage projects.

- Under the Mission, 257 projects on networked underground sewerage systems, augmentation & rehabilitation of old sewerage systems, Sewage Treatment Plants (STPs), Tertiary Treatment Reverse Osmosis (TTRO) plants, Faecal Sludge Treatment Plants (FSTPs), and mechanical & biological cleaning of sewers/ septic tanks worth Rs.5,264 crores have been completed. 548 projects worth Rs. 26,569 crores are under progress.

- So far, 59.38 lakh sewer connections have been provided, leading to treatment of waste water & its reuse in industries, thermal power plants, horticulture, etc. It has led to improved hygiene conditions, a 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, emphasizes on the objectives, septage collection and transportation, treatment & disposal, specific milestones and leveraging FSSM to Achieve 100% Access to Safe Sanitation.

- Construction and improvement of storm water drains while adhering to guidelines contained in "Manual on Stormwater Drainage Systems (2019)" has been taken up in order to reduce flooding. Rs. 2,969 crores (4%) has been allocated towards drainage projects. So far, 475 projects worth Rs. 700 crores have been completed, and 297 projects worth Rs.2,141 crores are under progress.

- SOP on urban floods was issued in 2017 to mitigate and manage floods in cities.

- Jal Jeevan Mission aims to provide water tap connections to every rural household in India by 2024.

8.

Waste Management

Key Priorities

Urban India accounts for a third of India's population and generates 54.75 Million Tonnes of municipal solid waste annually i.e., approximate to 1.5 lakh TPD (a rounded off figure). As per a 2009 report of the Department of Economic Affairs, per capita waste generation is increasing by about 1.3% annually. As the urban population is growing at an annual rate of 3–3.5%, the yearly increase in the overall quantity of solid waste comes to about 5%. It is estimated that 10-25% of the total MSW generated in Indian cities is Construction & Demolition (C&D) waste of which only 5% of C&D waste is recovered. Moreover, the total quantum of waste from the construction industry in India is estimated to be 100 million tons per annum in 2018 (Niti Aayog, 2019). According to the Ministry of Environment, Forest and Climate Change (MoEF&CC), MSW generation will reach 4.5 lakh TPD by 2031 and 11.9 lakh TPD by 2050. Therefore, actions must be taken to manage the increasing waste generation.

The relationship between solid waste and Greenhouse Gases (GHG) emission is well established. GHGs can be avoided through scientific management of waste and the first principle of the Integrated waste management hierarchy is the reduction of waste 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, Swachh Bharat Mission – Urban (SBM-U) was launched by the MoHUA for a period of five years and was extended up to 31.3.2021. The SBM objectives include making the country Open Defecation Free (ODF) and promote scientific Solid Waste Management (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 Plastic Waste Management Rules 2016 etc, with the combined impact of effective Solid

Waste Management. At the time of the launch of the Swachh Bharat Mission, 26,000 tonnes per day of waste was being treated. This has been enhanced substantially in the last 6 years of SBM to approx. 96,000 TPD (as reported by States in November 2020). The total waste generated is about 1,40,588 TPD (reflecting on-site management & 3R principles), 98% of wards have door to door collection, approx. 68% of the total waste generated is processed, and 77% of wards practice source segregation. To enhance the progress and sustain the achievements, the proposal to continue Swachh Bharat Mission under SBM 2.0 is under examination by the Government.

To create healthy competitiveness and to evaluate the performance of ULBs, the Annual Swachh Survekshan (cleanliness survey) is carried out under SBM since 2016, in which the ULBs are ranked against various parameters of cleanliness. In its first round in 2016, the 'Swachh Survekshan' was conducted among 73 cities with a population of 10 lakhs and above. In 2017, the survey was conducted among 434 cities, Swachh Survekshan 2018 covered 4,203 ULBs, Swachh Survekshan 2019 covered 4,237 cities. Swachh Survekshan 2020 (SS 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.

Solid Waste Management (SWM) Rules, 2016, emphasise source segregation of waste into three streams (i.e., bio-degradable, non-bio-degradable & domestic hazardous wastes) and proper transportation & treatment of solid waste. The Rules insisted that all industrial units located within one hundred km from the refuse derived fuel and waste to energy plants based on solid waste, replace their fuel requirement with solid waste based refuse derived fuel. As per the latest amendment to the Electricity Tariff Policy 2006 by the Ministry of Power, it has been made mandatory for the State Electricity DISCOMs to purchase all power generated from municipal solid waste at the rate determined by the appropriate authority. Further, as per the Policy on Promotion of City Compost, the Ministry of Chemicals & Fertilizers will provide a fixed market development assistance of Rs. 1,500/MT 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 fertilizer companies.

As a part of capacity building, MoHUA has conducted 130 workshops on various components of SBM, including MSWM, covering more than 2400 ULBs and 5000 officials across the country to build capacities. Additionally, MoHUA has brought more than 20 advisories on various components of the Swachh Bharat Mission.

Key Strategies

Cities are advised to follow the following strategies points for developing a sustainable habitat:

1. Implementation of segregation of waste and 3R (Reduce, Reuse & Recycle) principles in the city to better manage waste management. Further, promote and establish targets to replace virgin materials with recycled materials.

2. Resource efficiency of the cities with more than 500,000 population can be maximised by facilitating setups for Material Recovery Facility (MRF) with provision for sorting recyclables and facility for sorting SCF (Segregated Combustible Fractions)/RDF (Refuse Derived Fuels) 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 more than 500,000 population should develop a mechanism to collect and process/ reuse Construction & Demolition (C&D) waste as per 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 the waste generation at the source. Promote technology integration for efficient collection and processing of waste. Incentivise residents and RWAs 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 Solid Waste Management Rules, 2016.

7. City administration should maintain the drains and prevent clogging due to waste disposal to reduce the risk of flooding and other associated health hazards.

Segregated Waste Collection by Battery Operated Vehicle, Tirunelveli, Tamil Nadu

Linkages with Policies & Programmes

Initiatives of MoHUA

The relationship between solid waste and Greenhouse Gases (GHG) emission is well established. GHGs can be avoided through scientific management of waste. The first principle of the Integrated waste management hierarchy is the reduction of waste at thesource. Construction and Demolition (C&D) waste is a significant component of city waste, and 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.

Swachh Bharat Mission - Urban

- Waste to Compost
  - The assessed capacity of compost that can be generated in India from municipal solid waste is about 54 lakh TPA.
  - Current production is 17.58 lakh TPA from 635 operational centralised compost plants.
  - Another 206 plants of 6.84 Lakh TPA capacity are under construction.
- Waste to Energy
  - The assessed capacity of power that can be generated from municipal solid waste is 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

Smart Cities Mission

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

Guidelines for Sustainable Habitat, 2014

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

Sewage Collection in Devanahalli, Karnataka

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 above. These include strategies pertaining to Urban Governance, Capacity Building, Data, Technology & Innovation, and Financing mechanism for the mission.

Urban Governance

Urban governance in climate change context refers to the ability and capacity of local/municipal governments to make decisions and implement plans/programs 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, such governance requires adequate legal & 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, Urban Local Bodies play a vital role in providing access to these essential servicesand grievance/concern redressaletc. It is also to be noted that most of the urban missions in the country are being implemented and converged at the level of ULBs therefore, it is vital to address the issues and challenges of urban governance in a meaningful way. 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 (ULB and state officials on climate change related aspects) activities under the mission, along with developing Information, Education and Communication activities (IEC) materials, which will play an important role towards mass awareness generation and behaviour change aspects.
2. Cities to promote principles of sustainable neighbourhood planning, and climate resilience to address climate mitigation and adaptation in the ongoing and proposed activities. For example, mixed and specialised land-use, transit oriented development, risk-informed land use, and infrastructure planning.
3. Cities administration should analyse the local climate risks and consider the same within all policies, plans, projects, bylaws, regulations, and codes.
4. Cities to develop climate action plans (CCAP) in line with NMSH guidelines and ClimateSmart Cities Assessment Framework (CSCAF) of the MOHUA. CCAPs will also have to indicate proposed actions and budgetary requirements to carry out various proposed activities under each thematic area for an initial period of five years and from 2020 to 2025 and till 2030. The CCAPs are to be aligned with the CSCAF parameters.
5. Municipal Corporations will institutionalize monitoring and implementation of climate actions by establishing 'Environment & Climate Change Cell'. The Environment & Climate Change 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 cities and state level i.e., industry, civil society, experts, academia, and scientific institutions.
6. ULBs will conduct regular monitoring of critical climate and environment parameters to mainstream and improve on the same. This monitoring and review mechanism include and address CSCAF indicators as outlined by MoHUA.

7. States/Cities to 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.

City Level Monitoring Mechanism

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

Mitigation strategy

- **City inventory of green house gas emission,** identification of sources and opportunities for reduction under various thematic areas
- **Collected data to be analysed** and project future emission based on socio-economic profile of the city and setting of targets and proposed actions
- **Assessment of the local capacity** to take action and strategy for convergence with existing policies/missions schemes etc.
- **Goal setting to reduce emission**-short/mid and long term and consensus building on city action plans
- **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 people community and environment with respect of physical, finacncial and socio-economic; identification of **most vulnerable segment of the society.**
- Analysis of **different scenarios of climate impact** and risk levels (low, mid, high etc.) on people and 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 CCAP
- Planning and implementation to enhance resilience towards physical, environmental, economic, and social impacts of climate change

Figure 4: Framework for City Climate Action Plan

Bilaspur cycle for change

ClimateSmart Cities Assessment Framework (CSCAF)

The Ministry launched the "ClimateSmart Cities Assessment Framework" (CSCAF) under its Smart Cities Mission 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 Sustainable Development Goals (SDGs) and India's Nationally Determined Contributions (NDCs) towards addressing global climate change.

With 28 progressive indicators across five thematic areas (refer to figure below), the CSCAF will provide the overarching monitoring framework for assessing the progress on NMSH objectives and targets. **To this effect, the 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 will be used to monitor the progress and inform NMSH.** In addition, the CSCAF will also facilitate the dissemination of context-specific best practices adopted by Indian cities and access the required skills & 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

The Ministry of Housing and Urban Affairs (MoHUA), under its Smart Cities Mission, has established the 'Climate Centre for Cities' (C-Cube) at the National Institute of Urban Affairs (NIUA) to anchor climate actions across urban India. The Centre will help ensure continuity of ongoing initiatives under the CSCAF, of building capacity and knowledge retention for mainstreaming climate change action in all 500 Class-I cities of India. This will include but not be limited to municipal services such as water supply, solid waste management, built 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. As of present, 126 cities, including the 100 Smart Cities, impacting more than 140 million people, are reporting on climate actions. While the assessment is helping cities to assess their preparedness to tackle climate change, C-Cube is facilitating access to the required knowledge, training, project development, and financial support to achieve sustainable climate actions on the ground.

City Level Monitoring Mechanism

At the City level, the 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
CE (Water supply & Sanitation-Member)	Member
CE (Buildings)	Member
CE (Roads)	Member
CE (Electrical)	Member
Commissioner (Transport)	Member
Town Planner from Urban Development Authority	Member

Terms of Reference:

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.

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 programs. 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, ULBs and government organisations, engineers, planners etc. These initiatives should specifically help the stakeholders understand various technologies, methods and processes to develop sustainable cooling, waste and water recycling, use of sustainable materials, etc. to develop green infrastructure and its potential cost benefits.

Recommended strategies for Individual Capacity Building and Institutional Capacity Building are discussed below.

1. Strategic training plan at ULB/ department level officials should be carried out based on Training Needs Assessment (TNA) on various issues, particularly on climate change related aspects. Nodal officers from Environment & Climate Change Cell other relevant departments to be identified to participate in the various Capacity Building programs of MoHUA, including the training programs being implemented under CSCAF. This may also include exposure visits as outlined under various capacity building programs at the national, state, and city level.

2. Encourage nodal officers to enroll with both online and offline training with various recognised institutions and the National Urban Learning Platform of MoHUA. This will aim at building a dedicated practice of climate practitioners within the ULBs, in particular, at the city level.

3. Encourage participation of suitable staff in various workshops, seminars on a regular basis.

4. Individual capacity building focusing 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 programs and modules are being developed and implemented by MOHUA under CSCAF to train ULBs and city level experts & practitioners. ULBs and relevant city level departments, state line departments to be trained and to refer the same while formulating & implementing strategies for Mission implementation. Periodic review of the progress of capacity building and training activities shall be mandatory at National and State/UT levels, where every State/UT shall submit an annual action plan for capacity building to the Ministry at the start of each

financial year under various missions implemented from time to time.

3. Preparation of annual Information, Education and Communication (IEC) plans, materials and organising IEC programs to increase public awareness and participation on issues related to climate change, sanitation, public health and environment among others.

4. Develop research and development on climate change and related aspects with support from 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 the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA). The Alliance has several national and international organisations, industry partners, rating agencies, (I)NGOs, research and training institutes.

Data, Technology and Innovation

The Cities must use the transformational force of data and emerging technologies in all aspects of the urban sectors. To that end, urban managers and administrators require tools and early warning indicators that can provide them with objective insights on routine civic activities and use 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, and alongside, 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 table. With data insights giving a more accurate picture of resources, capabilities, and aspirations, our cities can effectively position themselves to strategize and negotiate policies and support provided by national governments and global organisations. In essence, with data-backed decision-making, our cities will not just be able to tackle the effects of climate action but identify and anticipate the root causes of it and advocate for responsible policies that can help cities evolve in an aspirational and sustainable direction. Recommended strategies are 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 standardized 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 the case of Smart Cities, where Integrated Command and Control Centres have been established, the same should be integrated with end-to-end early warning systems to predict and manage extreme events & risks emerging from climate change impacts.

Financing

The implementation of the NMSH will begin from 2020-21 till 2030 in alignment with the Sustainable Development Goals and India's Nationally Determined Contributions. The goals of NMSH are envisaged being achieved through various other Missions and programmes of MoHUA. Therefore, no separate financing is sought under 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 resources revenue of the States/ ULBs (user fees, beneficiary charges, and impact fees etc.), municipal bond markets, private sector investments, pool finance, Public Private Partnership (PPP) under Viability Gap Funding (VGFs) Scheme, Corporate Social Responsibility (CSR) funds borrowing from bilateral and multilateral agencies (World Bank/Asian Development Bank/ GIZ/KFW/European Union etc.), concessional loans, national carbon markets, Green Bonds among others. An incentive mechanism to be devised by the States to encourage ULBs to adopt climate friendly technologies.

2. ULBs should find appropriate financing options, including innovative mechanisms that tap land as a resource for investments in urban infrastructure. Value Capture Financing (VCF) Policy Framework will assist States/Cities and Urban Local Bodies in assessing the scope of resource mobilization, identifying the area of influence of proposed projects and optimizing resource mobilization.

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Annexure- I:
Case studies on various thematic areas

Chandigarh: Case study of Construction and Demolition (C&D) Waste Plant

Background: Govt. of India has notified the Construction and Demolition 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 of waste. All the local Govt. 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 from the C&D waste plant.

Project Objectives

- To develop a C&D waste processing unit in the industrial area of Chandigarh.
- To 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 construction and demolition waste processing plant in its industrial area for stacking, crushing, processing and manufacturing of various C&D products. The C&D plant has the following characteristics:

1. Set up with a capital cost of about 235 lakhs and plant capacity of about 120 MT per day (8 hr shift) for crushing construction waste.
2. It produces material that can be utilized for cement concrete works such as washed sand, crushed aggregates of 10 mm,20 mm and 40 mm.
3. The plant also manufactures road material, i.e., PCC kerbs, PCC Channel, PCC Tiles, Paver.Block etc. at a relatively low cost.
4. The plant reduces the in-house cost of construction by approximately up to 10% and has the tipping charges and processing cost at relatively lower costs.
5. Fee charged for Collection and Transportation are Rs.396+GST for RA and sand, Rs.198+GST for Silt per Cum.
6. Provides facility for the residents of Chandigarh to dump their construction waste in an authorized manner.
7. CMC has also come up with a C&D waste management policy, which has penalty provisions of Rs.1,000/- for residential and Rs.5,000/- for commercial buildings in case those are involved in indiscriminate dumping of C&D waste.
8. The policy also talks about provisions for C&D waste management while issuing new/reconstruction of building permits. An amount of Rs 20/Sq.m for new construction and Rs 160/Sq.m for re-construction.

Achievements

1. Till date, 5000 MT C&D waste has been processed into recycled products from the date of commissioning of plant, i.e. 15th May 2019. Natural Resource Savings due to development of recycled products, reduction in the quantum of waste reaching landfills, reduction in carbon footprints with numerous environmental benefits.
2. Economic benefits, for instance, reducing transportation costs of the construction materials, contributed to 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 material will require extra land and environmental clearance, general lack of awareness among residents of the city.

Thane: Case study on Energy and Green Buildings

Background

Thane city, Maharashtra, is rapidly growing due to extensive immigration and urbanization. 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

To establish a baseline of 8000 plus street-lights, performance contracting with shared savings, involvement of the third party for measurement and verification protocol, development of remote management system, highest lumen per watt LEDs, adoptive control panels to optimize power consumption of LEDs as per the requirement of the time etc.

Approach of LED Street Lighting Initiative

A systematic approach for execution of LED installation wherein stakeholders were consulted at every stage. The approach is summarized as follows:

- Numerous stakeholders, including energy experts, lighting experts, techno-commercial experts, political and administrative heads to 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.
- Payback and Public Private Partnership Financial Modelling: financial assessment to arrive at a feasible payback, developed a PPP structure around the estimated capital and operation expenditure. A suitable transaction procedure was established.
- Bids were invited through public competitive bidding.
- The streetlight replacement was carried out panel by panel. Once the entire replacement on a panel was carried out, the demand reduction was recorded and a new baseline established.
- TMC has implemented a third-party expert to verify the energy saving and ensure transparent transactions to the technology provider.

Financial Structure the initiative

The project was based on a PPP arrangement with multiple stakeholders. Benefits and Co-Benefits are energy savings LED ESCO project has achieved maximum energy savings in city, 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 4385 tonnes CO_2 eq. annually. On the operational level, the share of GHG emissions from municipal services in Thane have reduced from 35% in 2012-13 to 11.7% in 2017-18. Connected load of streetlight infrastructure reduced by 70%.

The citizens have reported that white light provides better visibility and provides a sense of safety on roads. Conventional technology was high maintenance prone, whereas higher life of lamp (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 leading to improved visibility.

LED Fitting in Thane

Thanjavur City: Case study on rejuvenation and conservation of urban environment

Background

Rejuvenation of a park with an area of 1282 sq. km is situated on the west side of area based development area of Thanjavur city in Tamil Nadu. It is one of the prominent public spaces of the neighbourhood with amenities like children park and open space for public, used for informal parking of four wheelers, trucks and buses which restrict the residents from using the park. This has led to the proposal of rejuvenating the other neighbourhood park.

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 undertaken to improve the condition of the park. The key activities included:

- Assessment of the existing condition of the park 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.
- Developed a comprehensive plan of action incorporating all the aspects identified through pre-assessment as well as residents' consultations.
- Financial proposal for the project (project is Rs. 1.30 Crore) and implementation of the proposed plan through active participation of municipal corporation and residents. This is service oriented, and no revenue is expected.

Benefits

- Increased green cover leading to improvement in the overall aesthetics and quality of environment.
- Installation of various children's play equipment's which resulted into increasing attractiveness of the parks.
- Enhancement in the park infrastructure, i.e., park furniture, water fountains etc.
- Improvement in the lighting facilities in and around the park.
- Dumping of garbage has been reduced thus reducing improved environment and air quality.
- The encroached portion of land has been reclaimed.

Rejuvenation of park in progress (Thanjavur)

Annexure II:
Indicative list of proposed cities under NMSH

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

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

Source: 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 Times Lines (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 by undertaking energy audit 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 to reduce the dependency on fossil fuels			
Integrate ECBC 2017 for all new municipal buildings & Eco-Niwas Samhita 2018 for all RAY housing	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 1 lakhs	In all Statutory Cities
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 SqM 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 1 lakhs	In all Statutory Cities
Promote district cooling techniques within new developments in peri urban areas for all new constructions of more than 20,000 SqM. area			
Rating systems notified in Development CRs/GDCRs and building rules/ bye laws to be made mandatory for all new constructions of more than 20,000 sqm. 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 1 lakhs	In all Statutory Cities
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	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 1 lakhs	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 1 lakhs	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 of the city 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/water bodies 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 (2010,2014,2019) 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	
Rejuvenation and conservation of urban water bodies should be carried out in line with Jal Jeevan Mission	All Million Plus cities	All AMRUT Cities	
Existing guidelines on preservation and protection of river floodplains, river banks, river beds, natural drainage canals and open areas should be enforced	All Million Plus cities	All AMRUT Cities	
Digitisation of the city of city drainage network should be undertaken and the information should be used for preparing drainage master plan	All Million Plus cities	All AMRUT Cities	
Cities should ensure 10-12% area under recreation space including green and blue infrastructure of the total developed area following URDPFI Guidelines	All Million Plus cities	All AMRUT Cities	
Green belt buffer zones should be developed around the industries in the areas where industries are situated within the ULB limit	All Million Plus cities	All AMRUT Cities	
Climate Action Plan (mitigation and adaptation) should be prepared and implemented by the cities with a Million plus population. It should be integrated with the Master Plan, local area plans and TP schemes of the city	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			
Incentives should be created to attract and enable public-private partnership 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 Transit Oriented Development Policy, 2017	In all Million+ Cities and State Capitals	In all Cities with a population of more than 5 lakhs	
Introduce strategies to decongest cities and discourage the use of private vehicles	In all Million+ Cities and State Capitals	In all Cities with a population of more than 5 lakhs	
Promote NMT by improving infrastructure for pedestrian safety, comfort and convenience on all streets. All Municipal Corporations will implement the Ministry guidelines on NMT (2016)	In all Million+ Cities and State Capitals	In all Cities with a population of more than 5 lakhs	
Cities should complement the Pollution Control Board's existing monitoring system to collect and analyse data on localised pollution hot-spots			
A city-level clean air action plan should be developed by all cities with Million plus population. The action plans should also include detailed monitoring of air pollution and its impact based on the CPCB guidelines			
Increase in share of public transport, and implementation of 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 Nigam 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 operation and management (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 (catering to 5% or more of the city's water needs) ground & surface water sources and preparation of a plan for augmentation of existing water resource through recharge, rejuvenation and storage. ULBs should make GIS enabled Urban Planning for water supply and sewerage systems. Rainwater harvesting should be made mandatory within all buildings to replenish and recharge the groundwater		In all Class-I Cities	
Continuous (24x7) mode of 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/water bodies and flood zones to ensure channels for surface runoff		In all Class-I Cities	
Mandate treatment, recycle and reuse of the wastewater in line with the guidelines of Jal Jeevan Mission (Urban) and promote circular economy of water through development of city water balance plan		City water balance plan for all the Cities & towns Treatment of waste water: 100% in all Class-I cities and 50% in Class-II & 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 Non-Revenue Water (NRW) assessments and put in place an 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 in the city, its level and frequency. All municipal corporations should implement an end to end urban flood early warning systems and link the same with the Integrated Command and Control Centres where possible		In at least Class – I cities	

Waste Management			
Deliverables	**2021-24**	**2024-27**	**2027-30**
Segregation of waste and 3R (Reduce, Reuse & Recycle) 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 the cities with more than 500,000 population can be maximised by facilitating setups for Material Recovery Facility (MRF) with provision for sorting recyclables and facility for sorting SCF (Segregated Combustible Fractions)/RDF (Refuse Derived Fuels) 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 Construction & Demolition (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 onsite 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 in the city to avoid mitigate GHG emissions. Cities need to scientifically operate and manage their landfills as per Solid Waste Management Rules, 2016		100 % in all cities & towns	
City administration should maintain the drains and prevent clogging of the same due to waste disposal to reduce the risk of flooding and other associated health hazards		100 % in all cities & towns	

Annexure- IV:
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