October 2021| Volume 22 no.2

ISSN 2347 - 4912

SHELTER

Theme paper | Policy Review | Case Studies

hudco

October 4, 2021

World Habitat Day

Accelerating urban action for a carbon-free world

Theme:

Accelerating Urban Action for a Carbon-free World

SHELTER

Volume 22, No.2 October 2021
www.hudco.org
ISSN 2347-4912

Shelter is an official publication of HUDCO/HSMI, distributed free of charge. It deals with issues related to housing, urban development and other themes relevant to the habitat sector. Contributions, comments and correspondences are most welcome and should be forwarded to:

EDITOR
SHELTER
HUDCO's HSMI
HUDCO House, Lodhi Road,
New Delhi -110003
Tel: 011-24308600
Fax: 011-24365292
Email: hsmishelter@gmail.com

Registered Office
HUDCO Bhawan, Core-7A
India Habitat Centre
Lodhi Road
New Delhi-110003
Tel(EPABX):011-24649610-23
CIN:L74899DL1970GO1005276
GST No.07AAACH0632A1ZF

Website: www.hudco.org

FROM THE EDITOR-IN-CHIEF

The world is becoming more urban than rural and India is no different. About 35 per cent of India lives in cities and about 63 per cent of India's national income comes from cities. At the same time, cities are also the biggest emitters of the greenhouse gases. As cities are where businesses and economic activities are concentrated, it is no exaggeration to say that the battle against climate change would be won or lost in our cities. Against this backdrop, the theme of this year's World Habitat Day forms the central focus of this issue of Shelter – "Accelerated urban action for a carbon-free world".

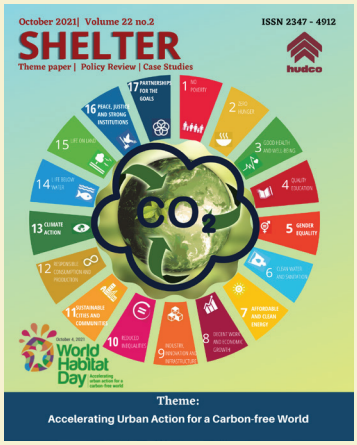
Indian cities are growing at a rapid pace and to cater to this surge, India would have to invest heavily in new urban infrastructure, 70 per cent of which still needs to be constructed. If we want our cities to be climate and pandemic ready then this new development would have to be green and resilient and planned with the objective of achieving social inclusion, economic growth and environmental sustainability. The benefits of urbanisation and agglomeration economies would have to be harnessed without compromising on the energy consumption and emissions benchmarks. To reduce the carbon footprint of growing Indian cities, the key strategies could include compact mixed land use development, low carbon and inclusive public transportation system, water, sanitation, waste management, and energy systems that are resource-efficient and financially viable.

India, a signatory to the Sustainable Development Goals, the Paris agreement on Climate Change and the New Urban Agenda, has been making concerted efforts to meet the targets set by the International Community. Some of the key policy initiatives of Government of India towards achieving this include the National Action Plan on Climate Change (NAPCC), National Adaptation Fund on Climate Change (NAFCC), Climate Change Action Programme (CCAP), International Solar Alliance Intended Nationally Determined Contribution (INDC), State Action Plan on Climate Change (SAPCC), and ClimateSmart Cities Assessment Framework. Various programmes being undertaken on a mission mode like Pradhan Mantri Awas Yojana (PMAY), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart Cities, Swachh Bharat and Urban Transport, etc. are also aiding in development of compact, low carbon sustainable and resilient cities. Other notable actions of Government of India to reduce emissions include transition from fossil fuel to renewable energy and from petroleum run vehicles to hybrid and electric mobility. India's forest and tree cover has increased by 1 per cent in the last five years. UJALA for LED distribution has crossed 320 million while UJJWALA for distributing clean cooking stoves to women below poverty line has covered more than 63 million households. The implementation of these programmes and projects are indicative of Government of India's commitment towards building a low carbon world.

The theme papers of the special issue of Shelter outline mixed land use compact cities with Transit Oriented Development, carbon free technologies for Smart cities and an effective green public transportation system coupled with mainstreaming of informal sector in commercial zones of cities as strategies for making our cities low carbon and resilient. The policy review papers focus on Impact of Housing investment under PMAY on Employment, Income and GDP; and gender-inclusive sanitation in India. This issue also gives a case study of Belagavi, Karnataka on reclamation of existing natural systems and infrastructure in cities.

I am sure that theme appropriate articles chosen for this volume of Shelter would kick start further deliberations on housing and infrastructure development which is clean, green equitable and resilient. As always readers are encouraged to send in their comments (critiques, suggestions and observations) about the issue.

INSIDE



Theme

The world is becoming more urban than rural and India is no different. About 35 per cent of India lives in cities and about 63 per cent of India's national income comes from cities. At the same time, cities are also the biggest emitters of the greenhouse gases. As cities are where businesses and economic activities are concentrated, it is no exaggeration to say that the battle against climate change would be won or lost in our cities. Against this backdrop, the theme of this year's World Habitat Day forms the central focus of this issue of Shelter – "Accelerated urban action for a carbon-free world".

Indian cities are growing at a rapid pace and to cater to this surge, India would have to invest heavily in new urban infrastructure, 70 per cent of which still needs to be constructed. If we want our cities to be climate and pandemic ready then this new development would have to be green and resilient and planned with the objective of achieving social inclusion, economic growth and environmental sustainability. The benefits of urbanisation and agglomeration economies would have to be harnessed without compromising on the energy consumption and emissions benchmarks. To reduce the carbon footprint of growing Indian cities, the key strategies could include compact mixed land use development, low carbon and inclusive public transportation system, water, sanitation, waste management, and energy systems that are resource-efficient and financially viable.

Theme paper

03 | Fostering Urban Climate Resilience: Leveraging The New Urban Agenda And SDGs In Cities
Ms. Serene Vaid and Ms. Adishree Pande

11 | Towards Low Carbon Cities
Mr A K Jain

22 | Overview of Carbon-free technologies for smarter cities
Ms. Abhisikha Das & Mr. Abhishek Upperwal

33 | Planning for 15 Minutes Neighbourhoods in India
Ms. Anchal Srivastava

WHD Concept Note

42 | Accelerating Urban action for a Carbon-Free World
UN-Habitat

Policy Review

49 | Economics Of Housing & PMAY-HFA(URBAN) - Impacts of Housing Investment on Employment, Income & GDP
Dr Akshaya K Sen

56 | Gender Inclusive Sanitation In India: A Legal Perspective To Urban Planning
Ms Aakriti Singhai & Adv. Krati Singhai

Case studies

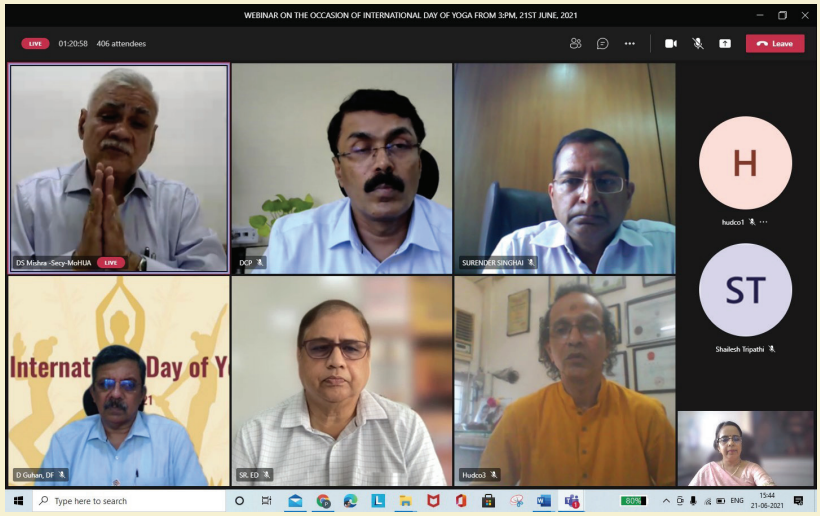
68 | Reclaiming the Existing: A tool for Urban Renewal
Ms. Maithily G. Velangi

IN THE BOX

- HUDCO organized Webinar to mark 7th International Day of Yoga 02
- HUDCO marks its 51st Annual Day 21
- Webinar on "RBI Regulatory Framework for NBFC" & Release of Shelter April, 2021 41
- Online Training Programme on Project Financing, Monitoring and Management 48
- HUDCO CSR initiative 75
- General Guidelines: Check list for Submission of Articles 77

HUDCO ORGANIZED WEBINAR TO MARK 7TH INTERNATIONAL DAY OF YOGA

Housing and Urban Development Corporation Ltd. (HUDCO), organized a Webinar on 'Yoga for Holistic and Healthy Lifestyle with emphasis on Covid', to mark the 7th International Yoga Day. The Chief Guest Shri Durga Shanker Mishra, Secretary, MoHUA stressed the benefits of yoga in leading a holistic and healthy life. Further, he highlighted the global acceptance of the benefits of yoga, particularly in the aftermath of the pandemic. The key speaker, Acharya Jagdish Naik, Swami Vivekananda Yoga Kendra, Navi Mumbai, provided tips on self-care protocol for healthy living through the practice of Yoga, especially during the current pandemic COVID-19. The webinar was attended by over 400 participants which included officials from HUDCO pan-India.



FOSTERING URBAN CLIMATE RESILIENCE:

LEVERAGING THE NEW URBAN AGENDA AND SDGS IN CITIES

MS. SERENE VAID
MS. ADISHREE PANDA

"The SDG 11 - Sustainable Cities and Communities - and SDG 13 - Climate Action - together lay out targets and indicators to capture progress in reducing vulnerability of urban communities while developing infrastructure that is climate resilient. There are a few trade-offs between the two goals, but with effective policy making and urban management, cities and communities can be made more sustainable, as well as help local institutions to spur climate action."

Key words: *Sustainable Development Goals, New Urban Agenda, Carbon neutrality, carbon emission, Resilience, Climate Change.*

Ms. Serene Vaid(serene.vaid@un.org) is Urban and Spatial Economy Specialist; and Ms. Adishree Panda (adishree.panda@un.org) is National Project Coordinator, LNOB project, UN-Habitat India.

More than half of the world's population currently lives in cities and the cities contribute to almost 80% of the global GDP (World Bank 2020). However, a rapid urbanization rate has its associated challenges, including accelerated demand for affordable housing, well-connected transport systems, and efficient infrastructure services. These systems and services further get disrupted by climatic events, such as flooding, heat waves, and earthquakes, etc. With these rising urbanization challenges and climate risks faced by cities, it is imperative for local governments to take the lead in implementing multi-pronged approaches, including both climate change mitigation and adaptation strategies, to reduce the risks and especially strengthen coping capacities of vulnerable communities. By interweaving the principles and targets of the New Urban Agenda (NUA) and the SDGs 11 & 13, Indian cities can enable different levels of stakeholders, ranging from the local governments to the citizens, to actively participate in urban policy and decision-making processes.

INTRODUCTION

Cities in India and across the world are impacted by climate change, both directly through sea level rise (in coastal cities), extreme weather events (floods or cyclones which have disruptive effect on social fabric (climate migration), economic activities and industries. Simultaneously, cities are also one of the main contributors to climate change due to high greenhouse gas (GHG) emissions. More than 40% of the India's rapidly rising emissions have origins in cities, majorly from the urban transport, buildings, construction, and waste sectors. India has committed to reduce its GHG emission intensity of its GDP by 33-35 per cent below 2005 levels by 2030 (India's Intended Nationally Determined Contributions – Towards Climate Justice).However, such mitigation strategies in isolation will be insufficient in addressing the challenges faced by vulnerable communities to cope with the urban climate change impacts and will need to be integrated with adaptation strategies. To ensure resilience building in

cities, the Urban Local Bodies (ULBs) will especially have to play a significant role in providing inclusive services for all and transforming cities into incubation centres for innovation and sustainable growth.

According to the estimates from Climate Watch by World Resources Institute, India emits per capita emissions of about 2.47 tonnes of carbon dioxide equivalent (tco2), as compared to the global average of 6.45 tco2per capita (WRI 2020).According to the Global Climate Risk Index 2020, India was also found to have had the highest number of deaths in 2018 due to extreme weather events, such as cyclones, heavy rainfall, floods, and landslides (Business Standard, 2019). In this scenario, it is imperative for Indian cities and governments to strengthen resilience building efforts and align with global goals and targets that focus on enhancing technical and financial capacities of cities.

To ensure global emission reduction, the Paris Agreement was adopted in 2015 wherein the member countries aimed to keep the global temperature rise this century well below 2 degrees Celsius above pre-industrial levels. And to reduce and prevent climate risks across the globe, the Sendai Framework for Disaster Risk Reduction 2015-2030 was also developed which aims to "strengthen social and economic resilience to ease the negative effects of climate change, man-made disasters, and natural hazards". The Sustainable Development Goals (SDGs) adopted by the United Nations in 2015, further outlines targets and actions that keep local governments accountable and promotes regular monitoring and reporting against the targets. The SDG 11 - Sustainable Cities and Communities - and SDG 13 - Climate Action - together lay out targets and indicators to capture progress in reducing vulnerability of urban communities while developing infrastructure that is climate resilient. There are a few trade-offs between the two goals, but with effective policy making and urban management, cities and communities can be made more sustainable, as well as help local institutions to spur climate action.

Additionally, the New Urban Agenda (NUA) initiated by the United Nations, and adopted in 2016 by national governments, provides a roadmap for sustainable urban development over the next 20 years. A key recommendation under the 'Environmentally sustainable and resilient urban development' policy is to promote "international, national, sub-national and local climate action, including climate change adaptation and mitigation, and to supporting the efforts of cities and human settlements, their inhabitants and all local stakeholders as important implementers." Member countries are also encouraged to commit to "supporting building resilience and reducing emissions of greenhouse gases from all relevant sectors". These transformations must ensure to "leave no one behind" in the path towards sustainable urban development. This highlights the importance of addressing needs of the vulnerable and marginalized communities while developing and implementing any climate action and resilience strategies in cities.

CHALLENGES OF MAINSTREAMING RESILIENCE IN CITIES

Achieving climate resilience in Indian cities needs to be a holistic and iterative process, as the cities face a myriad of challenges. There is a presence of complex urban ecosystems with multiple tiers of governance which exacerbate issues related to environmental degradation, vulnerable infrastructure, and inadequate attention to socio-economic wellbeing of citizens. A report by C40 Cities Climate Group (C40 Cities 2016) classifies urban climate action challenges into two broad categories - 1) systemic

governance challenges, which relate to vertical and horizontal coordination and internal local government operations and capacity; and 2) sequential challenges, which refer to challenges that are faced in the cycle of delivering or implementing action. Under these two overarching categories/ themes, some of the major challenges faced by Indian cities in mainstreaming climate resilience are as follows:

Governance: Need for integration of objectives of national policies with local aspirations

The governance structure in India can be described as a centralized quasi federal system, consisting of the central government, the state government and the local governing bodies. Climate action planning efforts are needed from all participating stakeholders. To ensure that the impact is visible and transformative, a robust bottom-up approach which enables feedback from local levels to refine and improve state and national level policy, programmatic, and financial decisions is required. Such an approach could strike a right balance between the bottom-up and top-down approach by correlating and tying policies and missions developed at the national and state levels with local aspirations and ambitions. Currently, climate resilience planning in India is disconnected from the discourse on urbanisation which is not preferable as Indian cities contribute significantly to emissions.

Monitoring: Need for disaggregated and spatial data at the local level for evidence-based decision making

It is important to track and monitor the impacts of local climate action on urban economies, environment, and communities, to ensure that national policies are grounded in local reality. Monitoring, Reporting and Verification (MRV) of local climate action is a vital step towards vertical integration. At the local level, MRV leads to increased transparency and credibility of local actions and identifies good practices (ICLEI 2016). Developing actionable climate change solutions requires disaggregated data, location intelligence, and GIS-based analysis. Under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) of the Government of India, there is a provision to collate geo-spatial data on urban land use, utilities, and building footprints and topography of Indian cities (TCPO 2016). For effective evidence-based planning, these datasets along with an in-depth vulnerability assessment of local communities and critical infrastructure in cities should form the backbone of climate action planning.

Climate Financing

Cities often face the challenge of accessing funding to take climate action forward. A potential reason is that the ULBs struggle to demonstrate a financial case for climate action. Often, they also lack financial autonomy to deploy appropriate fund-raising mechanisms. The constraints imposed by weaknesses in existing urban public finance institutions leads to distinct gap in - (a) the integration of climate resilience aspects in national urban missions and programmes that can support in funding adaptation-oriented city- and neighbourhood-level projects; (b) the channelling of urban resilience investments from different avenues, such as the disaster mitigation funds available with ULBs, green cess in environment and energy, and the penalties imposed by regulating institutions (e.g. National Green Tribunal) for environmental violations; and (c) sourcing of funds from non-governmental sources, including the private sector (Sethi, et al. 2021).

Technical Capacity

Indian cities are facing limitations in technical capacity and knowledge to interlink the process of

integrating resilience through climate change responses with other developmental actions at the local level. The current scenario calls for both individual and institutional capacity building in cities. This includes developing industry standards and processes, providing access to repositories of best practices, technical support, and enabling peer-to-peer knowledge exchange. City managers and officials require regular technical capacity building exercises which include supervision and training requisite to conduct baseline assessments, framing effective climate strategies, and correlating climate resilience with other strategies and action plans at the local level.

Developing robust climate policies at the local level can have environmental as well as economic benefits including cleaner air, inclusion of vulnerable population, livelihood generation and technological developments. It is essential to create this enabling environment for effective implementation (for example, capacity-building, citizen awareness, regulation, etc. will have impacts on institutional capacity). For instance, implementation of the Climate Smart Cities Assessment Framework (CSCAF) under the Smart City Mission (SCM) by the Ministry of Housing and Urban Affairs (MoHUA), Government of India which assesses smart cities along five sectors is an effort in the right direction for collating information about climate resilience and creating an enabling environment for climate action planning. India's commitment to global agreements, elaborated in the next section, will play a key role to overcome the aforementioned challenges in addressing climate resilience in cities.

LEVERAGING NUA AND SDG TO ENHANCE RESILIENCE BUILDING IN CITIES

The New Urban Agenda (NUA) elaborates on three interlinked principles to guide cities and human settlements to foster sustainable and inclusive urbanization (United Nations 2017). The first principle is to "leave no one behind" by eradicating poverty, ensuring equal rights and opportunities to all citizens, ensuring equal access to physical and social infrastructure and basic services, and eliminating all forms of discrimination and violence. The second principle is to "ensure sustainable and inclusive urban economies" by ensuring well-planned urbanization and equal access to resources and opportunities, promoting productive employment and innovation, and promoting secure land tenure. And the third principle is to "ensure environmental sustainability" by promoting clean energy systems and sustainable consumption and production patterns, by reducing climate risks and building urban resilience, and by protecting ecosystems and biodiversity.

If urban policy mechanisms and decision-making processes adhere to these principles, then it can provide several (inter-sectoral) avenues to engage citizens to build resilience in cities and address the diverse needs of the marginalized and vulnerable communities. For instance, the availability of "Universally accessible, safe and quality public space" (United Nations 2017) is imperative as it contributes towards positive impacts in both social and environmental aspects. If public spaces are created as well-connected and well-distributed networks of urban landscapes across the cities, then they can not only serve as multipurpose, open, and safe areas for social and cultural interactions, but also improve the resilience of cities to climate risks and disasters, such as floods and heat waves. Moreover, if access to decent livelihood and legal income-earning opportunities is provided to everyone without any discrimination to those in vulnerable circumstances (such as the women,

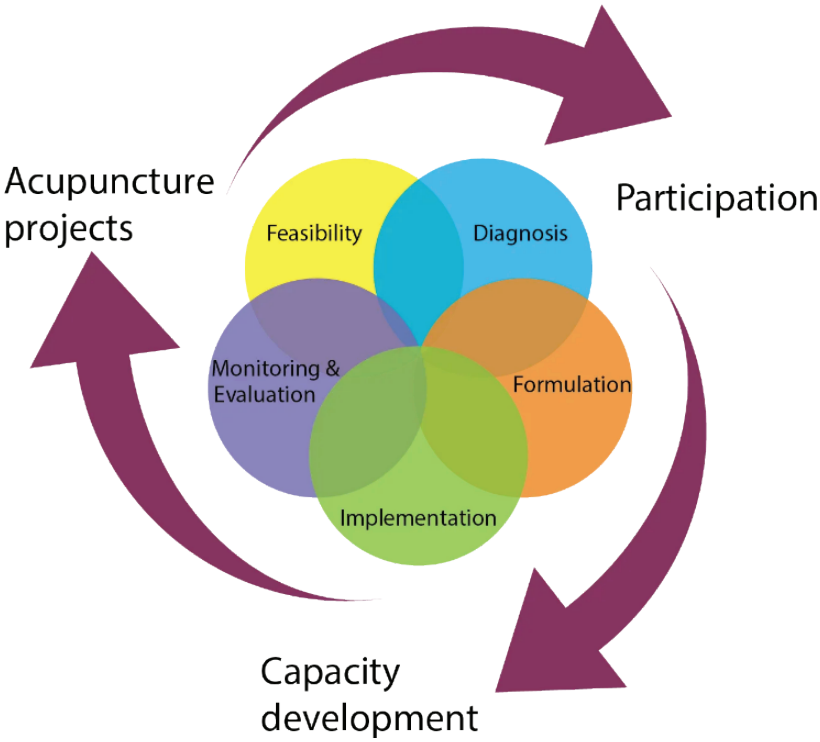
elderly, youth, persons with disabilities, etc.) then it will not only support and sustain the urban economies, but additionally, promote inclusion in technology upgradation, research and innovation, and enhance quality of life for all.

The Sustainable Development Goals (SDGs), adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development, are a "universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere" (United Nations 2019).To achieve these goals, the UN Secretary-General has implored communities to mobilize for a "decade of action" at three levels: global action, to promote global partnerships and networks and secure greater leadership along with useful resources and innovative solutions; local action, to support and embed transitions in the policy and regulatory frameworks and budgets prepared by local governments; and people action, to propel the needed transformations in cities by the youth, civil society, the media, the private sector, academia and other relevant stakeholders (United Nations 2019). Leveraging and utilizing the quadruple helix model of stakeholders - industry, government, academia, and users/civil society – to achieve sustainable urban development is significant to ensure there is participatory engagement while developing and implementing policies.

Within the global goals, the SDG 13 focuses on taking urgent action to combat climate change and its impacts. To align with the SDG targets 13.2 ("Integrate climate change measures into policies and planning") and 13.3 ("Build knowledge and capacity to meet climate change"), there is a necessity to enhance institutional capacities, increase sensitization and awareness-raising trainings, and improve education to implement climate change mitigation and adaptation strategies, and integrate the strategies into national-level policies and planning. Additionally, SDG 11 focuses on identifying key infrastructure and services, such as affordable housing and accessible transportation systems, that contribute towards making cities more sustainable, inclusive, safe, and resilient. The SDG targets 11.5 and 11.B emphasize the need for increased investment for developing and implementing climate resilience strategies, policies, and interventions, which can be supported by target 11.3 ("Inclusive urbanisation and participatory, integrated planning")to ensure that the vulnerable communities are included in the identified interventions (UNEP n.d.). Combining SDGs 11& 13, there is thus a special emphasis on improving the environment of cities and recognizing the need for urban infrastructure to be low-emission, resource-efficient, and resilient.

To align with and achieve the principles and targets of the New Urban Agenda and the SDGs, the National Urban Policy (NUP) Framework developed by the UN-Habitat can be utilized by governments as a guiding tool for cities. The NUP Framework can be considered as a "tool for governments that seek to manage and direct rapid urbanization, and to tap into urbanization's positive effects while accommodating its inevitable stresses"(UN-Habitat 2015).It consists of a "three-pronged approach" with three key thematic areas or "operational enablers": urban legislation, urban economy, and urban planning and design. Within each area, the NUP Framework is categorized into broad phases (feasibility, diagnosis, formulation, implementation and monitoring, and evaluation) and mentions key considerations for each phase, along with the suggested toolkits that can aid in undertaking each phase successfully. The NUP process has been illustrated in Figure 1.

Figure 1: The National Urban Policy (NUP) process.



Source: UN-Habitat, 2015

The NUP process (UN-Habitat 2015) is based on three key pillars which should be utilized and implemented throughout all the stages of developing a NUP to contribute to the overarching sustainability and effectiveness of the policy. In the first pillar 'Participation', it is imperative to integrate participatory processes throughout the formation of policy and the way of public engagement alters the degree to which their inputs are ultimately reflected in the policy. In the second pillar 'Capacity Development', it has been highlighted that an assessment of human, financial and institutional capacities should be conducted to ensure that a NUP is successfully developed, implemented, and monitored and evaluated by all governments. In the third pillar of 'Acupuncture projects', it is important to identify which small-scale projects or interventions will have a great impact within the resources available and will help in grounding the policy. This also promotes an interactive and dynamic design process as the policy can be revised if challenges are encountered during implementation. The pillars and phases can subsequently be adapted and modified according to the local context to develop an integrated urban policy.

WAY FORWARD FOR URBAN RESILIENCE BUILDING

With almost44% of India's carbon emissions having urban origins (NIUA, 2020), climate action planning is imperative to enhance the resilience of Indian cities. The New Urban Agenda (NUA), in its section on 'Urban Ecology and Resilience', highlights the need for resilient development specifically in the next decade as 70% of the urban infrastructure demand is yet to be achieved (UN-Habitat 2015). In India, the NUP framework is currently being finalised and cities should endeavour to implement this framework actively. The framework outlines an integrated approach for urban planning by analysing key challenges and priorities for the management of cities. Such an integrated approach is imperative for urban resilience building and climate proofing urban infrastructure.

The Ministry of Housing & Urban Affairs (MoHUA), Govt. of India has also recently released the National Mission for Sustainable Habitat (NMSH) 2.0. The mission

advocates for facilitating adoption and implementation of sector-wise climate action strategies pertaining to Urban Governance, Capacity Building, Data, Technology & Innovation and Financing mechanisms. To contextualise global and national commitments, i.e. the NUA, SDGs, the Intended Nationally Determined Contributions (INDCs) within the Paris Agreement, the NMSH was revised in 2019-20 with dual objectives of- "a) Promoting low-carbon urban growth towards reducing GHG emissions intensity for achieving India's INDC and eventually carbon-neutrality by 2050,and b) Building resilience of cities to climate change impacts and strengthening their capacities to 'bounce back better' from climate related extreme events and disaster risks" (MoHUA 2021).

With rapidly evolving global climate change scenarios, if a city has a long-term vision of sustainable development and climate resilience, it is likely to attract better financing options to fund its initiatives. Developing a comprehensive city climate action plan, which covers all major municipal sectors (including water, sewerage, solid waste management, and urban planning), will guide sustainable urban development in the cities. Mumbai city provides an example of becoming the first Indian city to develop a dedicated climate action plan (details in Box 1). A well-designed city climate action plan also has the potential to have wide-ranging economic benefits for the city and its residents.

Box 1: Mumbai Climate Action Plan (MCAP)

The city of Mumbai faces two major environmental challenges, urban flooding caused by extreme rain events and rise in temperature. To manage these and any other direct and indirect impacts, the Brihanmumbai Municipal Corporation (BMC) has started preparing the Mumbai Climate Action Plan (MCAP). With this, Mumbai has become the first Indian and South Asian city to develop a dedicated climate action plan.

It will look at climate resilience with mitigation and adaptation strategies by focusing on six key sectors: sustainable waste management, urban greening and biodiversity, urban flooding and water resource management, building energy efficiency, air quality, and sustainable mobility. Under the MCAP, a detailed assessment of data has also identified areas and communities in the city which are most vulnerable given rise in events due to extreme climate change. To minimise the impact of climate change, the MCAP plans to focus on reduction of sectoral GHG emissions and consumption patterns, for the near term (2030), medium term (2040) and long-term (2050).

Mumbai city was encouraged to develop the MCAP by 2021 in compliance with C40 guidelines and standards. There are six more cities (including Bengaluru, Chennai, the National Capital Territory (NCT) of Delhi, Jaipur and Kolkata) which are also in the C40 member cities' list from India. Developing a dedicated city climate action plan and conducting a detailed vulnerability assessment of the city is a step in the right direction and sets a precedent by one of the largest civic bodies in India.

Source: Source: Municipal Corporation of Greater Mumbai 2021. https://mcap.mcgm.gov.in/

City managers and ULB officials should work towards ensuring housing for all, technology-based solutions to enhance service delivery, better mobility and greener transport, smart governance within finite funding options (National Statement of India, UN-Habitat Assembly 2019). There is a need for efficient collaboration between different stakeholders including central and state governments, departments within city administrations, private sector, civil societies, and citizens to not derail from the progress made so far and deliver on key climate resilience objectives. Engaging communities in planning for climate action also plays an important role to nudge citizens to go beyond climate change advocacy. Community-led adaptation responses and citizen engagement mechanisms reinforce local ambitions whilst developing socially-just climate action and national level climate policy decision-making to achieve resilience in cities.

REFERENCES

Business Standard (2019), With 2081 deaths last year, India 5th most vulnerable to climate change. Accessed at: https://www.business-standard.com/article/current-affairs/with-2081-deaths-last-year-india-5th-most-vulnerable-to-climate-change-119120900108_1.html

C40 Cities (2016), Unlocking Climate Action in Megacities. Accessed at: https://www.c40.org/researches/unlocking-climate-action-in-megacities

ICLEI (2016), From strategy to delivery: Measuring, Reporting, Verification (MRV) of Urban Low Emission Development. ICLEI's Green Climate Cities Handbook for Local Governments. Accessed at: https://urban-leds.org/wp content/uploads/2019/resources/guidance_and_tools/GCC_Handbook.pdf

Municipal Corporation of Greater Mumbai (MCGM 2021), Mumbai Climate Action Plan. Accessed at: https://mcap.mcgm.gov.in/

MoHUA (2021), National Mission for Sustainable Habitat 2021-2030, Government of India.

NIUA (2020), Mainstreaming Urban Resilience: Lessons from Indian Cities, TERI, Accessed at:Mainstreaming Urban Resilience.indd (teriin.org)

Sethi M., Sharma R., Mohapatra S., Mittal S. (2021) How to tackle complexity in urban climate resilience? Negotiating climate science, adaptation and multi-level governance in India. Accessed at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0253904

TCPO (2016), Formulation of GIS-based Master Plan for Cities: Designs and Standards, 2016 Town & Country Planning Organisation, Ministry of Urban Development, Government of India, Accessed at: http://amrut.gov.in/upload/uploadfiles/files/designandStandards_AMRUT(3).pdf

United Nations (2017), New Urban Agenda. Adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III). Quito, Ecuador.

United Nations(2019), The Sustainable Development Agenda. Accessed at: https://www.un.org/sustainabledevelopment/development-agenda/

UNEP. n.d. Issue Brief: SDG 11. United Nations Environment Programme.Accessedat:https://wedocs.unep.org/bitstream/handle/20.500.11822/25763/SDG11_Brief.pdf?sequence=1&is Allowed=y

UN-Habitat (2015), National Urban Policy: A Guiding Framework. United Nations Human Settlements Programme. Nairobi, Kenya. Accessed at:https://unhabitat.org/sites/default/files/download-manager-files/NUP%20Guiding%20Framework.pdf

World Bank (2020), Urban Development: Overview. Accessed at: https://www.worldbank.org/en/topic/urbandevelopment/overview

World Resources Institute (WRI 2020), 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors. Accessed at: https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors

TOWARDS LOW CARBON CITIES

MR. A.K. JAIN

"Climate change mitigation generally involves reduction in emissions of greenhouse gases (GHGs). Mitigation may also be achieved by increasing the capacity of carbon sinks, e.g., through reforestation (IPCC 2007). Adaptation to global warming seeks to reduce the vulnerability of biological systems to climate change effects (UNFCCC, 2010). Adaptive capacity is closely linked to social and economic development".

Key words: *Carbon Foot print, Climate Change, Mitigation, adaptation, low carbon life style, resilience.*

Mr. A.K. Jain (ak.jain6@gmail.com) is former Commissioner (Planning), Delhi Development Authority, New Delhi.

Urban India is passing through the Anthropocene, where humans have permeated everywhere and shape everything leading to increasing carbon footprints. There are conflicts among spatial disfranchisement and sustainability due to chronic peripheralization, increasing pollution, transport, energy and water consumption. These impact urban sustainability, climate and disaster vulnerability. It needs relooking at the basics of urban development and adoption of circular concepts of the resources and economy. In this pursuit, the repertoire and urbanism must shift from fossil fuel era to renewable era, digital and circular systems, leapfrogging in the areas of fourth industrial revolution, big data analytics, the ubiquitous cloud and robotics, that would help in making the cities pollution free, green and carbon negative.

INTRODUCTION

Carbon footprint is the total set of greenhouse gas (GHG) emissions caused by an organisation, event or product. It is often expressed in terms of the amount of carbon dioxide, or its equivalent of other GHGs, emitted. A tool for calculating and reporting citywide GHG emissions was developed by WRI, C40 and ICLEI in 2015 as the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. Building on consolidated methodologies, this aims to overcome the challenges of data quality, analysis, strategic action planning and implementation.

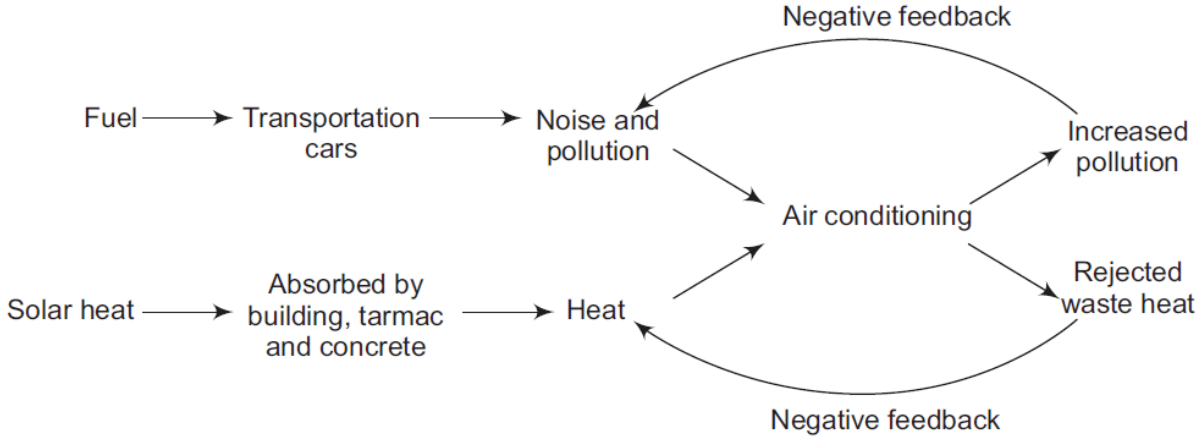
CARBON FOOTPRINT AND CLIMATE CHANGE

The carbon dioxide (CO2) is produced by the burning of fossil fuels. The research in 1967 determined that global average temperatures might increase by more than four degrees Fahrenheit if carbon dioxide levels were not controlled. The book *'The Population Bomb'* by Paul R. Ehrlich in 1968 wrote about the greenhouse effect mainly due to enlarged level of carbon dioxide, dust, and other contaminants. In 1975 Scientist Charles Bracker introduced the word "Climate Change". In 1988 the United Nations founded an Intergovernmental Panel on Climate Change (IPCC)

and warned that strong measures would be necessary to prevent significant global warming. In 1990, the IPCC in its first Report said that humidity and greenhouse gases have increased and enhanced the global warming. In 1992, Rio de Janeiro hosted the Earth Summit and the United Nations Framework Convention on Climate Change (UNFCCC) was adopted by 145 nations. In 1995 second Report of IPCC proposed curbing the activities causing climate change. In 1997, the Kyoto Protocol, signed by 178 countries, required signatory nations to cut emissions by taking prompt actions both in term of mitigation and adaptation to the effects of climate change.

According to the 6th Report of the IPCC (2021), in the next 20 years the global temperature will cross the 1.5degree Celsius limit. The previous decade was much warmer than the earlier 1.25 million years, which recorded a temperature of 1.09 degrees higher during 2011 to 2020 than between 1850 and 1900. If greenhouse gas emissions continue as at present, the global temperature will exceed the 2 C threshold by the middle of the 21st century. Every 1 degree Celsius rise in temperature will increase the intensity of heavy rain events by 7 per cent. The concentration of carbon dioxide is highest in 2 million years. Sea level rise is fastest in 3,000 years and Arctic Sea ice is lowest in 1,000 years. Oceans continue to warm, which have increased 2 to 8 times since the 1970s. The health and productivity are affected by high ambient summer temperatures. The cycle of urban pollution and rising temperature is depicted in Figure-1.

Figure 1: The cycle of Urban pollution and rising temperature



Source: UN Habitat

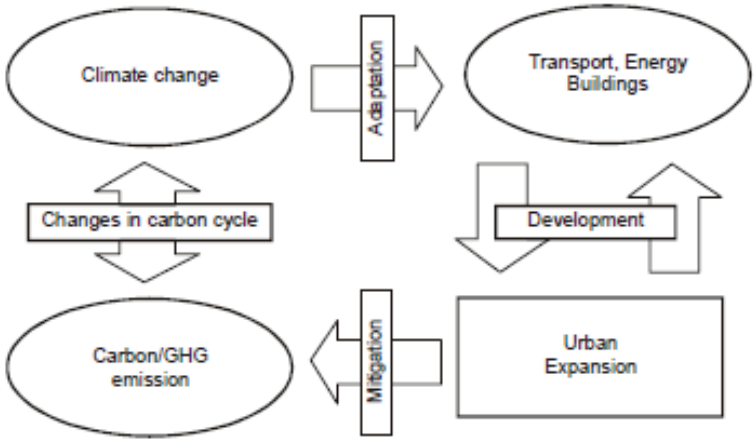
Models predict an average increase in temperature of 2.3 to 4.8 C in India for the benchmark doubling of carbon dioxide scenario. Although per capita carbon emission in India at 1.2 metric tons (mt) per year is one of the lowest in the world, it is predicted to double within next 10 years. Already in the urban areas the people with cars and air conditioners emit 4.5 mt of carbon dioxide/ greenhouse gases per year, while the low-income people without car and air conditioners, emit an average of 1.1 mt of CO2/GH gases. As per UN Climate Change Panel, a benchmark of 3.0 mt per capita per year should be the upper limit.

MITIGATION AND ADAPTATION

Without the so-called greenhouse gases, including carbon dioxide, methane, nitrous oxide, and water vapour, earth would be too cold to inhabit. These gases in earth's atmosphere absorb and emit heat energy, creating the greenhouse effect that keeps our planet's temperature liveable. Water vapour is the most plentiful greenhouse gas on the planet, accounting for about 60 per cent of the current greenhouse effect. Even ozone helps trap some of the heat that makes life on Earth possible. Since the industrial revolution, people have burned vast amounts of coal, petroleum, and other fossil fuels to create heat and power. This releases carbon dioxide, the most plentiful greenhouse gas into the atmosphere. As a result, more heat is trapped in earth's atmosphere instead of radiating out into space. This makes clear that there is a close relationship among carbon emissions, climate change and disaster vulnerability.

Climate change mitigation generally involves reduction in emissions of greenhouse gases (GHGs). Mitigation may also be achieved by increasing the capacity of carbon sinks, e.g., through reforestation (IPCC 2007). Adaptation to global warming seeks to reduce the vulnerability of biological systems to climate change effects (UNFCCC, 2010). Adaptive capacity is closely linked to social and economic development (IPCC, 2007). The mitigation and adaptation strategy for the vicious cycle of climate change is depicted in Figure-2.

Figure 2: Vicious Cycle of Climate Change



Source: UN Habitat

India with its diverse agro-climatic and morphological zones is particularly affected by GHG/carbon emissions. According to the Indian Network for Climate Change Assessment in 2010, 58 per cent of the total emissions were caused by the energy sector, followed by the industrial sector at 22 per cent, and remaining at 20 per cent by solid and liquid waste and forestry. Of the total carbon dioxide (CO_2) emissions, 85% are contributed by the energy sector, while 78% of nitrous oxide (NO_2)emissions were due to the agriculture sector.

According to the United Nations Framework on the Convention on Climate Change (2010), the predicted impacts of climate change in India include a surface air temperature rise up to 4 Celsius by 2100, up to 30% decline in yield in rain-fed areas for some crops and an increase in incidences of extreme events, such as droughts, floods and cyclones. Devastating floods, typhoons and hurricanes are being associated with climate change. The strategic adaptation interventions required for various sectors in urban areas are highlighted in Table 1.

Table 1: Strategic Adaptation interventions in Urban Sector

Sector	Adaptation option / strategy	Underlying policy framework	Key constraints and opportunities to implementation
Water	Expanded rainwater harvesting; water storage and conservation techniques; water re-use; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; integrated water resources management; synergies with other sectors
Infrastructure and settlements	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands / wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land-use policies; building codes; insurance	Financial and technological barriers; availability of relocation space; integrated policies and management; synergies with sustainable development goals
Human health	Human health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public health policies that recognize climate risk; strengthened health services; regional and international cooperation	Limits to human tolerance (vulnerable groups); knowledge limitations; financial capacity; upgraded health services; improved quality of life
Tourism	Diversification of tourism attractions and revenues; shifting ski slopes to higher altitudes and glaciers; artificial snow-making	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits	Appeal/marketing of new attractions; financial and logistical challenges; potential adverse impact on other sectors (e.g. artificial snow-making may increase energy use); revenues from new' attractions; involvement of wider group of stakeholders
Transport	Realignment / relocation; design standards and planning for roads, rail and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policy; investment in research and development for special situations, e.g. permafrost areas	Financial and technological barriers; availability of less vulnerable routes; improved technologies and integration with key sectors (e.g. energy)

Sector	Adaptation option / strategy	Underlying policy framework	Key constraints and opportunities to implementation
Energy	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy, increased efficiency	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards	Access to viable alternatives; financial and technological barriers; acceptance of new technologies; stimulation of new technologies; use of local resources

Source: Parry et al, 2009, IPCC (2007)

LOW CARBON CITIES

The cornerstone of making a city low carbon is to adopt an integrated approach towards ecology and the conservation of the natural resources. The composite urban environment includes the environmental infrastructure–greenery, water supply, air, sewerage, solid waste management, transportation and energy. It is necessary to strike a balance between conflicting demands- citizen freedom versus safeguarding community interests, commercial opportunity versus environmental sustainability and public service versus mandatory procedures.

The planning for low carbon urban development involves the following:

- Local Economic Promotion and Jobs
- Urban Restructuring for socio-economic growth, decentralization of activities, economy of scale, better quality of life, higher level of mixed land use, densities and compact urban form
- Biodiversity and Greenery
- Urban Heat Island
- Water Conservation and Efficiency
- Sanitation and Intelligent Services
- Air Quality
- Clean Transport and Transit- Oriented Development
- Energy
- Green and Resilient Buildings
- Gender Equity
- Low Carbon Lifestyles

Local Economic Promotion and Jobs

In India, the cities generate 60% of GDP of the country and 70% of the jobs. With Covid19 pandemic, climate change and diminishing jobs, the factors of public health, creation of jobs, environmental sustainability and climate resilience are the key issues. A target of 10 million jobs in urban areas can be achieved in next five years by development of janta markets, workshops/ sheds, kiosks, shops, small offices, etc. At least 10 per cent of city's commercial area may be reserved for the informal sector (street vendors, kiosks, fruit and vegetable stalls, etc.). This also needs a higher level of mixed use and the rationalisation of FAR/FSI, height and densities.

Urban Restructuring

The densification and urban

restructuring can lead to travel reduction, economy of services and conservation of agricultural areas. The Indian cities have an overall density of 100 to 240 PPHa, which can be selectively doubled along public transit corridors, excluding the archaeological, heritage and conservation zones. The focus has to be on redevelopment of the brown fields, infrastructure services, transportation, public greens and facilities. The urban eco-system must be compact and dense. The cities and their planning, governance and businesses and industries have been transformed by fourth industrial revolution. These have helped in developing the circular economy and new technologies, such as combinatorial and discrete optimisation, algorithms, complexity theory, artificial intelligence, big data, and the ubiquitous cloud. The new economic development models and green urban development strategies are essential for clean, intelligent and emissions free urbanism.

Biodiversity and Greenery

A study of the present land use pattern in India indicates shortfall of land under forests and greens. Land under agricultural use are being increasingly getting converted and annexed for uses like expansion of highways, airports and settlements for habitation. The rate of conversion shows that an additional 2 to 3 million hectares would be required for human settlements during 2013–2031. Sacrificing agricultural land for habitation implies reduction of land for producing food for the ever growing population. Thus agricultural lands need to be protected from the process of conversion. Moreover, lands that sustain biodiversity, water quality and groundwater recharge, fragile areas, sensitive areas, coastal zones, etc. need protection and conservation. Land for development needs to be judiciously utilized for various uses according to the inherent sustainability and its suitability for the particular land use.

In a city, about 10sq.m of green area per capita should be reserved as open space. A system of landscaped linkages connecting various parts of the city, water bodies and important monuments should be planned. These should provide a sense of oasis and shelter from oppressive climate. Peripheral green belts can be utilised as wind breakers, filters of SPM and dust-storms and as transition zones. The green buffer with indigenous trees, land formations, mounds, embankments, etc. also provide effective barriers to transmission of noise.

The development of greenways along natural water drainage corridors and harvesting of rainwater in balancing lakes and ponds can be a new frontier in landscape development. Such ponds, reservoirs and sediment traps are located in the catchment zones on low-lying ground, which are developed for greenery. In water deficient and dry areas, the landscape can be in form of Xeriscaping, which can reduce total water demand by as much as 50 per cent or 90% by micro-irrigation. Vertical Garden and Urban Farming are particularly useful for dense areas with shortage of land, water and greenery.

Urban Heat Island

In a dense urban area, air rises over the warmer city centre and settles over cooler environs so that a circulatory system develops. The hot air dome and its effect on city climate may persist until wind or rain disperses it. Increased aerodynamics of built-up areas cause rapid deceleration of wind compared with open countryside. It has been calculated that wind velocity within a built-up city is half of what it is over open land. At the town edge, it is reduced by a third. The mutations and reservation of greenery and open space in windward direction and cooler surface materials (roads, parking, buildings, roofs, etc.) help in

mitigating the effects of urban heat island.

Water Conservation and Efficiency

Water scarcity has become a persisting problem in Indian cities due to rapid urban growth, haphazard and unplanned development. The average annual per capita water availability in the country has gone down from 5,236 cubic meters in 1951 to 1800 cubic meters in 1991. Several cities in India have become water stressed. Only 18% of the renewable water resource is being used. India, though endowed with a good monsoon and ample rainfall, uses only 10% of the annual rainfall. The parameters of concern are increasing coliform levels and Bio-chemical Oxygen demand (BOD) in surface waters and increased concentration of nitrates in the groundwater. To overcome the health problems, water sources need to be protected by interception, recycling and treatment of wastewater. Water resources can be augmented through recharging of groundwater resources, rainwater harvesting, conservation of rivers and water bodies, dual plumbing and recycling of wastewater.

Sanitation and Decentralised Intelligent Services

Surveys of Indian cities reveal that though approximately 60% of the population is not covered by sewerage system, the treatment facilities are inadequate. Various alternative technologies, based on decentralized services, like Extended Aeration Technique, Bio-gas production, Bubble Diffusion Process, Flotation, Anaerobic reactors, etc. can be explored for urban sanitation.

Intelligent, alternative and innovative ways to provide services are necessary for low carbon development. The use of IT, simulation, automation and robotics can make them smart and intelligent. The common method of land filling for solid waste disposal is an environmental disaster. Instead, decentralized systems based on recycling, energy generation and organic decomposting should be explored. Three bins provide separate bins for trash, recyclable and compost. Collection charges drop as trash drops. Biotechnology, enzyme based STP, bio-remedial treatment vessel system, sludge gas/energy recovery, vermi-culture, fossilization and compositing options can be adopted for solid and liquid waste management.

Common utility ducts or tunnels carrying electricity, water, pneumatic waste, cable television and broadband internet minimize damage from traffic, road repairs, rains, etc.. A series of low carbon zones across the city with co-located tri-generation energy systems (combining power, cooling and heating), dual piping for recycled water and automated, segregated waste collection and recycling can lead to bundling 'green infrastructure' together.

Air Quality

Air quality in Indian cities is deteriorating due to indiscriminate use of fossil fuels and vehicular and industrial emissions. According to the surveys conducted by the CPCB, ambient air quality in Delhi has reached a very critical situation. Relatively high frequency of suspended particulate matter, dust, SPM, SO_2, NO_2, CO_2 and heavy metals, including lead content in the exhaust of automobiles and scooters have been observed. The recent changes in the fuel like electric and hydrogen vehicles, adoption of clean technologies, new emission norms, and development of shared taxis, NMTs and mass rapid transport system can reduce the pollution levels due to vehicular emissions.

Clean Transport and Transit Oriented Development

Prime Minister Narendra Modi, while inaugurating the Global Mobility Summit in September 2018, encapsulated 7 Cs of mobility-common,

connected, convenient, congestion-free, charged, clean and cutting-edge. He underlined the need to use clean energy for transport as a powerful weapon against climate change. This means a pollution-free clean drive for clean air. He championed the idea of clean kilometres which could be achieved through bio-fuels, electric or solar charging and electric vehicles.

As urban transport contributes nearly two-thirds of the total suspended particulate matter and 18 per cent of carbon emissions, it is time to think of sustainable modes of transit and provide Integrated Transit Corridors (ITC) integrating BRT, Metro and trains linked with pedestrian and cycle lanes. These can be flanked by public, semi-public, high-density, high-rise development. Metro, trains, sub-way and primary roads can run underground for easy bike and pedestrian traffic on the grade. Besides controlling growth of private vehicles, it is necessary to explore parking space in stilts, multi-level puzzle/skeleton structures, on roofs and in underground spaces. Seamless multimodal public transport system comprising bus rapid transit, rail-based mass transport system would work only by adoption of single ticketing and restructuring of land uses by transit-oriented development. Subterranean garages near commuter destination reduce the need for ground parking. Digital parking meters tell mobile phone when a space opens up, reducing traffic caused by drivers trolling for space.

The concept of walk to work, transit-oriented development, travel demand management and smart growth, promoting NMTs, hybrid electric vehicles, multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. River/water transport and ropeways can be explored which are almost pollution free and cost-effective. The concepts of cordon pricing, minimum occupancy vehicles, ceiling on new registration of private vehicles and establishment of a Unified Metropolitan Transport Authority can contribute in sustainable, clean and coordinated urban transport.

The Ministry of Housing & Urban Affairs (MoHUA), Government of India has recently issued Metro Rail Policy and Transit Oriented Development Policy. These provide useful guidelines for preparing comprehensive proposals for urban public transit with private sector participation and financing.

Energy

Energy scenario in India is characterised by increasing demand for energy, growing at the rate of about three times in the last two decades making the country the fifth largest energy consumer. Low carbon energy can be derived from renewable sources, such as bio-fuels, wind, tidal and solar power. The concept of energy efficiency, renewable energy and Zero-fossil Energy Development (ZED) can reduce the level of energy demand and slow down the rate at which resources are depleted. The renewable energy not only helps in energy generation, but also in a pollution-free environment.

The energy guzzling air-conditioning can be avoided by innovative methods like Net Zero Energy Design, variable refrigerant volume (VRV) system, earth air tunnel (EAT) and thermal storage. By HVAC and EAT systems inside temperature of building can be maintained within 27 degree Celsius during summer and 19 to 24 degree Celsius during winter. Lower ambient lighting with bionic controls and integration of natural light with high performance glazing combined with light sensors can save energy use in a building. Optimum glazing design can also help to reduce glare. Synchronized lighting and climate control systems can be designed to match building loads and schedules, which are segmented into

multiple zones to allow more intelligent controllability. Green roof, light coloured finishes and insulation can help to reduce energy demand.

Green and Resilient Buildings

A low carbon building can also be comfortable, green and energy efficient with adequate lighting, good quality air, low noise, and the ability to control the environment. It should limit the use of fresh resources by resorting to recycling and reuse. An energy efficient building is closely linked to conserving fossil fuel usage. The heating, lighting, cooling, ventilation and powering of buildings are responsible for approximately 40% of the total energy use. As buildings are the largest energy users, incorporating energy storage into them will increase the resilience of the total energy distribution network and enable widespread use of renewable energy.

It is estimated that 60% of the buildings required for urban India by 2030 are yet to be built. This is a unique opportunity to shift towards green, sustainable, resilient and low carbon buildings. The use of energy can be reduced by day lighting, courtyards, green roof, ventilation, and integration of renewable energy sources. These are built with ecologically sustainable and renewable resources. By passive design, the building can be more climatically comfortable. It is necessary to specify building materials which are locally sourced and recycled from reclaimed construction and demolition wastes, that have low embodied energy and require less energy for transportation to the site.

Cement production currently accounts for around 2% of global CO_2 emissions. In this light, several companies are developing carbon-negative cements that absorb CO_2 during their production and use. Super-heat steam is used to make cement from calcium magnesium carbonate particles that take up large quantities of CO_2 as it hardens. By using magnesium oxide, carbonates and silicates, low-temperature process absorbs carbon dioxide during cement production. The alternatives to steel reinforcement for bridges and buildings that reduce the carbon emission include new materials, like basalt, fiber composite bars.

Building Information Models (BIM) can simulate the entire construction sequence beforehand addressing sustainability issues and reducing carbon emissions. Automated procedures can be adopted for dust free, speedy and more precise building construction. Computer-Aided Manufacturing (CAM) and Computer Integrated Manufacturing (CIM) for prefabricated components, viz. ceilings, walls, roofs, etc. are useful in reducing emissions, dust and GH Gases. The simulation of construction process enables better control of time, machine, expenditure and the manpower, and could reduce costs and time by half to one-third in comparison to the conventional construction.

Gender Equity

Low carbon strategies cannot succeed without involving the women, who comprise nearly half of the population and use energy for everyday work, mobility, cooking, etc. However, they often face the 'gender service gap' in terms of inequitable access to energy, water and toilets. A low carbon city has to be gender sensitive with adequate, safe and affordable spaces for living, working and vending by the women.

Low Carbon Lifestyles

Low carbon lifestyle is a cluster of habits, embedded in a social context and enabled by efficient infrastructure that minimizes the use of natural resources and generation of emissions, wastes and pollution. Creating sustainable lifestyle requires a change in social norms and rethinking the ways of living based on the principles of

organicity, non-accumulation (*aparigraha*), minimalism and slowing down. It is also about caring, sharing, recycling and living, working and moving in balance with the natural environment at local and community levels. Education, capacity building and full participation of civil society, business and industry are necessary to develop pragmatic and innovative practices of sustainable lifestyles.

CONCLUSION

A low carbon city comprises transport, energy, water, sanitation, drainage and other services and buildings with an annual zero net carbon emissions. It produces surplus energy from renewable sources that ensures that it compensates for all carbon emissions associated with the transport, construction, industries and buildings. Zero net energy development goes beyond carbon neutral. It creates an environmental benefit by removing carbon dioxide from atmosphere and turning it into useful form. It promotes creation of jobs, urban variety, gender equity, digital planning and governance, and adoption of passive micro-climatic design approach and intelligent services. Optimum use of land and other resources, new partnerships and innovative financing are critical elements of a low carbon habitat.

REFERENCES

Central Pollution Control Board (2018), Reports on Air Pollution in India, New Delhi.

Central Pollution Control Board (CPCB), Status of Water & Wastewater Generation, Collection, Treatment & Disposal in Class I Cities, New Delhi

CPHEEO (2014), Water Supply and Sanitation, New Delhi.

Delhi Pollution Control Committee (DPCC), Real Time Ambient Air Quality Data of Delhi, India: http://www.dpccairdata.com/dpccairdata/display/index.php.

Ehrlich Paul R (1968), The Population Bomb, Sierra Club/Ballantine Books, New York

IEA (2008), India Energy Efficiency Policies and Measures: Energy Conservation Building Code, http:// www.iea.org/textbase/pm?mode=pm&id=4162 & action= detail.

ICLEI (2007), Preparing for Climate Change: A Guidebook for Local, Regional and State Government, Washington.

Indian *Network for Climate Change Assessment*(2011), 'Ministry of Environment and Forests, Lodhi Road, New Delhi,

IPCC (2021), Climate Change Working Group, Impacts Adaptation and Vulnerability, IPCC, Cambridge University Press, UK and New York.

IPCC (2014), Climate Change Working Group, 6th Assessment Report, Cambridge University Press, UK and New York

Jain A.K. (2021), Environment, Urbanisation and Development, Discovery Publishing House, New Delhi

Jain A.K. (2017), Urban Transformation, Discovery Publishing House, New Delhi

Jain A.K. (2018), City Planning for a Changing India, Bookwell Publishers, New Delhi

Jain, A.K, (2009), Low Carbon Cities-Policies, Planning and Practice, Discovery Publishing House, New Delhi.

Jain, A.K. (2015), Smart Cities: Vision and Action, Discovery Publishing House, New Delhi,

Jain, A.K. (2015), River Regeneration and Water Resources. Discovery Publishing House, New Delhi

MoHUA (2015), Urban and Regional Development Plan Formulation and Implementation Guidelines, Ministry of Housing & Urban Affairs, GoI, New Delhi

Narain, Sunita (2002), The Flush Toilet is Ecologically Mindless, *Down To Earth,* New Delhi, Feb.

Parry, M, N. Arnell, P. Berry, D. Dodman, S. Fankhauser, C. Hope, S. Kovats, R. Nicholls, D

Satterthwaite, R. Tiffin and T. Wheeler (2009), Assessing the costs of adaptation to climate change: a review of the UNFCCC and other recent estimates. International Institute for Environment and Development/Grantham

Institute for Climate Change, London.

Satterthwaite, D. (2008), Cities' contribution to global warming: Notes on the allocation of greenhouse gas emissions. Environment and Urbanization, 20 (2).

Tewari, S. (2013), ICLEI-ACCCRN Process, Presented at the International Conference on Resilient Cities, Experiences from ACCCRN in Asia and Beyond, New Delhi.

UNFCCC (2010), United Nations Conference on Climate Change, Proceedings, Mexico

UN-Habitat (2011), Cities and Climate Change, Global Report on Human Settlements, Earthscan, UK/USA/Nairobi.

United Nations General Assembly (2015), Sustainable Development Goals-2030, United Nations, New York.

WRI, C40 and ICLEI (2015), Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, Washington.

HUDCO MARKS ITS 51ST ANNUAL DAY

On the occasion of the 51st Foundation Day of Housing & Urban Development Corporation Ltd., officials and stakeholders from across the country joined a live webcast to commemorate years of distinguished service to the nation.

Shri Durga Shanker Mishra, Secretary, Ministry of Housing and Urban Affairs, the Chief Guest on the occasion, addressed the officials and appreciated HUDCO's stupendous contribution towards nation building. He urged HUDCO to redefine the housing and urban development sector by innovatively addressing the emerging needs of the habitat sector. Shri Mishra stressed the need to plan and design for a new urban India that is capable of addressing the challenges thrown up by the COVID-19 pandemic and meeting the housing needs of people across all sections of society. He exhorted HUDCO to scale greater and newer heights by seeking a bold new path and reorienting its business plans to respond to the dynamic sectoral requirements. Further, Shri Mishra emphasized the urgency of getting vaccinated and reiterated the responsibility of each person to follow all covid protocols.

Shri Kamran Rizvi, Chairman and Managing Director, HUDCO congratulated the employees for their commitment and dedication to HUDCO's business model of 'profitability with social justice', in a very tough and challenging year.

Shri M Nagaraj, Director (Corporate Planning) welcomed the participants and Shri D Guhan, Director (Finance) proposed the vote of thanks.

OVERVIEW OF CARBON-FREE TECHNOLOGIES FOR SMARTER CITIES

MS. ABHISIKHA DAS
MR. ABHISHEK UPPERWAL

"Green buildings have the features of efficient use of energy, water and other resources. It uses renewable energy sources like solar and recycled materials in constructions. It is necessary to decarbonize buildings and reduce the carbon footprint of buildings to meet global climate goals. And carbon-free technologies are the medium to achieve these goals".

Keywords: *green buildings, transport, energy, waste management, green house gas emissions*

Ms. Abhisikha Das (adas@niua.org) is Social Development Professional, and Mr. Abhishek Upperwal is Data Scientist, National Institute of Urban Affairs, New Delhi

As the world population is growing at an exponential rate and with changing energy consumption, the ecological dynamics are getting affected every day. This has contributed to climate change where greenhouse gas emissions in the ecosystem are huge. The polluting industries, unplanned settlements and modern lifestyles, that are characteristics of cities use large amounts of energy supply, accounting for 70 per cent of greenhouse gas emissions which trap heat and result in global warming. As the world is trying new technologies to achieve the goal of the Paris Agreement on climate change, which is to keep the average global temperature increase to well below 2°C and preferably below 1.5°C. Energy consumption in India will touch 4 trillion units by 2030. Consequently, there comes the necessity of innovations and technologies by different stakeholders to find alternatives to control and monitor the emissions of these gases in our environment. The articleexplores different technologies for green buildings, transport, energy and waste management as also precedent impacts and changes for reducing carbon emissions in our ecosystem. The paper concludes that there is urgent need of supporting adequate carbon-free technologies and strategies required to meet energy demands and supplies as well as keep the greenhouse gas emissions in control.

INTRODUCTION

Cities around the world are undergoing dynamic changes. Urban areas are also one of the causes of climate change as huge amounts of energy are consumed to sustain the lifestyles of communities that have increased the greenhouse gas emissions in our environment. Over half the world's population now live-in cities, account for 78 per cent of energy consumption and generate over 70% of global CO_2 emissions (The World Economic Forum (weforum.org)). Urbanization has played a huge role in implications for climate change contributing to the depletion of air quality, availability of water, landfills with waste and health effects. The Lima Paris Action Agenda (LPAA) at COP21 in Paris and

the Sustainable Development Goals (SDGs) have demonstrated the recognition of cities as global solution hotspots with the capability to contribute proactively to each country's climate actions. Indian cities will host 200 million more people by 2030 — mostly starting from a low base of development who will demand modern fuels, appliances, air conditioners and vehicles for improved quality of life (The Hindu Business Line, 2021). For cities to adequately mitigate climate changes, it is essential to adopt a "systems" view of the challenges involved and identify and undertake systemic reforms for a sustainable solution. Janaagraha's Annual Survey of India's City-Systems (ASICS) helps identify specific gaps in city-systems across cities, which inhibit the ability of cities to mitigate climate change across four components (Mint, 2021). A major fraction of greenhouse gases emissions originates due to anthropogenic activities like consumption of energy in residential, commercial and industrial sectors, transportation, municipal solid waste generation etc. and tend to absorb and emit the radiations emitted by the earth's surface at particular wavelengths within the thermal infrared radiation spectrum. (IPCC, 2007)

The changes that can bring immediate control of emissions include positive actions for behavioural change eg. switching off energy sources like lights and water taps, using sustainable products, saying no to plastic and inter alia, there is also a need for macro changes to be taken up at policy level that can bring immediate control of emissions like technologies and policy interventions by decision-makers to encourage carbon-free ecosystem right starting from houses to industries. There is an absolute necessity to introduce and work on innovative carbon-free technologies to help mitigate the burning problem of greenhouse gas emissions in the air. Around the world, efficient green technologies are welcomed to move towards a future of self-sustaining demand and supply of energy. The following sections will try to highlight some of the carbon-free technologies for green buildings, transport, energy and waste management.

GREEN BUILDINGS:

Buildings are responsible for nearly 40% of global greenhouse gas emissions (World Economic Forum, 2020). It is surprising to visualise as the building sector is actually responsible for an undistributed one-third of global energy consumption and energy-related emissions. In 2016, the World Green Building Council (WorldGBC), the overarching organization for national GBCs, began working with a group of member councils through its Advancing Net Zero project. India is one of the countries to participate in this exercise. Inspite of the goals of the Paris Agreement, less than 1 percent of buildings are considered net zero carbon today In developed countries from the European Union and North America. Very limited net zero carbon buildings are being built in India. Indira Paryavaran Bhawan , an Office building in New Delhi, is one of the green buildings with many technologies designed and utilized to aspire for zero-carbon building.

Therefore, alternative technologies and introducing countries to 'Green Buildings' becomes apt to drive the Sustainable Development Goal 13 which deals with climate action. According to the World Green Building Council, a green building is defined as a building whose design, construction or operation, reduces or eliminates negative impacts,

and can create impacts on our climate and natural environment as well as preserve natural resources and improve quality of life altogether. Practically green buildings have the features of efficient use of energy, water and other resources. It uses renewable energy sources like solar and recycled materials in constructions. It is necessary to decarbonize buildings and reduce the carbon footprint of buildings to meet global climate goals. And carbon-free technologies are the medium to achieve these goals. Some of the carbon-free technologies can be segregated into Energy Efficiency, Renewable Energy and Carbon offset as follows:

a) **Energy Efficiency:** To regulate and reduce the consumption of energy, efficiency matters. Passive design measures that helps buildings to reduce the consumption of energy considering local codes and regulations of government/ municipalities. Some examples are wall and ceiling insulation, installation of an Efficient HVAC system, double/triple window pane, window size and position, natural lighting and evaporative cooling. The basic minimum required standards can be implemented by individuals and institutions for achieving green development..

b) **Renewable Energy:** For more rigorous reductions in building emissions, few carbon-free renewable energy sources options could be Solar photovoltaic panels, Solar water heating, Electric storage, Geothermal cooling, Solar power plants, Windmills, Hydro, Geothermal. Decarbonization of the electric power grid is one of the innovative techniques to reduce the carbon emissions in buildings as renewable electricity generation is good for the environment. However, some challenges are that it gives rise to grid integration costs and new grid planning requirements. Consequently, the system is intermittent and unpredictable. However, decarbonisation of the power electric grid is a future end goal. Once decarbonised, it can provide needed flexibility in meeting the needs of building occupants. Distributed energy resources (DERs) and distributed resource aggregators (DRAs) are other ways to mitigate the decarbonization of the electric grid. This can help in managing and monitoring the needs as well as reach decarbonised goals. Reliability, security, and affordability are the parameters that citizens look for if any alteration of the current electric grid they have. When these parameters are fulfilling, the transition and acceptance of new green technologies become positive. The seawater-source natural refrigerant heating pump is yet another technology that can make an impact on the increased greenhouse gas in the environment as the development of the national ocean energy is quite useful. The use of seawater heat pump (SWHP) systems is considered to be a better choice than air-source heat pump (ASHP) systems as the former is more efficient.

Cities can be the leaders of change to bring about the paradigm shift from high emission buildings to net zero carbon buildings (ZCBs) and

build the roadmap to achieve the goals of a decarbonized world. The decision-makers along with community leaders can actually pave the way for these technologies to be utilized to balance energy demands and renewable energy supply and limit or control over use or energies beyond regulations and standards. Incentivising the efforts of stakeholders and citizens to adopt carbon-free technologies through credit funds and relief in tax, procurement of these technologies and more will be essential for scaling up. India is developing building energy efficiency policies to implement regulations but, these policies are still in the pipeline. Some of the policy initiatives by India are:

1. Renewable energy targets set by the national government, which include rooftop PV panels;
2. The widespread availability across Indian states of net-metering schemes; and

The opening up of the electricity market, allowing users to engage in nonutility PPAs as well as to purchase RECs.

TRANSPORTATION

a. A distributed renewable energy source for EV charging stations

It is estimated that Power consumption share of EVs shall range between 31% to 51% (470 GW to 1313 GW) of power generated by India by 2030 [Ali,2018]. The EV energy needs in 2030 shall be about21.5% more than the total power generated by India in 2021 (386.8 GW) [Ministry of Power,2021]. This massive energy need might impact the adoption of EVs if energy requirements are not met. 19.6% to 34.3% or more of the energy produced in 2030 (1522 GW to 2660 GW) is expected to be renewable (523 GW) [India Brand Equity Foundation,2021]. This huge demand for renewable energy would require decentralised interventions where energy is generated at a localised or community level and distributed for local use. An EV charging station would buy electricity from local solar or wind power stations installed in houses, buildings or a farm for its day-to-day operations. Local production and consumption of energy would save on power distribution and transport but would require significant investment in energy storage.

b. Solutions for traffic congestion

People in Mumbai spend 7 days 4 hours extra on the road every year because of traffic congestion during rush hours. For Bengaluru, this figure stands at 6 days 23 hours, for Delhi, it's 6 days 12 hours and Pune, 5 days 13 hours [TomTom,2021]. Traffic congestion contributes to more greenhouse gases emissions, it also reduces the productivity hours with increased human resource cost and mental stress. **Hyperloop** is an ultra-high-speed ground transportation system proposed by Elon Musk which allows the movement of vehicles in low-pressure tubes with close to zero air resistance. The idea was inspired by the old pneumatic tubes used to deliver mail and packages within and between buildings. A capsule or pod is envisioned to be propelled by electricity using an external linear electric motor. This would accelerate the pod

to high subsonic velocity and provide a periodic reboot at set intervals [Tesla,2013].

Loop by The Boring Company is an all-electric, zero-emissions, high-speed underground public transportation system in which passengers are transported to their destination with no intermediate stops. Loop is built to use electric autonomous cars to minimise human errors and have a high-speed transportation system. [Loop,2021]

Adaptive Traffic Signals with AI: Advances in Artificial Intelligence (AI) and the availability of big data has enabled us to build sophisticated deep learning and reinforcement models to manage complicated traffic scenarios. This has evolved from induction loop-based technologies to automatic number plate recognition and traffic flow detection using computer vision. IoT has enabled traffic signals to connect with each other and share real-time information on traffic congestion and plan traffic movement as a swarm [SeyitAlperenCeltek et. al., 2020].

V2X Technology: Real-time communication between the vehicle and the road infrastructure and other vehicleshas the potential to save fuel by increasing the braking efficiency andlesser carbon footprint due to the long life of tyres.

c. **Geolocation based toll collection** Traditional toll collection methods require vehicles to stop at a toll collection point which results in congestion. An IIT Varanasi study showed that over 53,98,776 litres of fuel could be saved in a period of a year over the three toll booths under study [A. Jaiswal et. al.,2020]. This also means that an equivalent amount of greenhouse gases would not be released into the atmosphere. FASTag has been used to digitise the toll collection process. It uses RFID (Radio Frequency Identification) technology to identify a vehicle and deduct toll fees from a wallet attached to that vehicle. Passive RFIDs that are used in FASTag have a range of 10 m [RFEnergie] which would need a vehicle to be present in close range to the RFID reader. It is commonly seen that RFID also requires the vehicle to be stopped or slowed down for a brief period to be scanned hence causing slow movement of vehicles at the toll collection point. GPS based toll collection can solve this problem by tracking the movement of vehicles at high speed and deduct toll by detecting the direction of movement and proximity to the toll collection point. This system suffers from at least two fundamental problems i.e. lack of privacy along with measurement error of the GPS devices. Moreover, this system could be mis-used by an authoritarian government as a tool to track its citizens and inaccurate GPS location could incorrectly deduct money from the wallet.

d. **Fuel cell-based Electric Vehicles** Fuel cell-based electric vehicles use hydrogen as fuel in a process called reverse electrolysis to combine hydrogen and oxygen to generate

electricity. Unlike conventional internal combustion engines, fuel cells based vehicles produce no harmful tailpipe emissions, instead these vehicles emit water vapour and warm air [US Department of Energy, 2021]. Compressed hydrogen gas is stored in vehicles as fuel which takes a few minutes to fill at a hydrogen filling station. This filling rate is comparable to fossil fuel-based vehicles and a lot less than a battery-operated electric vehicle that can take from an hour (fast charging) to up to 8 hours to charge. Although fuel cells have higher efficiency as compared to internal combustion engines [US Department of Energy, 2021], it requires significant energy and cost to produce, transport and store hydrogen safely. Hydrogen is stored in high-pressure tanks with up to 10,000 PSI capacity. Other ways of storing hydrogen that is under development are bonding hydrogen chemically with a material such as metal hydride or low-temperature sorbent materials [Office of Energy Efficiency and Renewable Energy,].

e. Carbon capture from vehicles

Carbon capture is one of the foremost methods for curtailing greenhouse gas emissions. Incumbent technologies are inherently inefficient due to thermal energy losses, large footprints, or degradation of sorbent material. [SahagVoskian et. al.,2019]

Electro-swing Absorption System: An electro-swing reactive adsorption system uses an electrochemical cell that binds carbon dioxide molecules to electrodes and lets other gas molecules pass through during the carbon capture step. Once the electrodes are filled with carbon dioxide molecules it unbinds them to be released in a separate chamber. [MIT News, 2019] Temperature Swing Absorption (TSA): TSA uses high temperature along with hot purge gas or steam to separate carbon dioxide from a mixture of gases. [Temperature Swing Adsorption][Sharma & François, 2019]

f. Superelastictyre technology

1.5 billion tyres are dumped each year, the majority of which are sent to landfills for long term storage [Williams Jeremy]. Fire is a significant issue with a huge quantity of tyres being stored. Fires due to tyres are pretty difficult to put out, and they create a lot of smoke that carries toxic chemicals, like carbon monoxide and sulfur oxides, resulting from the breakdown of rubber compounds. From respiratory ailments to cancer, these substances can have short- and long-term health effects. [OzdemirDerya] An alternative to rubber tyres is developed at NASA. Superelastic, airless and non-pneumatic tyres have an ability to flex with the terrain, unlike current rigid wheels. It uses shape memory alloy which was originally developed for Martian and lunar rovers. These tyres are a great alternative to rubber-based tyres due to their long life and non-rubber based material. Air pollution from tyre wear is a significant contributor to non-exhaust emissions and applications of superelastictyres can help in the reduction of tyre wear pollution.

ENERGY

g. Decentralised Renewable Energy

Energy production in India has largely been centralised due to the nature of power plants which require significant investments in terms of cost, human resources and infrastructure. Renewable energy like solar, wind, tidal on the other hand is distributed by nature and spread over a large area that can be harnessed at any scale. Energy decentralisation involves individuals, small business owners or communities producing renewable energy by deploying a small power generation unit within their own premise. This energy can be utilised for their own use and surplus can be sold to either a power distribution company or to a local energy consumer. This trend in local power production and consumption will have a huge impact on the power industry especially in India where DISCOMS has no competitors in an area. Technological innovation and new trends in this sector could produce a much more flexible, resilient and efficient energy grid [Carter Charles]. Local production and consumption will also help in reducing the cost of transportation of electricity and maintenance of the energy grid. Deploying a local power generation unit would require a moderate initial investment which would be around Rs 65,000 per kW [Ranjan Rakesh] but the variable cost is way less especially for solar power due to the low maintenance requirements of the photovoltaic cells. One of the challenges in decentralised energy production is storage for nighttime usage and low demand. The most widely used method is storage with batteries which are expensive. Alternatives to batteries are also explored which include compressed and hydro pumped storage[UNESCAP].

h. Concentrated Solar Power

Photovoltaic cells (PVC) have been primarily used to convert solar energy to electrical energy. PVCs have low efficiency and high cost as compared to non-renewable energy generation methods. New methods like concentrated solar power (CSP) uses the sun's energy to convert water to steam to drive a traditional turbine. CSP uses curved mirrors to concentrate the solar energy to superheat a high-temperature heat transfer fluid that passes through a heat exchanger to heat the water and produce steam. The steam drives the conventional steam turbine to generate electricity [SEIA, 2021]. One of the major challenges with solar energy is its availability at night time. Heat transfer material like synthetic oil [SEIA,2021], quartzite rock and silica sand as a high-temperature particle receiver [Ho, Clifford K, 2019] can be heated and stored to generate electricity at night time. [Office of Energy Efficiency and Renewable Energy] Compressed air and pumped hydro are some other ways to store solar energy for the long term. Energy storage is almost 50 times less than batteries [Ho, Clifford K, 2019] but CSP setup will require significant cost and land area.

i. **Energy Storage for Renewables** Energy storage is one of the most important factors in the integration and adoption of renewable energy. Efficient and economical storage of renewable energy plays a significant role in building a modern power grid. It can reduce power fluctuations, enhance the electric system flexibility, and enables the storage and dispatching of the electricity generated by variable renewable energy sources such as wind and solar. [S.OuldAmrouche et. al] Energy storage technologies can broadly be classified as chemical and mechanical storage. Most chemical storage techniques have a moderate to high carbon footprint. These include lithium-ion, lead-acid, nickel-zinc batteries along with other types. These batteries are very difficult to scale up for a large power generation unit. Flow batteries are rechargeable batteries in which electrolytes flow from one or more tanks to one or more electrochemical cells separated by a membrane. The power and energy capacity of a flow battery can be dynamically scaled up or down based on the size of the electrolyte tanks. Flow batteries also have high efficiency and low maintenance cost [S.OuldAmrouche et. al] Another way of storing energy chemically is in hydrogen. In a fuel cell, hydrogen and oxygen react to form water to produce electricity. [S.OuldAmrouche et. Al, 2021] Mechanical methods to store renewable energy includes compressing air, hydro-pumped storage that includes pumping water to a high terrain to be used later in a hydropower station, using synthetic old, quartzite rocks and silica sand to store energy from a concentrated solar power plant [SEIA, 2021] [Ho, Clifford K.,2019]. Some of these methods like hydro-pumped, compressed air and hydrogen storage can be used for long term storage of energy.

j. **Peer-to-peer energy trade on Blockchain** With the decentralisation and digitisation of the power grid, individuals and small organisations will get an opportunity to trade energy with their local communities. Decentralised trade of energy would require a decentralised marketplace build on decentralised technology like Blockchains. Blockchains are distributed and decentralised ledgers managed by multiple parties through a common consensus protocol. No single party has control over the transactions happening in the Blockchain system and hence consistency is maintained by all the parties through consensus.

WASTE MANAGEMENT

Cities offer opportunities of economic upliftmentand accomodate growing population and their carbon footprints. Wastemanagement is one of the problems cities are facing. Waste from industries, households and other establishments are dumped in landfills and harmful chemicals/gases are emitted into the environment leading to climate change. As per the central pollution control board (CPCB) of India, the per capita waste generation has increased at an

exponential rate (0.26 kg/day to 0.85 kg/day) (CPCB India, 2018a). There are embedded health and environmental risks which need immediate attention by the decision-makers and citizens too. Technical interventions in low carbon waste management become necessary to monitor and manage this waste to mitigate the climate change. Waste should be seen as wealth when it is converted to various forms of energy that can help fulfil the city's energy needs. . A decentralized waste management approach needs to be followed keeping in mind the density of the population and segregation at the source. GPS-based Vehicle Tracking and Monitoring System (VTMS) for SWM is a good example from Indore smart city for other cities to adapt these technologies for making life easier and efficient. VTMS does online real-time monitoring of garbage vehicle movements in the city wherever they travel to collect waste. An exemplary use of a waste tracker which is integrated with the Central Command and Control Centre (CCCC) in the city. Some of the carbon-free technologies in waste management which cities can adopt are as follows:

k. Route Planning for SWM Vehicles

A systematic and optimal routing is necessary to protect the environment and also reduce the harmful emissions. Therefore, route optimization software becomes essential to enable the mechanism of collection of waste following routes that are short and take minimum time. This is a more efficient approach as well as financially viable as compared to the current static routes.

l. Sensors in Waste Collection Bins

IoT has enabled us to monitor the waste bins and plan waste collection by deploying fill detection sensors on the dustbins sending alerts to operators and authorities when full and in need of service.

m. Incentivise recycling of e-waste

People can be incentivised with monetary or nonmonetary benefits in exchange of e-waste like phones, tablets, batteries that will help in waste segregation. Collected e-waste can later be recycled and refurbished instead of ending up in the landfill.

n. Waste management apps:

This is an eco-friendly way of managing waste and citizens can also be aware and contribute to the efficiencies by informing/helping locate bins to empty, report of inconveniences and other services. Too Good To Go, Site Buddy are some of the useful apps which can be installed in phones.

o. AI waste sorter to recycle more:

AI and robots can help in the end-to-end processes in various stages right from collection of waste to transporting the waste, sorting and even in recycling. Various companies, start-ups are investing time and money in curating innovative tech solutions to loosen the cost on trash and encouraging recycling. AI can provide analytics and insights into the type of waste to be collected which can be integrated with fleet management solutions. Municipalities can have the advantage of making data-driven decisions to monitor and regulate waste collection frequencies, routes and times of collections for efficiency in the system.

CONCLUSION

To conclude, climate change is real and the communities of the world including decision -makers as well as individual households and all others should come together to help reduce the carbon footprint and with mindfulness should encourage, develop and accept the carbon free technologies. The policy level interventions are also necessary to support green technologies and incentives provided, creation of market and as well localizing these technologies as per demand and geographical locations. The cities have to be the armor to increment the process of sustainable goals and mitigate climate change all together as world leaders.

REFERENCES

An Assessment of Solid Waste Management System in Chandigarh City, India Rishi Rana, Rajiv Ganguly*, Ashok Kumar Gupta

A. Jaiswal C. Samuel, *Fuel wastage and pollution due to road toll booth*, 2020

Carter Charles, Future energy systems: Decentralisation and virtual power plants, visited 12th September, <https://www.smartcitiesworld.net/special-reports/special-reports/future-energy-systems-decentralisation-and-virtual-power-plants>

CPCB India, 2018a

Carter Charles, Future energy systems: Decentralisation and virtual power plants, visited 12th September,

<https://www.smartcitiesworld.net/special-reports/special-reports/future-energy-systems-decentralisation-and-virtual-power-plants>

Ho, Clifford K., *High-Temperature Particle-Based CSP with Thermal Storage*, 2019

IPCC (2007),. In: Pachauri RK, Reisinger A, editors. Report by the intergovernmental panel on climate change (IPCC), synthesis report. Contribution of working groups I, II and III to the fourth assessment report. Geneva, Switzerland: Core Writing Team; 2007. p. 104

India Brand Equity Foundation, Renewable Energy Industry in India, viewed 12th September 2021, <https://www.ibef.org/industry/renewable-energy.aspx>

J.García-Nieto, E.Alba, A.Carolina Olivera, *Swarm intelligence for traffic light scheduling: Application to real urban areas*, 2012

Loop, *Loop Tunnel Homepage*, viewed 12th September 2021, <https://www.boringcompany.com/loop>

Mint https://www.livemint.com/Opinion/4OhRiQWn4kIaGKrXISe3tK/Opinion--How-Indias- cities-can-face-climate-change.html viewed 12th September 2021

Mohd. Sahil Ali, Tongia Rahul, *Electrifying Mobility in India - Future Prospects for the Electric and EV Ecosystem*, 2018 <https://www.brookings.edu/wp-content/uploads/2018/05/ 20180528_impact-series_ev_web.pdf>

Ministry of Power, Government of India, *Power Sector at a Glance - All India*, viewed 12th September 2021,

<https://powermin.gov.in/en/content/power- sector-glance-all-india>

MIT News, *MIT engineers develop a new way to remove carbon dioxide from air*, visited 12th September, <https://news.mit.edu/2019/mit-engineers-develop- new-way-remove-carbon-dioxide-air-1025>

OzdemirDerya, Kuwait's Tyre Graveyard With Over 7 Million Dead Tyres Poses a Fire Hazard, visited 12th September, <https://interestingengineering.com/kuwaits-tyre-graveyard-with-over-7-million-dead-tyres-poses-a-fire-hazard>

Office of Energy Efficiency and Renewable Energy - Thermal Storage, Thermal Storage System Concentrating Solar-Thermal Power Basics, visited 12th September, <https://www.energy.gov/eere/solar/thermal-storage-system-concentrating-solar-thermal-power-basics>

Office of Energy Efficiency and Renewable Energy, Hydrogen Storage, visited 12th September, <https://www.energy.gov/eere/fuelcells/hydrogen-storage>

Ranjan Rakesh, Cost to Install a 1 kW Solar System on a Residential Rooftop Can Range from ₹45,000 to ₹85,000, visited 12th September, <https://mercomindia.com/cost-install-1-kw-solar-residential-rooftop/>

RFEnergie, *FASTag Specifications*, visited 12th September 2021, <http://rfenergie.com/FASTag.html>

SEIA, Concentrated Solar Power, visited 12th September 2021, <https://www.seia.org/initiatives/concentrating-solar-power>

S.OuldAmrouche, D.Rekioua, T.RekiouaS.Bacha, Overview of energy storage in renewable energy systems, 2016

SEIA, Concentrated Solar Power, visited 12th September 2021, <https://www.seia.org/initiatives/concentrating-solar-power>

SeyitAlperenCeltek, Akif Durdu, MuzamilEltejani Mohammed Ali, *Real-time traffic signal control with swarm optimization methods*, 2020

SahagVoskian, T. Alan Hatton, *Faradaic electro-swing reactive adsorption for CO2 capture*, 2019

Sharma Shivom, Maréchal François, *Carbon Dioxide Capture From Internal Combustion Engine Exhaust Using Temperature Swing Adsorption*, 2019

Temperature Swing Adsorption, visited 12th September, <http://www.separationprocesses.com/Adsorption/AD_Chp02b2.htm>

TomTom, *India Traffic Report*, viewed on 12th September 2021,

<https://www.tomtom.com/en_gb/traffic-index/india-country-traffic> viewed 12th September 2021

Tesla, *Hyperloop Alpha*, 2013, <https://www.tesla.com/sites/default/files/blog_images/hyperloop-alpha.pdf>

The World Economic Forum The World Economic Forumhttps://www.thehindubusinessline.com/opinion/columns/indian-cities-and-climate-challenge/article21986133.ece1 (weforum.org) viewed 12th September 2021

The Hindu Businessline<https://www.thehindubusinessline.com/opinion/columns/indian-cities-and-climate-challenge/article21986133.ece1> viewed 12th September 2021

UNESCAP, Decentralised Energy System, visited 12th September, <https://www.google.com/url?q=https://www.unescap.org/sites/default/files/14.%2520FS-Decentralized-energy-system.pdf&sa=D&source= editors&ust=1631474727683000&usg=AOvVaw3PdW_3nI_i2EHwJeCb1fD4>

US Department of Energy, *Fuel Cell Electric Vehicles*, visited 12th September 2021, <https://afdc.energy.gov/vehicles/fuel_cell.html>

Williams Jeremy, *What can the world do with 1.5 billion waste tyres?*, visited 12th September, <https://earthbound.report/2017/06/29/what-can-the-world-do-with-1-5-billion-waste-tyres/>

World Economic Forum, visited 12th September, <https://www.weforum.org/agenda/2020/01/zero-carbon-buildings-climate/>

PLANNING FOR 15-MINUTE NEIGHBOURHOODS IN INDIA

MS. ANCHAL SRIVASTAVA

"This concept of 15-minute neighbourhoods is in direct contrast to the urban planning paradigms that dominated for the last century, whereby residential areas are separated from business, retail, industry and entertainment. Nonetheless, most of the ideas and principles underpinning the 15-minute neighbourhoods are not new and most cities already contain areas that align with 15-minute principles."

Key words: *Car-free city; city of short walks; urban mobility; accessibility; daily life services; Hyperlocal Neighbourhoods; Urban mobility; 15-minute neighbourhood; COVID-19; pandemic; environment; urban planning*

Ms. Anchal Srivastava (anchal.srivastava92@gmail.com) is Assistant Professor UPID, NOIDA AKTU University & associated with SPA First and CDRI, UN

As conurbations work towards COVID-19 retrieval, the 15-minute neighbourhood is more relevant than ever as an establishing principle for urban advancement. Neighbourhood in India has been defined as an amalgamation of one or two "mohallas", and it is the lowest element that aids the resident community and inspires them to foster the locality spirit or rapport which seems to have been lost in urban life". During this pandemic, one of the positives was the appreciation of one's neighbours; when families were unable to help, our neighbourhoods came together to fight this misfortune. The importance of social cohesion has been appreciated in all of the urban spheres irrespective of the gender, economic background, rather any perspective. One and all stood collected, and unity and democracy were perceived, which seemed to had been lost in the concrete jungle of our cities. Planning skills do not lack prudence in regard to accessibility in urban settings. There is a need to sanction more micro level planning styles. During the Covid-19 pandemic, it has been observed that people rediscovered their local centers. This paper combines three linked concepts revolving around the notion of the '15-minute neighbourhood' – the inkling that residents should be able to access their basic needs within a quick distance from their homes.

INTRODUCTION

A 15-minute Neighbourhood is a union of three concepts namely, (a) *digital neighbourhood networks*, which talks about how a city should cope with any crisis or any change – which cannot be determined by its plans and procedures but by the strength of the relationships that have already been built; (b) *neighbourhood accessibility planning* with an aim of refining daily mobility and social interface within the same region; Planning a resilient city begins with building a strong sense of community (Denniss, 2018); and lastly *bringing all of the concepts systematized* with the modelling of travel time in urban networks, by focusing on meeting the needs of the citizens by giving them access to everything they could need within a 15-minute distance of their home.

Distance measuring was one of the main strategies up till COVID 19 pandemic which has monopolized public attention by changing the ways in which humans lived, worked, and navigated the world. The urgency for social distancing during these times is against any fundamental philosophies of urban planning or design, which typically celebrate the dense nature of cities.

There is an urgency to manage time to achieve larger distances using sustainable modes. The aim is to create or reallocate infrastructure in such a way that all residents are able to meet most of their needs within a short walk or bicycle ride from their residences. Now, the question arises as to how and where to draw a line, are the existing benchmarks enough, or do we need to adapt with the uprising of the technological advancements. The purposes, thus framed, can be such that all inhabitants of every single neighbourhood to have easy access to goods and services, particularly groceries, fresh food and healthcare, which were the most basic need observed during this contagion. Secondly, all neighbourhoods to have a variety of housing types, of different sizes and levels of affordability, to accommodate many types of households and enable more people to live closer to where they work.

Curiosity is the mother of invention, they say, but when planners talked about reducing work distances or using technologies, it was labeled to be a utopia. During coronavirus lockdown across the globe, work from home became the best time to not only work but to also utilize the time that was wasted in travelling in traffic jams into improving professional skills, quality time with families, and people seem to be more productive. The population which feared technology, also learnt to use it, and understood the convenience of it as well. Several people started to work on their healthy routine and what not. So, third objective is that more people can work close to home or remotely, with the presence of smaller-scale offices, retail and hospitality, and co-working spaces. And finally, we have to accept that residents of every neighbourhood have a right to be able to breathe clean air, free of harmful air pollutants, there must be green spaces for everyone to enjoy.

URBAN CHALLENGES

The urban population of India is expected to increase from 377 million (2011) to estimated 600 million by 2031 (S.M., 2017), which implies an increase of over 200 million in just 20 years. 53 metropolises share the load of 42.6% of urban population in India. Hence the pressure of development is concentrated in Metropolises. The time to address the situation of our cities and its resident is now before the pollution, the sprawl, the unsatisfied residents might make our cities into dead ones.

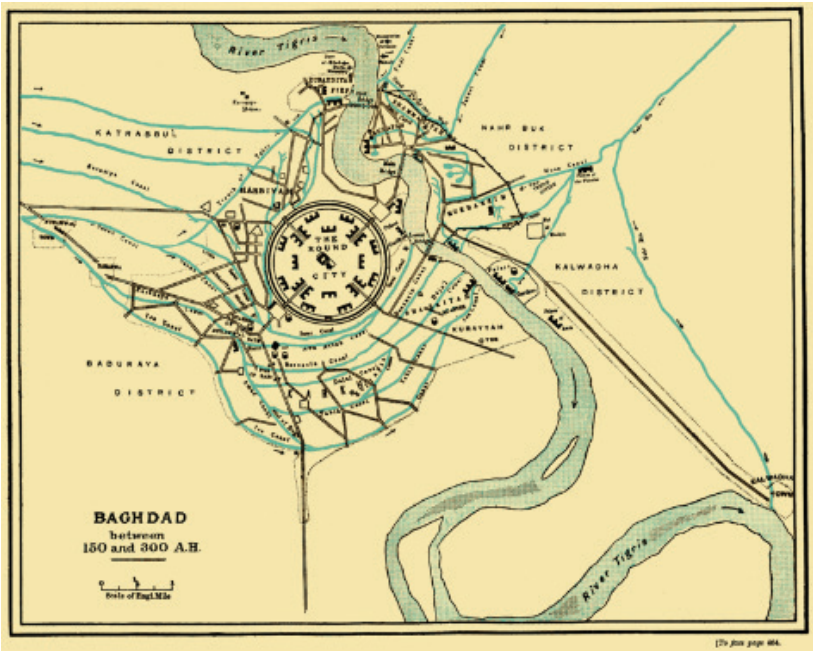
Facts from History

The 15-minute neighbourhood idea has been an integral part of almost every city everywhere for several centuries. In fact it was emblematic of medieval cities all over Europe, Asia and several other cities around the World, from the ancient city of Copenhagen which used to have walls on all sides to protect against the enemies, and the walls were at a distance of about a 30 minute or 20-minute walk from one end to the other. This reminds us of several walled cities of India. Another thing to distinguish is the networks and the typical land use of the city which had a lot of resemblance with our contemporary urban designs such as a separate residential space, industrial in one corner as per wind direction, taking the smokes out of the city center, an administrative zone with fields on the fringes to act as buffers, market spaces to have piazzas for community festivities. We seem to have lost our roots during the automobile times, and now everyone is moving back

from the car centric designs to human centric designs, like the Paris City, which has been successful in removing 70% of its on-street parking, thanks to the urban innovator Carlos Moreno and Political acceptance by Anne Hidalgo, the mayor of Paris.

On learning about some other examples such as Baghdad –the largest city of Iraq and one of the most populated urban agglomerations of the Middle East: In 767 to 912 AD, it was also a closed city with travelling time from one end to the other being a mere 25 minutes' walk (Figure 1).

Figure 1: Baghdad - 767 and 912 AD (Muir)



Other cities include Venice of Italy, Constantinople, Harappa, Mohen-jo-Daro and the list goes on. It's been theorized by Harvard Health that "human under their own capacity have about a *30-minute mental limit* i.e., they are not going to walk more than 30 minutes unless they have to – that's about 1.7 kilometers or cycle for about 30 minutes which is 7 kilometers." Many cities were scaled to accommodate this inherent transport psychology in earlier days.

The Last Century

With urbanization, the urban designing principles thrifted from human sensitive design to economic development designs, where the distances became easier to reach, and cities started to sprawl. With the introduction of cars and other automobiles, cities began to stretch beyond the human limit of walking or cycling, hence they started to move away from the center instead of densifying the cities first, which is not only unsustainable but also economically expensive for the municipalities, environmentally unjustifiable and people do lose time in the bubble of illusory acceleration.

This concept of 15-minute neighbourhoods is in direct contrast to the urban planning paradigms that dominated for the last century, whereby *residential areas are separated from business, retail, industry and entertainment.* Nonetheless, most of the ideas and principles underpinning the 15-minute neighbourhoods are not new and most cities already contain areas that align with 15-minute principles, even if by accident rather than by design, some already have longer-standing urban development plans that strive for the very outcomes sought by the 15-minute-city model of Carlos Moreno, extending its assistances across the whole city, for everyone (Group, 2020); but the merger of it with the other two concepts, might be the answer to every city everywhere.

Pragmatic use at the city level, the creation of 15-min

clusters would need a sort of deconstruction of the city, improving diversity and lowering the unbalanced distribution of facilities between districts (Pisano, 2020). As Carlos Moreno, a Columbian scientist states "there are six things that make an urbanite happy: dwelling in dignity, working in proper conditions, [being able to gain] provisions, well-being, education and leisure. To improve quality of life, you need to reduce the access radius for these functions" (Moreno, Ted: Ideas worth Spreading, 2020). But Paris (105.4 sq. kms.) is a lot smaller in comparison to Indian cities. Our capital city, i.e., Delhi is 1484 sq. kms. and even the smallest city in our country, which is Sambalpur in Odisha is 303 sq kms. So, in context with Indian cities, we have to work from the smallest unit aka Neighbourhood level.

That vow to fetch all life's essentials to each neighbourhood means creating a more cautiously integrated urban fabric, where recreation center is available at a much smaller scale as well, anonymous centers available by accepting that it is okay to live one day at a time, where stores mix with homes, bars mix with health centers, and schools with office buildings or activity areas. The functional mix challenges especially the car-centric suburban areas shaped by large schools, blind box retail strips, and massive industrial and office parks, all separated from each other and connected by networks of roads and parking infrastructure – The concrete jungle.

The notion of "hyper proximity" introduced by Carlos Moreno to express the qualities of the 15-min city seeks to bring back to the city level some of these uses inserting them into a new social logic. During the recent pandemic outbreak, several more cities are coming up with a motivation to convert their cities into 15-minute neighbourhoods.

15-MINUTE NEIGHBOURHOOD CONCENPT IN INDIAN CONTEXT

In 2020, the 15-minute city concept has gained momentum; more cities are now embracing this model to support a deeper, stronger recovery from COVID-19 and to help foster the more *local, healthy and sustainable* way of life that many of their citizens are calling for. Table 1 gives an example of some of the Indian cities that have agreed to convert themselves into 15-minute city. Under the agenda for Green and Just recovery from COVID19 – C40 global mayors have come together to implement 15-minute city (hyperlocal neighbourhoods) (Apolitical, 2020). Hyperlocal is data focused around a precisely well-defined community with its primary focus directed toward the concerns of the population in that community (Researcher, 2020)

The strategies that are required to be implemented for hyperlocal neighbourhoods are:

Table 1: Indian cities to convert themselves into 15-minute city

CITY	POPULATION	AREA (Sq Km)	DENSITY (Pers/ Sq Km)
Delhi	30,291,000	1484	20411.7
Jaipur	3,909,000	484.6	8066.4
Kolkata	14,900,000	205	72682.9
Bangalore	12,327,000	709	17386.5
Chennai	10,900,000	426	25586.9

Source: TIMESOFINDIA.COM, 2020

(i) The new city will have all basic amenities such as healthcare, schools, parks, food outlets & restaurants, essential retail & offices within a 15-minute distance. It will also aim to digitize some of its services.

(ii) (ii) As indicated by the C40 group, in order to achieve this, effort must be made to create a regulatory environment that encourages inclusive zoning, mixed use development, & flexible buildings & spaces (TIMESOFINDIA.COM, 2020).

The aim of the 15-minute neighbourhood concept is: (i) to give streets back to the people, by permanently reallocating more road space to walking & cycling, invest in city wide walking & cycling networks & green infrastructure; (b) to act as a defense against the impact of climate change by reducing air pollution; and (c) better quality of life by cutting down on commute time (TIMESOFINDIA.COM, 2020).

Brown Field Development V/S Green Field Development

Greenfield Development

Greenfield sites are often on the fringes & may have better access, with less traffic congestion, with a pleasant environment and extra space to sprawl. Large family houses with gardens are more likely to be able to be built on Greenfield sites. New sites are easier to construct on and is more attractive to retail parks, housing developers, etc. On the other side of the coin, using Greenfield sites is often not sustainable, as these sites take the core from towns and locate them on the fringes. In such sites new infrastructure has to be provided. Wildlife may suffer as many lose habitats, trees may have to be cut down, and history speaks that environmentalist protest to Greenfield developments.

Brownfield Redevelopment

Brownfield redevelopment eases pressure on Greenfield sites and is more sustainable – it's good to reuse land. *House prices would increase* in core city areas as *people are encouraged back into the area. Infrastructure* already exists in urban areas. New employment opportunities come up. New housing can lead to redevelopment (old housing – area becomes trendier & more affluent) so the neighbourhood will improve. Providing public transport networks is easier in central areas where the population densities are high – investment is focused in central areas. Towns & cities do not want their areas to decay – redevelopment results in more people coming to the area, which helps local businesses. Redeveloping Brownfield sites can bring a 'dead' area back to life. On the other side of the coin, *increased house prices* due to core city redevelopment might mean that *local people cannot afford* the houses, & the authority will have the *problem of providing for them. Clearing rubbish* from Brownfield areas is expensive. There may be an issue of *contamination & making sites safe for development*, given what the land may have been used for before. In cases of "Hyperlocal" neighbourhoods – all brownfield sites can have a usage in each locality for one or the other usage.

Specifications Sum up

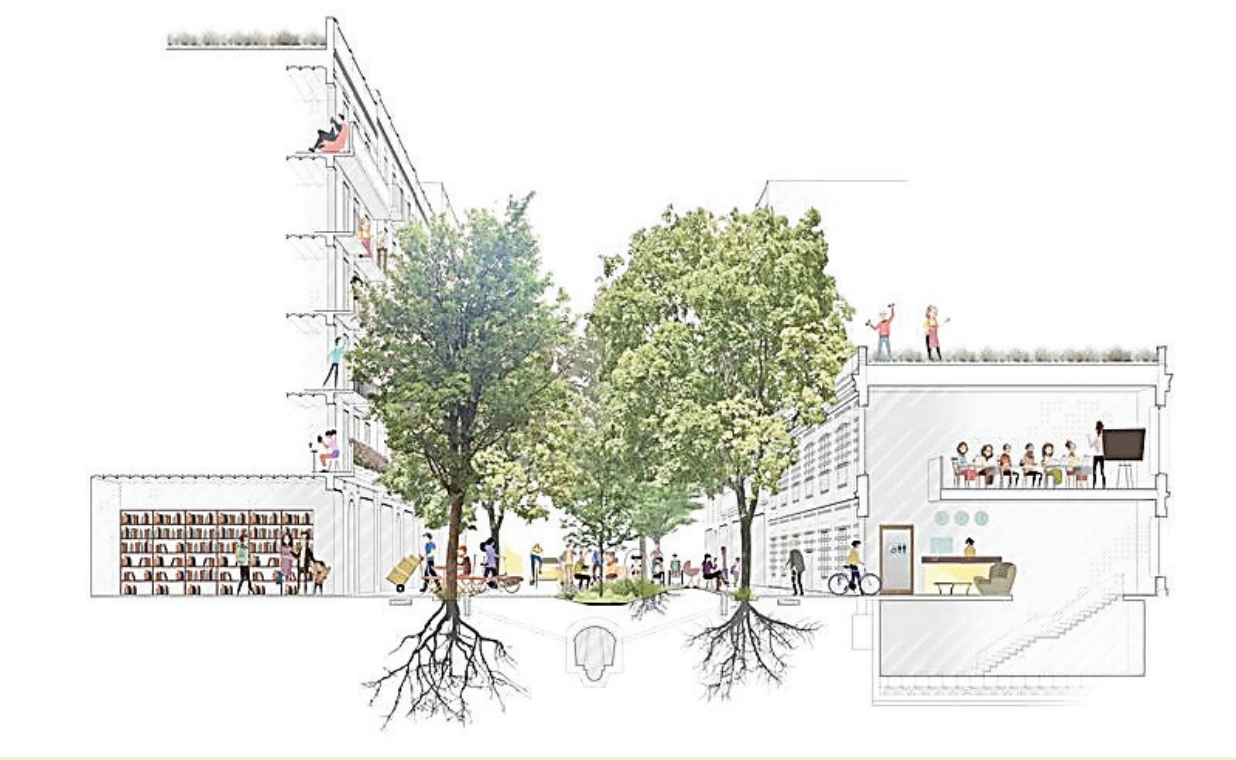
The specifications for 15-minute Hyper local neighbourhood are as follows:

1. At least 80% of the street should be shaded by trees (Figure 2) in summer (Researcher, 2020) .

2. At least 20% of surfacing should be permeable and 50% of this total planted with grass, to allow the ground to soak up rainwater & improve flood resilience (Pisano, 2020).

3. Priority should be given to create safe spaces for children & elderly, while all public areas to be

Figure 2: Extensive tree plantings along car-free streets will help reduce summer temperatures.



Source: Ajuntament de Barcelona. (O'Sullivan, 2020)

equipped with drinking fountains (Researcher, 2020).

4. The city could free up to 70% of its current road space for active travel & recreation space if it covers its whole surface area in superblocks (O'Sullivan, 2020), slashing air pollution, carbon emissions & noise pollution in the process (Researcher, 2020).

5. Expanded tree cover will reduce summer temperatures. According to a 2019 study published in the journal Environment International, a full realization of the Barcelona city's 503-block plan could prevent 667 premature deaths per year (O'Sullivan, 2020). Figure 3 shows how the intersections of Barcelona's Eixample district could be redesigned to create green plazas.

The Guiding Principles

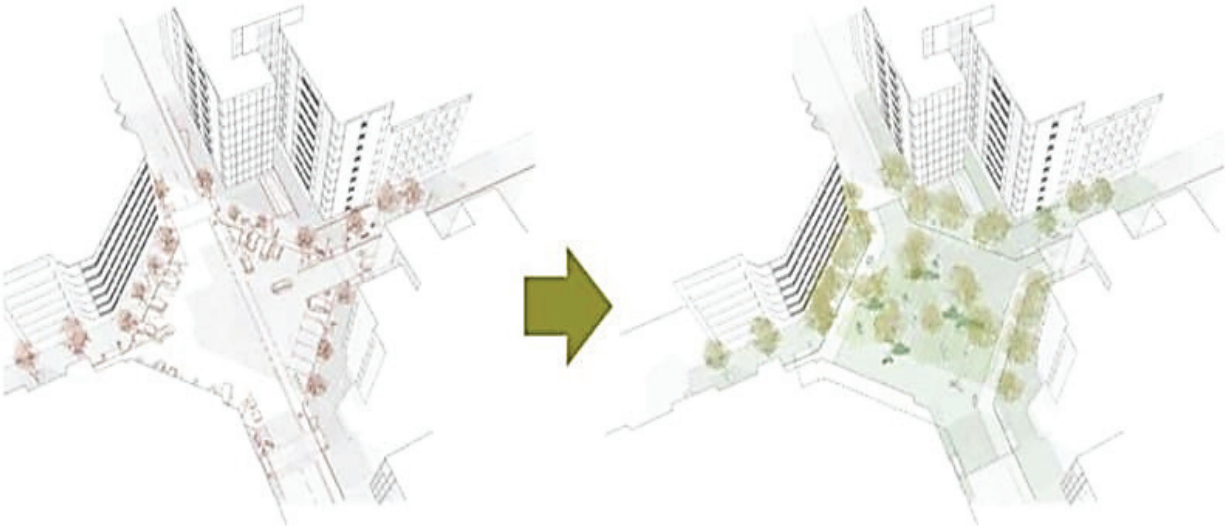
We need to rethink cities around the four guiding principles that are *the key building blocks of hyperlocal neighbourhood. These are:*

1. *ECOLOGY* - for a green and sustainable city;

2. *PROXIMITY* - to live with reduced distance to other activities;

3. *SOLIDARITY* - to create links between people; and

Figure 3: How the Eixample district's intersections could be redesigned to create green plazas.



Source: Ajuntament de Barcelona (O'Sullivan, 2020)

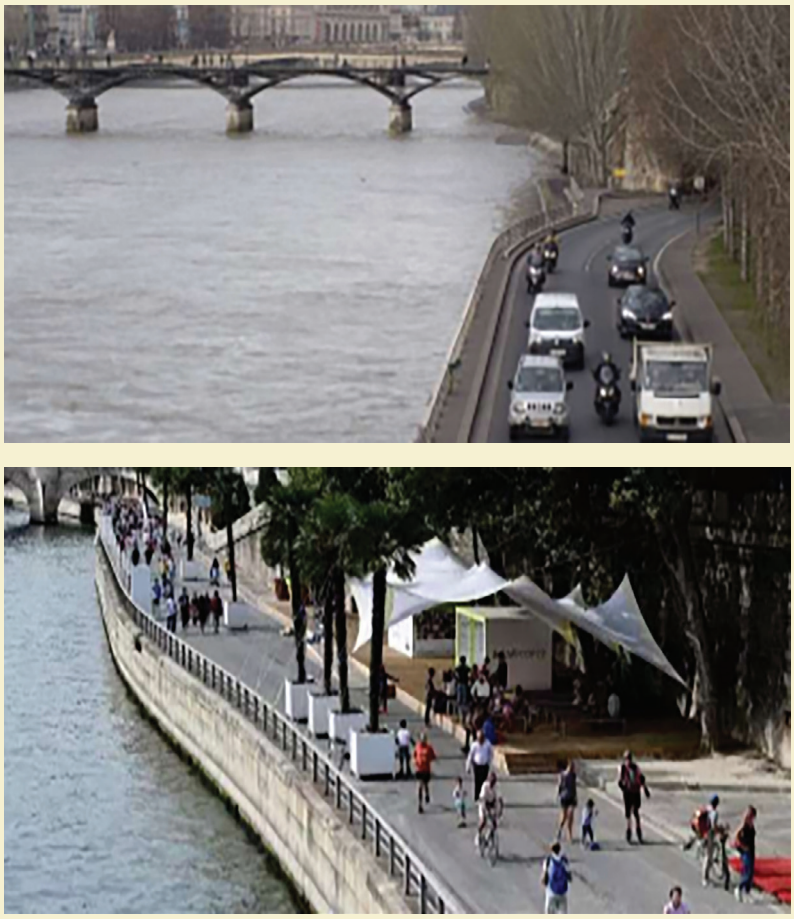
4. *PARTICIPATION* - should actively involve citizens in the transformation of their neighbourhood (Moreno, Ted: Ideas worth Spreading, 2020).

Urban life is vibrant and creative and cities are places of economic dynamism and innovation. But, the need to make urban life more pleasant, agile, healthy & flexible is always around. And, to do so, the need to make sure everyone- those living down-town and those living at the fringes – have access to all key services within proximity (Moreno, Ted: Ideas worth Spreading, 2020).

CONCLUSION

One-way journeys and peak hour simulation are integral part of the hyperlocal neighbourhood concept. The *car usage within neighbourhood blocks needs to be reduced a minimum of 70 to 75%.* It has been *theorized that human* under their own power have about a *30-minute mental limit* i.e., they are not going to walk more than 30 minutes unless they have to – that's about 1.7 kms, and bike ride for 30 minutes is around 7 kms. *This concept works great in cities with high density* like Paris (Figure 4), Milano, Barcelona, etc. and a minimum density must be 4800 persons per sq.km. For this concept to work for low density cities - a lot of work and redevelopment is required. The 3 key features include: (i)The rhythm of the city should follow humans, not cars; (ii) Each square meter should have many different purposes; and (iii) Neighbourhoods should be designed so that we can live, work & thrive in them without having to constantly commute elsewhere (Moreno, 15-Minute City, 2021).

Figure 4: Paris towards the 15 Minute City- Closure of the Seine River motorway



Source: Group, 2020

REFERENCES

Apolitical. (2020, October 26). The '15 Minute City': Fantasy or Reality? *Apolitical*, p. 1.

Bührmann, S. (2010). *Guidelines for implementers of Neighborhood Accessibility Planning.* Burgos: rupprecht-consult.

Coles, M. (2011). *Land use change brownfield vs greenfield.* Kent, UK: geogdebens. wordpress.

Denniss, R. (2018). *Social sustainability policy & action plan* . Sydney: The Australia Institute Sydney 2030.

Ergazakis, K. &. (2006, Jan 1). Knowledge cities: The answer to the needs of knowledge-based development. *Research Gate*, 67-84. Retrieved from Research Gate: https://www.researchgate.net/publication/235293486_Knowledge_cities_The_answer_to_the_needs_of_knowledge-based_development

Fiedler, M. (2010). *Good practice: Munich, Germany.* Munich: Rupprecht Consult.

Forum, I. T. (2019). *Benchmarking Accessibility in Cities.* ITF: OECD/ITF.

Foth, M. (2009). *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City.* Queensland University of Technology, Australia: IGI Global.

Group, C. C. (2020). *How to build back better with a 15-minute city.* Paris: c40knowledgehub.org.

Hou, L. (2016). *Facilities' distribution of 15-minute community life circle.* Shanghai: Shanghai Urban Planning and Land Resources Administration Bureau.

Jagannath, T. (2018). *Brownfield Development – Background, Setbacks and Examples.* Urbanisation: Planning Tank.

Mj6s. (2007, June 29). Palmanova aerea. Palmanova , Italy.

Moreno, C. (2020, October). Ted: Ideas worth Spreading. *Ted: Countdown* (p. 1). Paris: Ted talks. Retrieved from Ted.com.

Moreno, C. (2020, March 24). The 15-minute infrastructure trend that could change public transit as we know it. 1. (J. Reimer, Interviewer)

Moreno, C. (2021, Feb 23). 15-Minute City. (Plannogram, Interviewer)

Muir, W. 1. (n.d.). The city of Baghdad between 150 and 300 AH(767 and 912 AD). *File:Baghdad 150 to 300 AH.png*. muhammadanism. org, Baghdad.

Nielsen, O. (1884). *Kjøbenhavn paa Holbergs Tid*. Copenhagen: www.eremit.dk.

O'Sullivan, F. (2020). *Barcelona Will Supersize its Car-Free 'Superblocks'*. Barcelona: Bloomberg City Lab.

Pan, R. (2020). *Brownfield Redevelopment of Urban Areas for Optimal Family Living*. Sacramento: HMC Architects.

Pisano, C. (2020). *Strategies for Post-COVID Cities: An Insight to Paris En Commun and Milano 2020*. Florence: Department of Architecture, University of Florence.

Reid, C. (2020, January 21). Every Street In Paris To Be Cycle-Friendly By 2024, Promises Mayor. *Forbes*, p. 1.

Researcher. (2020). *Planning for accessibility based hyperlocal neighborhoods*. Delhi: SPA Delhi.

S.M., L. (2017). Urbanisation v/s Rurbanisation. *World wide Journals*, 1.

Subramanian, A. (2020). *how will covid-19 shape urban planning*. Delhi: ITDP.

TIMESOFINDIA.COM. (2020, July 16). Coronavirus recovery plan: What is '15-minute city' concept? *Times of India*, p. 1.

Tritt, N. (2020). *Bringing 15-Minute Neighborhoods to Seattle*. Seattle: Seattle Neighborhood Greenways.

WEBINAR ON "RBI REGULATORY FRAMEWORK FOR NBFC" & RELEASE OF SHELTER, APRIL 2021

Hudco's HSMI organized a Webinar on 'RBI Regulatory Framework for NBFCs-Implications for Hudco' on 18th August 2021. Mr. M. Nagaraj, Director Corporate Planning Hudco delivered the inaugural address and Mr. D. Guhan Director Finance Hudco delivered the concluding address. The guest speaker was Mr. Rajesh Mahajan, Ex-GM, Bank of Baroda. During the Webinar, April 2021 issue of ' Shelter, an ISSN Magazine published by Hudco's HSMI was also released by the DCP along with DF & Sr.ED- HSMI Dr. Subrahmanyam. The program was coordinated by Dr. Akshaya Sen.

ACCELERATING URBAN ACTION FOR A CARBON-FREE WORLD

October 4, 2021
World Habitat Day 2021
Accelerating urban action for a carbon-free world

"It has been estimated that GHG emissions from cities can be reduced by almost 90 per cent by 2050 using technically feasible, widely available mitigation measures. This means that city actions can potentially reduce global emissions by over 70 per cent."

The World Habitat Day 2021 Concept Note has been reproduced from the UN-HABITAT website https://urbanoctober.unhabitat.org/sites/default/files/2021-09/concept-note-whd.pdf

URBANIZATION AND CARBON EMISSIONS

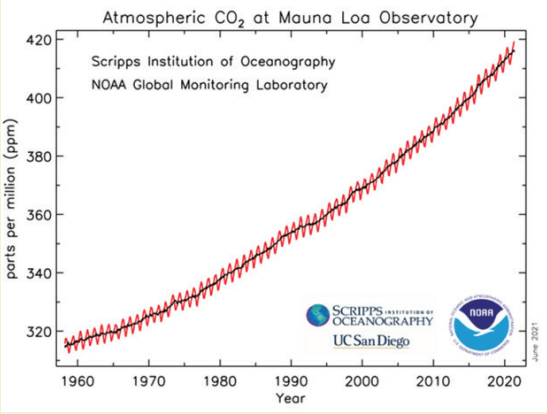
The global urban population has spiralled upwards since the mid-twentieth century. Between 1950 and today, the population of cities around the world has more than quadrupled with over 4.2 billion people now living in urban environments according to the World Bank. Over the same time, the concentration of atmospheric carbon dioxide, a key indicator of global warming, has risen by over a third (figure 1) almost entirely due to human activity. Today, **cities account for about 75 per cent of the world's energy consumption** and are responsible for over **70 per cent of global greenhouse gas emissions.** The way cities are planned, built and managed, is key to reducing carbon emissions and keeping global warming within the limits set by the 2015 Paris Agreement on Climate Change.

This is especially important as cities and towns are projected to add a further 2.5 billion people in the next 30 years according to UNDESA, raising the **proportion of people in urban areas** from 55 percent today, to nearly **70 percent in 2050**. Urbanization is taking place most rapidly in the less developed regions of the world (figure 2). Currently, three times as many urban dwellers live in the less developed regions than in the more developed regions, and **90 per cent of new urban residents will live in Africa and Asia.** Most cities in developing Africa and Asia are still to be built, and the World Economic Forum projects two-thirds of the investments in urban infrastructure in Africa needed by 2050 have yet to be made. There is a window of opportunity to shape these cities in a way that reduces overall energy consumption and greenhouse gas (GHG) emissions.

The increasing population growth and migration to cities, in many cases caused by climate stress, **create challenges in providing basic services to urban residents**, particularly the

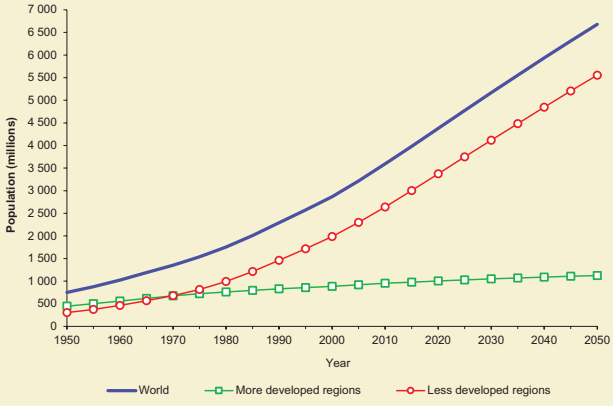
poor. Ensuring that growing cities are compact, and that expansion takes place in a planned manner to accommodate the growing number of residents helps reduce their carbon footprint. Compact cities also make the provision of basic services such as waste management, transport, energy and water and sanitation more resource-efficient and financially viable. UN-Habitat therefore promotes a strategy that combines compact city planning together with good governance and equitable provision of basic services. Avoiding urban sprawl also reduces stress on ecosystems, promoting **a balanced coexistence between human settlements and nature, and contributes to the prevention of zoonotic diseases such as COVID 19.**

Figure 1: Atmospheric CO2 concentrations measured at the Mauna Loa Atmospheric Baseline Observatory.



Source: NOAA

Figure 2: Estimated and projected global urban populations in more and less developed regions, 1950-2050.



Source: UNDESA

THE PARIS AGREEMENT, URBANIZATION AND THE NEW URBAN AGENDA

Adopted at COP-21 in 2015 and endorsed by 195 countries, the **Paris Agreement on Climate Change** sets the legally binding global aim of limiting global warming to well below 2, and preferably 1.5 degrees Celsius, compared to pre-industrial levels. These countries committed to action and strategies called **Nationally Determined Contributions (NDCs).** Since the start of the second five-year cycle of NDCs in 2020, 86 countries have submitted new or updated NDCs to the UNFCCC Secretariat.

NDCs vary by how enthusiastically countries embrace climate action in cities. A 2017 UN-Habitat review of the first NDC cycle found that **113 out of 164 NDCs showed strong or moderate urban content.** Most of these were framed in the context of adaptation to climate change, with **mitigation rarely featuring**. Surprisingly, some of the most urbanized countries have little explicit city-related content in their NDCs. It is encouraging, however, that NDCs from Asia and Africa contain the strongest urban elements.

According to recent estimates, the impact of current NDCs will result in a global temperature increase of 2.4 degrees Celsius by 2100.

Addressing a meeting of Mayors convened by C40 cities on 16 April 2021, the UN Secretary-General said:

"Cities are also on the frontlines of the climate crisis. More than half a billion urban residents already face rising sea levels and more frequent or severe storms. By mid-century more than 3.3 billion urban residents could be at risk from severe climate impacts. Cities also have an outsize carbon footprint. With just over half the global population, they emit more than 70% of global greenhouse gases. The COVID-19 pandemic is a global catastrophe. But investment in recovery is a generational opportunity to put climate action, clean energy and sustainable development at the heart of cities' strategies and policies. How we design power generation, transport and buildings in cities – how we design the cities themselves - will be decisive in getting on track to achieve the Paris Agreement and the Sustainable Development Goals. We need a revolution in urban planning and in urban mobility: including better fuel efficiency; zero emission vehicles; and shifts toward walking, cycling, public transport, and shorter commutes. Cities stand to gain most from phasing out coal: clean air; green outdoor spaces; healthier people."

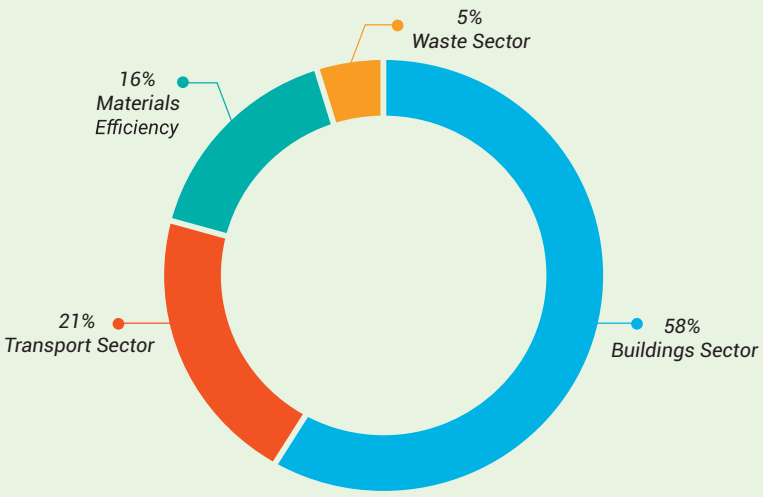
UN Secretary-General António Guterres, at the Meeting with leading mayors supported by C40 Cities, 16 April 2021.

This is an improvement from previous estimates but will still miss the Paris Agreement targets and result in potentially catastrophic impacts on human settlements and ecosystems.

This scenario led to a global campaign to rally diverse urban actors including companies, cities, regions and financial institutions being launched on World Environment Day 2020 to "take rigorous and immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero carbon world in time: the 'Race to Zero' campaign". This global campaign, which reinforces the objectives of the Climate Ambition Alliance launched at the UN Secretary-General's Climate Action Summit in September 2019, rallies 120 countries, 708 cities, 24 regions, 2,360 businesses, 163 large investors, and 624 Higher Education Institutions in the largest ever alliance committed to achieving net zero carbon emissions by 2050 at the latest - representing almost a quarter of global carbon dioxide emissions and over half of the world's GDP. Rapid advances in technologies and the falling cost of renewable sources of energy have resulted in a shift to renewables as a source of energy. It is estimated that two-thirds of the global population live in countries where renewable sources are more competitive than energy generated from conventional fuels. Such gains on the supply side must be matched by action on the demand side to reduce overall energy consumption and to meet the Paris Agreement goals. Cities, the main centre of energy demand, must lead the Race to Zero.

It has been estimated that GHG emissions from cities can be reduced by almost 90 per cent by 2050 using technically feasible, widely available mitigation measures (figure 3). This means that city actions can potentially reduce global emissions by over 70 per cent. This potential reduction can be achieved through a combination of measures that target the urban form in expanding cities as well as the buildings, transport, material efficiency and waste management sectors. Urban planning can steer urban growth towards low carbon

Figure 3: Sectoral breakdown of technically feasible and available mitigation measures to achieve a 90% greenhouse gas emission reduction.



Source: UN-Habitat

urban development through advancing climate-friendly urban forms (compact, mixed land-use and connected and accessible cities) geared towards reducing vehicular trips and instead, encouraging the use of non-motorized transport such as walking and cycling.

Public and green areas play a key role as carbon sinks, in regulating temperature and reducing urban heat-island effects. Simultaneously, measures can be taken to improve access to basic services while reducing their carbon footprint. These could include better water demand management, waste-water treatment through nature based solutions, better municipal waste management and material recovery, uptake of micro-grids, renewable energy and net-metering, retrofitting buildings to improve their energy efficiency, promoting a transition to shared and public transport and the uptake of electric mobility.

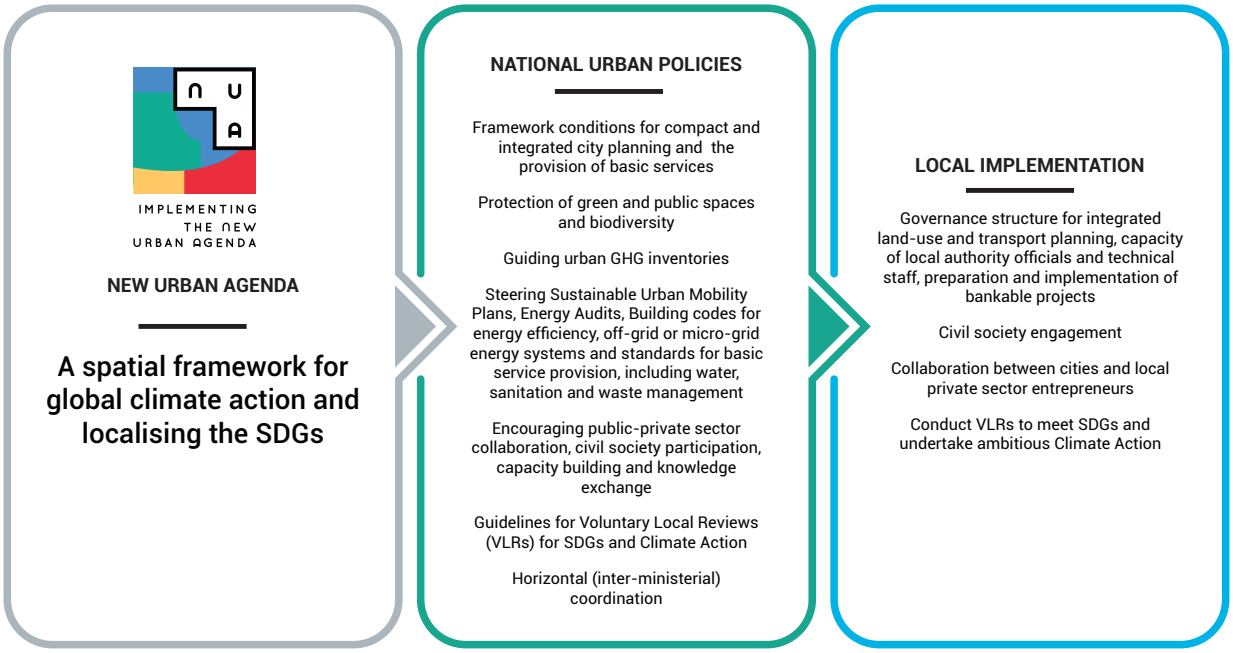
Investors and businesses are playing a central role in the transition to a green economy. Investments focused on environment, social and governance factors have surged recently. Cities in collaboration with national governments can attract investments, for example, for smart energy grids and buildings through enabling policies and incentives and by show-casing innovative projects as seen in the **SOLUTIONSplus** project bringing cities and entrepreneurs together to develop electric mobility.

The **New Urban Agenda**, the shared vision for a better and more sustainable urban future adopted at the UN's Habitat III conference in Quito, Ecuador, in October 2016, provides an enabling framework for implementing these measures.

Speaking on the topic of "From rapid urbanisation to the Green Shift" during the "European Development Days", on 15 June 2021, UN-Habitat Executive Director, Maimunah Mohd. Sharif said:

"Urban transition can be an opportunity to change the way cities are organized, to leapfrog to more sustainable infrastructure, and deliver on the green transition. 70 per cent of all the infrastructure in 2030 is yet to be built. Decision-makers need to realise that they have the power to either support resilience, equality, and low-carbon development by the decisions they make today. Their indecision or lack of conviction will deprive future generations of a better future. It is really that simple "

Figure 4: Framework for localising SDGs



It sets out how cities and human settlements should be planned, designed, governed and managed. Policy, legal and governance frameworks have an important role to play in increasing cities' resilience and in helping cities reducing their GHG emissions. They define urban forms, determine where land, infrastructure and basic services can be built, lay out the rules for planning and decision-making, and set the context within which urban authorities, local governments and communities are expected to fulfil their mandate and react to emerging challenges.

The New Urban Agenda comprehensively addresses these aspects and lays out a broad, multilevel, and cross-sectoral framework with a spatial focus that can accelerate global climate action and provide the means to localise the SDGs (figure 4).

COVID-19 AND BUILDING BACK GREENER

While devastating in its impact, the COVID-19 pandemic has highlighted some important lessons to address the climate crisis. For example, the increase in remote working should ease traffic congestion in the long term and reduce the perceived need for ever-increasing road construction to meet the demand for car-based travel. At the same time facilities for walking and cycling must be improved and urban transport should become more low-carbon and inclusive. Access to reliable and clean energy is essential for a range of activities ranging from remote working, household lighting and cooking and maintenance of cold chains for the delivery of medicines and vaccines. The crisis has also highlighted the need to improve basic services such as water supply, sanitation, and waste management particularly for the poor who live informal settlements and bear a disproportionate burden of the risk from such infectious diseases.

The fiscal stimulus programmes now being rolled out in many countries are also emerging as trial runs

for carbon-neutrality and a better ecological future for cities. How countries arrive at their climate strategy will vary, but these investments provide a basis for countries, cities and communities to commit more effectively to renewable energy, sustainable production and consumption patterns, and better management of natural resources, food systems and waste.

- Response and relief funding should be targeted to improve basic services for the poor and for nature-based solutions and ecosystem services that integrate blue, green and grey infrastructure into regional open space and basic service networks, helping regions enhance their climate resilience and advance their socio-economic recovery.

- Some national governments have responded to the impacts of COVID-19 by channelling financial assistance through municipal governments and communities, providing much-needed funds while ensuring these are allocated to local needs and priorities. For example, in Canada, the government has amended the 'Investing in Canada Infrastructure Programme' to allow provinces and municipalities to access federal funding to undertake a range of local projects, such as upgrading schools and hospitals to investing in green spaces and cycling lanes, to **"support longer-term goals of sustainable, economically healthy, low-carbon, and inclusive communities".**

To be truly effective, these changes need to be accompanied by a broader shift in the way cities and neighbourhoods are planned and managed with investments in infrastructure leading to energy savings, a reduction in greenhouse gas emissions and increased low-carbon mobility planning to promote a green transition as outlined in UN-Habitat's Report on **Cities and Pandemics: Towards a more just, green and healthy future.**

WORLD HABITAT DAY 2021

Mandated by the General Assembly in 1985, **World Habitat Day** is observed on the first Monday of every October, followed by events held worldwide throughout **'Urban October'**. Its purpose is to reflect on the state of our towns and cities, to recall the right of all to adequate shelter, basic services and social and economic opportunities, and to remember that we all have the power and the responsibility to shape the future of our cities and towns, and to promote sustainable urban development policies.

The theme of World Habitat Day 2021 is **Accelerating urban action for a carbon-free world** which is particularly relevant in light of the upcoming COP-26, scheduled to take place in Glasgow, UK, from 1-12 November 2021. In line with the World Habitat Day theme, UN-Habitat is calling for cities to accelerate urban climate action and in particular:

- In the run-up to COP-26, invites cities to join the Global "Race to Zero" Campaign, as well as UN-Habitat's **#ClimateAction4Cities Campaign** and to share their solutions.

- Offers technical assistance and capacity building support to cities in planning and implementing climate-targeted actions including planning for more compact and walkable cities, support in enhancing national building codes, sustainable building and construction practices, improving public and non-motorised transport, introducing electric

mobility, promoting clean energy generation in cities and improving waste management and provision of water and sanitation.

- Offers support to develop basic services/ infrastructure projects and social housing to attract multilateral and other financing – including climate investment to build back better and greener with a "just and green recovery".
- Offers support in conducting **Voluntary Local Reviews** to assess progress against both the Sustainable Development Goals and the Paris Agreement goals and present findings in forums such as the High Level review of the New Urban Agenda, planned for early 2022.
- Facilitates the exchange of lessons learnt and best practices among cities.
- To join UN-Habitat's **Waste Wise Cities programme** which aims at 'A Thousand and One Waste Wise Cities' by the World Urban Forum 2022 in Katowice, Poland.

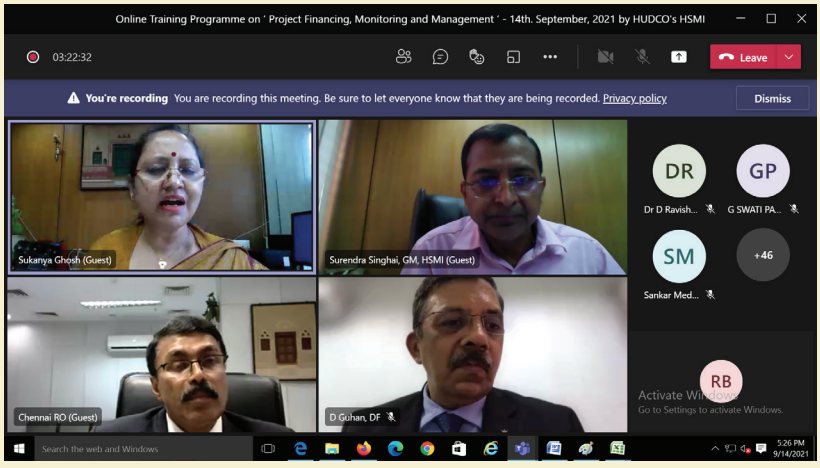
"With our attention focused on responding and recovering from the COVID-19 crises, let us ensure that every action we take today, every investment and support we mobilise, stimulates more sustainable, low-carbon and resilient development pathways that leave no one and no place behind."

UN-Habitat Executive Director
Maimunah Mohd Sharif

Enhancing Nationally Determined Contributions through Urban Climate Action

ONLINE TRAINING PROGRAMME ON PROJECT FINANCING, MONITORING AND MANAGEMENT

HUDCO's HSMI conducted this program on 14th September, 2021 as a part of its training and capacity building efforts to infuse professionalism and to strengthen capacities of HUDCO's own officials with the objective of sensitizing participants regarding various issues on HUDCO Project Financing, Monitoring and Management. A total of 56 participants from Project, Finance and Law Disciplines from various Regional Offices of HUDCO including Corporate Office participated in the programme. Various issues of HUDCO financing including marketing at field level, business generation, formulation of viable schemes, appraisal, documentation and monitoring, loan servicing, default resolution and NPA management were covered under the programme. The training was imparted by HUDCO's internal resource persons who are experts in each domain. Director Corporate Planning, HUDCO Shri M. Nagaraj and Shri D. Guhan graced the valedictory session. The training coordinator was Dr. Sukanya Ghosh, Senior Fellow HSMI.



ECONOMICS OF HOUSING & PMAY-HFA (URBAN)

- Impacts of Housing Investment on Employment, Income & GDP

DR. AKSHAYA KUMAR SEN

"The impact of PMAY-HfA(urban) on the provision of affordable housing has been well documented. It has not only provided roof over the head of those who needed it, but also provided gainful employment and income to vast majority of workforce, particularly those in the informal sector."

Key Words: *Multiplier, PMAY, Employment, Income, GDP*

Dr. Akshaya Kumar Sen (aksen@hudco.org) is Joint General Manager(Economics) & Fellow at HUDCO's HSMI, New Delhi.

The role of housing as a growth accelerator has been well established with its strong inter-industry linkages that create greater employment opportunities, generate more income and help in macroeconomic stability. This paper attempts to analyze and estimate the impact of housing investment under the Government of India's flagship Mission of 'Pradhan Mantri Awas Yojana-Housing for All -Urban' (PMAY-HfA-U) on employment, income and Gross Domestic Product (GDP) of the country.

INTRODUCTION

There is a growing and large body of evidence on the economic role of housing in not only helping people meet their housing aspirations but also in helping deliver macroeconomic stability and more flexible labour markets. The housing sector has been a catalyst for sustainable urbanisation as well as national economic growth and is seen as a core sector in the economy having strong 'backward' and 'forward' linkages with other industries in the economy. In India, it is estimated that construction sector has inter-industry linkages with 250 ancillary industries with strong multiplier effects on generation of income and employment in Indian economy. As explained by John F.C. Turner (1972), it is the use of 'housing as a Verb' which means housing as a 'process' or 'activity of housing' that is responsible for creating the chain of activities through the backward and forward linkages with other industries in the economy, thereby creating more employment and income opportunities. Housing, therefore, matters in macro-economic terms, having strong income, employment and output multipliers.

IMPACT OF CONSTRUCTION SECTOR INVESTMENT

As per an estimate (Dholakia

& Dholakia, IIM-A 2000), investment in construction has a Type-I employment multiplier (showing the extent of direct and indirect employment generation in the economy as a whole due to an additional unit of investment in construction sector) of 2.02 which indicates that an additional unit of final expenditure in construction sector results in employment generation by an extent which is twice the direct employment generated in the construction sector itself (Table-1). The Type-II employment multiplier for construction (showing the extent of direct, indirect and induced employment generation in the economy as a whole due to an additional unit of investment in construction sector), which includes the effects of induced changes in the final demand for other sectors on the total employment generation, is 7.76. This indicates that an additional unit of final expenditure in construction sector induces overall employment generation in the economy as a whole by an extent which is almost eight times the direct employment generated in the construction sector itself, through the direct, indirect and induced effects.

Table-1: Multipliers of Investment in Construction Sector

Multiplier	Type-I	Type-II
Employment Multiplier	2.02	7.76
Income Multiplier	1.95	4.71

Source: Dholakia & Dholakia, IIM Ahmedabad Study, July 2000

Further, the construction sector has Type- I (direct & indirect effects on income level of a change in final demand in construction sector) & Type- II (direct, indirect as well as induced effects on income level of a change in final demand in construction sector) income multipliers of 1.95 and 4.71 respectively. The Type-II income multiplier indicates that a unit increase in the final expenditure on the construction sector would generate additional income in the economy as a whole which would be almost 5 times as high as the direct income generated within the construction sector itself.

The role of construction sector in the growth of Indian economy can also be seen from the recent growth in Gross Domestic Product figures in the pandemic ravaged years. As per the CSO estimates, the GDP growth in first quarter (Q_1) of FY 2021-22 was 20.1% compared to the (-)24.4% in first quarter of FY 2020-21. One of the key reasons for this revival in GDP in Q_1 of 2021-22 is the substantial growth in the construction sector during the same period, i.e. from being (-)49.5% in Q_1 of FY2020-21 to 68.3% in Q_1 of 2021-22.Therefore, it is evident that any investment in construction sector including the housing sector has the potential to give a big push to the economy through its strong multiplier effects.

IMPACT OF HOUSING (RESIDENTIAL CONSTRUCTION) SECTOR INVESTMENT

Investment in housing and real estate activities can be considered a barometer of growth of the entire economy. Housing is an important employment generator, particularly for the unskilled and semi-skilled people, including the urban poor and women. As per a Study (NCAER 2014), for every lakh rupees invested in the housing sector, 2.69 new jobs (2.65 informal and 0.4 formal) are created in the economy (direct and indirect effect of housing investment with Type-I employment coefficient of 2.69). With induced effect (Type II employment coefficient), the

number of jobs created would be 4.06 (3.95 informal and 0.11 formal) in the economy (Table-2), out of which over 97 per cent are jobs in the informal sector. The role of housing for creation of jobs for the informal sector is very important considering the fact that the informal sector is the backbone of India's economy. The type-I output multiplier for housing sector is 2.33 and type-II is 5.11, which means that an increase of 1 unit in the final demand of housing translates into induced cumulative revenues of 5.11 units in the economy. The type-I income multiplier for housing sector is 1.54 and type-II is 2.84. This would mean that a unit of increase in the final expenditure in the housing sector would generate additional income as high as 3 times the income generated within the housing sector itself.

Table-2: Multipliers of Investment in Housing Sector

Multiplier	Type-I (Direct & Indirect effects)	Type-II (Direct, Indirect & Induced effects)
Employment Multiplier	1.15	1.73
Income Multiplier	1.54	2.84
Output Multiplier	2.33	5.11
Employment Coefficient	2.69	4.05

Source: NCAER Study, 2014

The NCAER, 2014 Study further estimates that every additional rupee invested in the housing sector is expected to add Rs. 1.54 to the GDP and with household expenditure considered, this is going to add Rs. 2.84. Further, for every rupee invested in creation of housing, Rs. 0.12 gets collected as indirect taxes. The Study also established that for every investment in the housing sector/ every unit of housing created, the household income increases by Rs. 0.41. With induced effect, this is estimated to be Rs. 0.76.Housing construction also helps in supplementing agricultural income of the seasonal migrant labour.

All these figures show the significance and relevance of putting housing at the centre of urban agenda at national, state and local level for stimulating the economy, reducing poverty and promoting inclusion at all levels.In this context, the role of Govt. of India's flagship mission of 'Pradhan Mantri Awas Yojana-Housing for All -Urban' (PMAY-HfA-U) assumes much more significance in not only ameliorating the urban housing shortage in the country but also acting as an engine of economic growth through the provision of more employment, income and livelihood support.

AFFORDABLE HOUSING OPTIONS UNDER PMAY- HFA (U)

Provision of affordable housing has always remained a priority area of the government of India. In fact, since our Independence, recognizing the crucial role of housing development for planned and holistic development of the country, a large number of housing schemes are being operated for all segments of the society, with particular focus on adequate and affordable housing for weaker sections and lower income groups of the society.

In an effort to address the challenges of urban housing shortage through a set of policies and incentives so as to bridge the gap between price and affordability, the Government of India launched its flagship program 'Pradhan Mantri Awas

Yojana (PMAY)-Housing for All (Urban) on 25th June 2015 with four economically viable affordable housing models targeted for the economically weaker sections (EWS) including the slum dwellers, the lower income groups (LIG) and the middle income groups (MIG) to ensure a pucca house having basic amenities like toilet, water supply, electricity and kitchento all eligible urban households by the year 2022, when India completes 75 years of its Independence. A house under PMAY-HfA(U) ensures dignified living along with sense of security and pride of ownership to the beneficiaries.

The PMAY-HfA(U) adopts a cafeteria approach to suit the needs of individuals based on the geographical conditions, topography, economic conditions, availability of land, infrastructure, etc. (MoHUA, 2021). The four housing verticals under the Mission include: (i) 'In-situ Slum Redevelopment (ISSR), in which central assistance of Rs. 1 lakh per house is admissible for all houses built for eligible slum dwellers using 'land as Resource' with participation of private developers; (ii) Credit Linked Subsidy Scheme (CLSS), in which beneficiaries of Economically Weaker Section (EWS)/Low Income Group (LIG), Middle Income Group (MIG)-I and Middle Income Group (MIG)-II seeking housing loans from Banks, Housing Finance Companies and other Prime Lending Institutions (PLIs) for acquiring, new construction or enhancement of houses are given interest subsidy of 6.5%, 4% and 3% on loan amount up to Rs. 6 lakh, Rs. 9 lakh and Rs. 12 lakh respectively; (iii) Affordable Housing in Partnership (AHP) under which central assistance of Rs. 1.5 lakh per EWS house is provided by the Government of India; and (iv) Beneficiary-led Individual House Construction/ Enhancement (BLC), where central assistance up to Rs. 1.5 lakh per EWS house is provided to eligible families belonging to EWS categories for individual house construction/ enhancement.

A Technology Sub-mission (TSM) under the Mission has been set up to facilitate adoption of modern, innovative and green technologies and building material for faster and quality construction of houses. Technology Sub-Mission will also facilitate preparation and adoption of layout designs and building plans suitable for various geo-climatic zones.

In order to address the shelter needs of the migrants and urban poor in the country, the Govt. of India has launched the 'Affordable Rental Housing Complexes (ARHCs) Scheme, as a sub-scheme under Pradhan Mantri Awas Yojana - Urban (PMAY-U). The ARHC scheme will be implemented through two models: (i) Utilizing existing Government funded vacant houses to convert into ARHCs through Public Private Partnership or by Public Agencies; and (ii) Construction, Operation and Maintenance of ARHCs by Public/ Private Entities on their own vacant land.This will provide ease of living to urban migrants/ poor in Industrial Sector as well as in non-formal urban economy to get access to dignified affordable rental housing close to their workplace.

IMPACT OF PMAY-HFA(U) ON EMPLOYMENT, INCOME AND GDP

An attempt is made in this section to estimate the impact of investments made under PMAY-HfA (Urban) on employment generation, addition to household incomes and country's Gross Domestic Product (GDP) using the methodologies developed by two research and policy think-tank Institutions of the country, i.e. National Institute of Public Finance & Policy (NIPFP) and National Council of Applied Economic Research (NCAER). Till date, the PMAY-HfA

(Urban) has enabled sanction of 113.06 lakh houses with the total approved investment of Rs. 7.39 lakh crore (Table-3) consisting of central assistance of Rs. 1.82 lakh crore, state assistance of Rs.1.41 lakh crore and beneficiary share of Rs. 4.16 lakh crore. Out of the sanctioned houses, 86.4 lakh units have already been grounded with the total investment of Rs. 2.79 lakh crore.

The impact of PMAY-HfA(urban) on the provision of affordable housing has been well documented. It has not only provided roof over the head of those who needed it, but also provided gainful employment and income to vast majority of workforce, particularly those in the informal sector. In addition, through the strong multiplier effects, it has contributed considerably for the growth of the national economy.

Table-3: Progress of PMAY-HfA(Urban) (as on 6th September, 2021)

Houses Sanctioned (Nos. in lakh)	113.06
Houses Grounded (Nos. in lakh)	86.41
Houses Completed (Nos. in lakh)	50.21
Total Investment (Rs. in lakh crore)	7.39
Central Assistance (Rs. in lakh crore)	1.82
State Assistance (Rs. in lakh crore)	1.41
Beneficiary Contribution(Rs. in lakh crore)	4.16

Source: MoHUA, PMAY- Dash Board, accessed on 16 September, 2021

Estimation using NIPFP Methodology

Using the PMAY-HfA (Urban) data as on 31st January, 2019 as well as data from Detailed Project Reports (DPRs), NSSO 68th roundand other sources, the National Institute of Public Finance and Policy (NIPFP, 2019) had estimated that 34.12 lakh houses which were grounded up to 31st January 2019 with the estimated investment of Rs. 1.11 lakh crore including governments' contribution as well as contribution by the beneficiaries, and bank loans would have generated total employment of 172.17 crore person days of which direct employment is 52.97 crore person days and indirect employment is 119.20 crore person days. In terms of number of jobs, the program would have generated about 61.49 lakh jobs under all four verticals consisting of 18.92

Table 4: Impact of PMAY-HfA (U) Investments up to 31st January 2019 on Employment

Verticals	Houses Grounded (No. Lakh)	Employment Person Days (No. Crore)			Jobs (No. Lakh)		
		Direct	Indirect	Total	Direct	Indirect	Total
BLC & CLSS (Individuals)	20.06	26.17	40.06	66.24	9.35	14.31	23.06
AHP, ISSR & CLSS (Apartments)	14.56	26.80	79.14	105.94	9.57	28.26	37.83
PMAY Total	34.62	52.97	119.20	172.17	18.92	42.57	61.49

Source: NIPFP, 2019

Lakh jobs through effects and 42.57 lakh jobs through indirect effects (Table 4).

Using the NIPFP methodology and extrapolating for the PMAY latest data of 86.41 lakh houses which were grounded upto 6th September 2021 with the estimated cost of Rs. 2.79 lakh crore, it can roughly be estimated that around 2.50 crore jobs would have been created in the economy as a whole, as a result of the inter-industry linkage of housing industry with about 130 other industries belonging to 21 broad sectors of the Indian economy.

Estimation using NCAER Methodology

The employment figure arrived at using the NIPFP methodology shows the huge impact of housing investment under PMAY for creation of employment opportunities in the urban areas. However, by using the methodology of NCAER (2014) for residential construction (housing) sector, one can get much bigger impact of housing investments under PMAY on employment creation, especially for the unskilled informal sector workforce. In addition, NCAER methodology also enables to estimate the impact of housing investment on household income and Gross Domestic Product (GDP) of the country. Table-5 depicts the estimated impact of housing investment under PMAY-HfA(Urban) on employment, household income and GDP.

Table 5: Impact of PMAY Investments

Impact	Houses Grounded (No. lakh)	Total Investment (Rs. lakh cr.)	Employment (No. cr.)	Addition to Household Income (Rs. lakh cr.)	Addition to GDP (Rs. lakh cr.)
Type-I	86.41	2.79	6.53	1.14	4.30
Type-II			11.3	2.12	7.93
Type-I	113.06	7.39	17.29	3.03	17.22
Type-II			29.93	5.62	37.76

Source: Own Estimates using multipliers of NCAER Study, 2014

As can be seen from Table-5, 86.41 lakh houses were grounded up to 6th September 2021 with the estimated cost of Rs. 2.79 lakh crore. Using the Type-I (direct & indirect effects) employment co-efficient of 2.69 derived by NCAER Study, it is estimated that the investment of Rs. 2.79 lakh crore would have generated direct employment of 7.51 crore in the housing sector. Adding the induced effects of housing investment because of its inter-industry linkages through the Type-II employment coefficient, the total employment of 11.3 crore would have been created in the economy.Of this, around 11 crore jobs would have been for informal sector, as it constitutes 97% of the total jobs created. Further, when the entire sanctioned housing units of 113.06 crore are grounded, total employment of 29.93 crore would be generated in the economy, including 17.29 crore direct & indirect employment in the housing industry itself, vast majority of which would belong to the informal sector employment.

The NCAER Study also estimates that for every investment in the housing

sector, the household income increases by Rs. 0.41 through direct and indirect effects; and with induced effect, this is estimated to be Rs. 0.76. Therefore, for an investment of Rs. 2.79 lakh crore for 86.41 lakh houses grounded so far under PMAY(U), additional total income generated for households would have been to the tune of Rs. 2.12 lakh crore, including Rs. 1.14 lakh crore due to direct & indirect effects. Further, for 113.06 lakh houses involving Rs.7.39 lakh crore, total additional income to be accrued to all the households would be around Rs. 5.62 lakh crore.

As the NCAER Study estimates, for every additional rupee invested in the housing sector, Rs. 1.54 is added to the GDP and with household expenditure considered, this is going to add Rs. 2.84. Therefore, an investment of Rs. 2.79 lakh crore under PMAY(U) would have added Rs. 7.93 lakh crore to GDP of the country, including Rs. 4.30 lakh crore due to direct and indirect effects. Further, Rs.7.39 lakh crore investment under PMAY(U) would add Rs. 37.76 lakh crore to the GDP through direct, indirect and inducted effects of housing investment. All these estimated figures reaffirm the huge role of housing sector in not only improving the quality of living of the people but also in the nation building.

CONCLUSION

It has been established that increase in investment in the housing activities generates strong multiplier effects, triggering the development of other different inter-related industries and sectors. Therefore, priority investment in the housing and real estate sector is one of the key factors for not only increasing overall welfare of population and increasing business activities in various sectors but also improving overall economic growth of the nation. Theforegoing analysis clearly highlighted the significant role of housing sector in not only addressing the urban housing challenges but also providing employment, income and livelihood support, most importantly for the informal sector of the economy.The pace and performance of the PMAY Housing for All (Urban) Mission, the largest housing programme in the world in terms of its scale and impact,is certainly going to be a key factor in achieving India'sambitious goal of $ 5 trillion economy by 2025 as well as the Sustainable Development Goals (SDGs).

REFERENCES

Dholakia, Bakul H, & Dholakia, Ravindra H. (2000), Impact of Investment in Housing Sector on GDP and Employment in Indian Economy, Indian Institute of Management, Ahmedabad, Study sponsored by HUDCO, July, 2000.

MoHUA (2021), Pradhan Mantri Awas Yojana (Urban) - Housing for All, Operational Guidelines. Ministry of Housing and Urban Affairs (MoHUA), Government of India, New Delhi and PMAY Dash Board accessed on 16th September, 2021 at http://mohua.gov.in.

NCAER (2014), Impact of Investment in Housing Sector on GDP and Employment in the Indian Economy, National Council of Applied Economic Research (NCAER), New Delhi, Study supported by DFID and Ministry of Housing and Urban Poverty Alleviation, April, 2014.

NIPFP(2019), A Report on Assessing Employment Generation under Pradhan Mantri Awas Yojana (Urban), National Institute of Public Finance and Policy, New Delhi, February 2019

Turner, John F.C (1972), Housing as a Verb, in 'Freedom to Build, dweller control of the housing process', John F.C Turner & Robert Fichter (eds.), Collier Macmillan, New York, 1972.

GENDER INCLUSIVE SANITATION IN INDIA

A LEGAL PERSPECTIVE TO URBAN PLANNING

MS. AAKRITI SINGHAI
ADV. KRATI SINGHAI

"The essence and substance of women's right to sanitation in India, goes beyond the construction of toilets and the creation of an 'open defecation-free Bharat'. The main takeaway has been the value of strong governance and participatory mechanism. Women-inclusive programme preparation, gender-disaggregated data collection and field research are all things that the sector needs to work on. Legal and policy interventions could go a long way in building equitable cities."

Key-words: *Sustainable Development; Gender Equality; Inclusive cities; Sanitation; Public Policy; Legal framework, SDG6, open defecation free*

Ms. Aakriti Singhai (aakriti.123000@gmail.com) is Masters in Planning (Housing), SPA, New Delhi and Adv. Krati Singhai Masters in Law (LL.M.), National Law Institute University NLIU, Bhopal

The United Nations' 17 Sustainable Development Goals (SDGs), which were proposed after comprehensive discussions with stakeholders around the world, set targets for countries to achieve by 2030. Gender Equality has been considered as a very important development Agenda in the SDGs. Equality and non-discrimination also form the foundation of Articles 14 and 15 of the Constitution of India and are well recognized fundamental rights.

In India, sanitation interventions have largely ignored the gender aspects of sanitation and hygiene. As a result, women's sanitation and hygiene requirements, as well as their vulnerabilities, have received insufficient consideration. While the legal and policy structure for sanitation addresses some of the women's issues, implementation at the local level has almost entirely ignored them, raising serious concerns about gender equality. This article examines the current legal and policy system in India relating to sanitation from a gender perspective. Equal access to sanitation is a gateway service for ensuring human dignity, human health, and gender equality. Health and dignity outcomes are ultimately intertwined, and indicators should be used to measure and assess both under a human rights framework. This article uses a gender lens to examine the existing legal and policy framework for sanitation in India and highlights that sanitation in publicly shared spaces—in slums and schools and streets—must be pulled out of its current neglect in public policy circles to become a cornerstone of sustainable development and inclusive planning. This research focuses on SDG 5's gender equality agenda and how it intersects with SDG 6, which will improve the SDGs' "social" pillar by improving access to water and sanitation, which is a key enabler for achieving gender equality in urban areas. By illustrating the case of gender, this paper also emphasises the importance of a coordinated approach to SDG implementation.

This article is an attempt to define the essence and substance of women's right to sanitation in India, which goes beyond the construction of toilets and the creation of an "open defecation-free Bharat." The main takeaway

has been the value of strong governance and participatory mechanism. Women-inclusive programme preparation, gender-disaggregated data collection and field research are all things that the sector needs to work on. Legal and policy interventions could go a long way in building equitable cities.

INTRODUCTION

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end hunger, protect the environment, and ensure that all people live in peace and security by 2030. The 17 SDGs are interconnected, in the sense that the UN recognise that actions taken in one area have an impact on outcomes in others and that development must strike a balance between social, economic, and environmental sustainability. The SDGs aim to achieve several life-changing 'zeros,' such as poverty, hunger, AIDS, and discrimination against women and girls.

The SDGs highlight the importance of gender-inclusive development and ensuring equality in spheres of economic, legislative and social framework. To ensure that future generations inherit a better world, governments, the private sector, civil society, and citizens must work together to achieve the SDGs. Gender equality has been pitched as a key driver for the economic growth of a country. Hence, the countries should strive towards seriously considering it as a developmental agenda.

Fig 1: SDG 5 and 6

SOURCE: un.org - sustainable development

Likewise, the Human Rights Committee affirms that governments "should ensure that traditional, historical, religious or cultural attitudes are not used to justify violations of women's right to equality before the law and equal enjoyment of all Covenant rights."

Articles 12 and 14 of the Convention on the Elimination of all forms of Discrimination Against Women (CEDAW) mandate states to take effective steps to eradicate discrimination against women in the field of healthcare and to ensure that men and women have equal access to healthcare facilities.

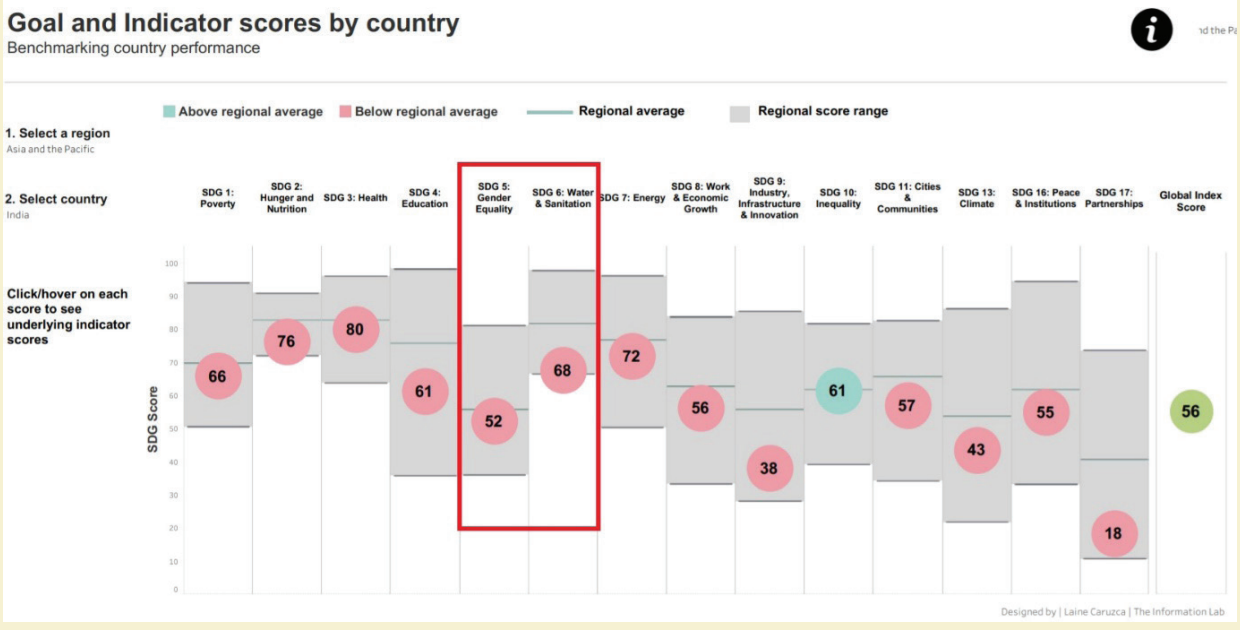
The Right to Health in India is derived from the Directive Principles of State Policy and it is also an established fundamental right under Article 21 of the Constitution, which guaranteed the right to life and dignity. The positive obligation of the State to provide healthcare facilities is established by various decisions of the Supreme Court.

However, despite all these recognitions, little importance has been given to sanitation from a woman's perspective. India's SDG Scorecard has been below average as compared to other Asia Pacific countries. Even after 73 years of Independence, many women in different parts of India do not have access to basic sanitation facilities, which puts their health, safety and privacy at risk. As part of its life cycle, half of the global population menstruates. Insufficient menstrual hygiene presents a barrier to the dignity and health of women and hence amounts to discrimination based on gender.

SANITATION RELATED NEEDS AND VULNERABILITIES OF WOMEN

The lack of sanitation facilities presents many problems for women, as women have a greater need for privacy than men for sociocultural reasons.

Fig 2: India Score – SDGs: Below Regional Average



Source: https://data.em2030.org/countries/india/

Some of them are listed below–

- **Open Defecation**: Women, especially young women, avoid going out during daylight hours and use coping strategies such as limiting their food and liquid intake during the day. These activities can lead to health issues including urinary tract infections, chronic constipation, and other gastric disorders, as well as safety concerns associated with going to the toilet in the dark.
- **Absence of Clean and Safe Toilets:** The absence of clean and efficient toilets at schools, workplaces and public spaces has gender implications where women and girls have to suffer due to unhygienic infrastructure.
- **Menstrual Hygiene Management**: Women and girls are subjected to many restrictions as a result of the societal stigma surrounding menstruation. Restrictions apply to both the household and societal levels. The lack of sanitation and hygiene facilities at home, in educational institutions, in workplaces, and public spaces amplifies the difficulties of handling the menstrual cycle. Lack of accessibility to proper and safe menstrual absorbents is another issue.
- **Gender- based Violence**: It has been reported that incidents of violence against women, including sexual violence, can be due to a lack of sanitation facilities at or near the home.

ACCESS TO SANITATION IN INDIA

A number of laws and policies have been enforced by the central government and state governments to address sanitation issues in India. Despite greater focus

Fig. 3: State of Sanitation Facilities in Slums: Temporary and open bathing areas

Source: Author, Slum surveys in Bhopal and Delhi

and budget allocations, the country's abysmal sanitation situation persists. As per the National Family Health Survey 4 (2015-16), only 48% of Indian households have sanitation facility which is not shared while 9% use shared facilities. Moreover, 39% of households have no sanitation facility and the members engage in open defecation.

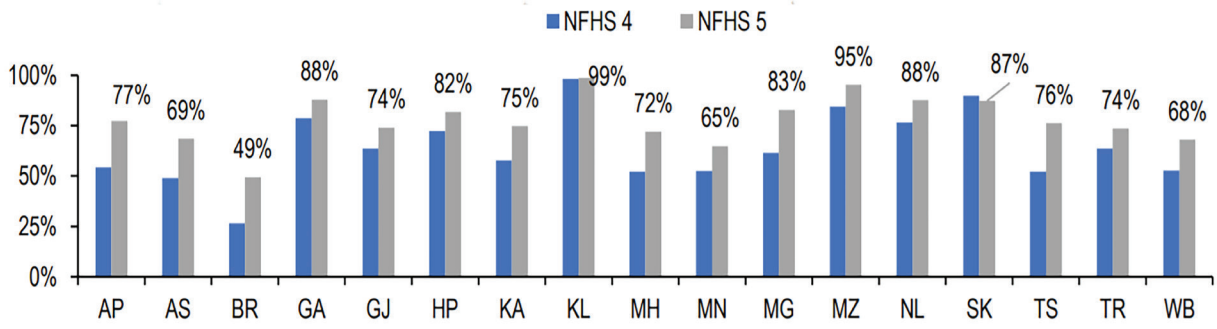
The following graph illustrates the comparison between NFHS 4 and 5. While the numbers improved in NFHS 5 (2019-20), it remains poor in many States. In Kerala, 99% of households have sanitation facility but the States like Bihar are still lagging with only 49%.

Women have specific sanitation and hygiene requirements, which are affected by social and cultural factors as well as biological factors. Women find it difficult to perform their everyday sanitation routine with dignity and safety due to the shortage of basic sanitation facilities such as toilets, as well as social and cultural taboo. They are prone to several risks such as reproductive tract infections, psychosocial stress and gender-based violence. According to a study published by the India sanitation portal, nearly 355 million women and girls in India menstruate every month, and on average, a woman needs 7,000 sanitary pads to handle her menstruation days before menopause. Just 12% of young girls and women have access to safe and hygienic menstrual absorbents.

Millions of women and girls are compelled to use unsanitary items such as old rags, husks, dry leaves and grass, ash, sand, or newspapers because they have no other alternative. Furthermore, in homes, schools, universities, and communal bathrooms, there are seldom systems in place for the proper disposal of sanitary napkins. Since they are non-biodegradable, improper disposal can result in an environmental hazard and there is a lack of awareness about the eco-friendly and sustainable alternatives to sanitary napkins.

In terms of school, hygiene becomes a big concern. Many studies suggest that young girls drop out of school once they hit puberty due to a lack of hygienic sanitation facilities and menstrual hygiene management. The right to sanitation affects the right to education. When girls are forced to drop out of school due to a shortage of proper sanitation facilities, it does not bode well for their right to dignity. The true realisation of human rights will remain impossible until adequate sanitation steps are taken and services are given to everyone.

Fig. 4: Proportion of households with sanitation facilities



Source 3: National Family Health Survey – 5 (2019-20), Ministry of Health and Family Welfare

LEGAL AND POLICY FRAMEWORK: GENDERED PERSPECTIVE TOWARDS SANITATION

Individuals' wellbeing and hygiene requirements are gendered due to variations in biological bodies as well as the conventions, perceptions, and taboos that affect them. Women have special sanitation and hygiene standards that are related to their menstrual cycle and reproductive system. Women are often compelled by social and cultural conventions to demand protection while performing their bodily functions. These needs are scarcely met, resulting in a slew of sanitation-related problems and vulnerabilities. If we are to realise the right to sanitation, we must make legislation and programming changes.

The aspects of gendered perspective to right to health and sanitation have been given due consideration in the Convention on Elimination of all forms of Discrimination Against Women (CEDAW), 1979 under its General Recommendations.

Furthermore, CEDAW General Recommendation No. 24, under point 6 states that the biological differences between men and women lead to differences in their health and sanitation requirements. Hence, the sanitation facilities for women deserve special attention.

Gender equality is a fundamental right guaranteed by the Indian Constitution. Articles 14 and 15 of the Constitution of India ban various types of discrimination, including discrimination based on gender. The idea of equality as envisioned in the Indian Constitution goes beyond formal equality and it is a constitutional goal to transform the Indian society into a place that is free from all forms of discrimination, oppression and violence based on caste, class and gender. The Indian Constitution under Article 15(4), recognises positive discrimination and empowers the government to make special arrangements for the upliftment and advancement of women to do equity to them and provide them equal opportunity in all spheres.

Personal hygiene, household sanitation, drinking water, waste collection, waste management systems, and so on are all included in the definition of the right to sanitation. In terms of human rights, sanitation refers to a method for storing, distributing, handling, disposing, or reusing human excreta, as well as related hygiene. Everyone has the right to safe sanitation facilities, socially and culturally appropriate, secure, hygienic, physically accessible, and affordable, as well as providing privacy and dignity. Right to sanitation being a constitutional right cast a duty upon the government to make policies and schemes to provide facilities to everyone.

The foremost attempt at securing the basics of sanitation was brought up in an interesting decision by the Supreme Court in *Environmental and Consumer Protect Fund v. Delhi Administration & Ors.*, where it ordered all government schools to ensure separate washrooms for girls were built to improve sanitation. Asserting the importance of the same, the Court made the following observation:

> *"Empirical researches indicated that wherever toilet facilities are not provided in schools, parents do not send their children (particularly girls) to school which is violative of the right to free and compulsory education of children as guaranteed under Article 21-A of the Constitution."*

As per this pronouncement, disobedience by government schools in providing toilets for female and male students will now translate into a violation of the Right to Life of the children and is subject to direct scrutiny by the Courts.

Many constitutional rights will only be realised if proper sanitation is secure. The Constitution of India protects rights to food, water, climate, and a safe and balanced atmosphere. The Supreme Court has repeatedly declared in its decisions that Article 21 of the Constitution guarantees the right to a clean and healthy climate. Provision for sanitation is also linked to the Right to Education. Article 21A of the Constitution provides the right to education. The learning area/school becomes a breeding ground for infections which creates many issues in school-aged children if it does not have a good hygienic environment. The lack of sanitation in school is one of the major discouraging factors for female students and parents, generally, refrain from sending their daughters to schools. Also, the Right to dignity is an important and integral facet of the right to life. The entire edifice of Human Rights is built and dependent upon it. Without the right to dignity, all other fundamental rights become meaningless.

A gendered perspective towards the right to sanitation has to be considered since men and women, and girls and boys, have very different sanitation needs, for biological and social reasons. Women have unique needs to which the sanitation facilities are required to cater. Safe sanitation is a basic human need and therefore access to safe sanitation is a fundamental right and the State is duty-bound to ensure the same.

Having established that the right to gender-responsive sanitation is a fundamental right that can be enforced Article 14, 15(4), 21 and 21A of the Constitution of India, it becomes pertinent to note that the Supreme Court and the High Courts are the guardians and protectors of fundamental rights. Hence, it is a right of a woman to invoke the writ jurisdiction of these courts under Article 32 and 226 of the Constitution respectively to compel the State agencies to provide access to adequate and safe sanitation facilities to every individual.

POLICY INITIATIVES TO MAKE SANITATION ACCESSIBLE TO WOMEN

The most critical facets of the right to sanitation are regulated at the local level. The 73rd Amendment Act of the Constitution envisions Panchayats taking on this position. Since sanitation is a state responsibility, it is mostly managed by states and local governments, with Panchayats serving as the final stretch. The law places the responsibility for maintaining a clean and healthy environment in the hands of Panchayats in rural areas.

The Ministry of Drinking Water and Sanitation (MDWS) restructured the former Nirmal Bharat Abhiyan (NBA) into Swachh Bharat Mission in 2014. The scheme was divided into two sub-missions: (i) Swachh Bharat Mission (Gramin) and; (ii) Swachh Bharat Mission (Urban). As the name implies, the key objective is to build a clean India. One of the main objectives is to build toilets in all rural areas, schools, and other public places. The Scheme also calls for maintaining cleanliness and establishing a robust waste management system, including solid and other domestic waste. It also seeks to improve people's behaviour so that they can follow sustainable sanitation practises.

To cater to the special biological needs of women, a separate component of the mission is dedicated towards menstrual hygiene management through information, education and communication (IEC Strategy). Separate funds are allocated for this component, which is to be utilised in raising awareness, building separate community sanitary complexes for women and

setting up incinerators in schools. It also aims to encourage civil society organisations and self-help groups are being to play a key role in spreading awareness and making sanitary products accessible.

The right to sanitation affects the right to education. The union government has highlighted the positive effect of sanitation facilities on student attendance in Swachh Bharat Swachh Vidyalaya: A National Mission, a document launching the school sanitation campaign. Subsequently, the Government launched the "Rashtriya Kishor Swasthya Karyakram" in 2014 to ensure the holistic health development of adolescents. One of the schemes introduced under this program is the National Menstrual Hygiene Scheme.

Women and adolescent girls' menstrual hygiene needs are also addressed in new age public toilets, in addition to providing safe conditions. Working women and female students have long struggled with a lack of adequate facilities, as most public restrooms are not designed to meet their needs. The goal of the Swachh Bharat Mission is to provide safe, clean and hygienic toilets and implement safe menstrual waste disposal systems. Specific guidelines for Menstrual Hygiene management have been issued by the Ministry of water and sanitation in 2005.

Additionally, some states have begun to install "Smart She Toilets" to provide clean and safe sanitation for women. The majority of these toilets include amenities such as a western-style toilet, a washbasin, a napkin vending and incinerator unit, a feedback mechanism, and a baby feeding and diaper-changing station to provide much-needed privacy to nursing mothers.

Following are some of the examples of State Initiatives-

1. She Toilets in Telangana

Telangana was the first state to implement 'She Toilets' in 2016. The authorities installed several toilets in various locations throughout the state, with a focus on public areas such as bus stops. The way these toilets work is particularly striking: waste is treated on the spot, without the intervention of sanitation workers, using advanced systems such as anaerobic bio-degradation. The fact that these toilets use less water is fascinating. The toilet also burns any cloth or sanitary pad that is dropped in it, preventing sewer line clogging. On November 19 2017, World Toilet Day, the Greater Hyderabad Municipal Corporation announced the priority installation of 100 "She toilets" throughout the city. There are currently 25 She Toilets in the city.

Figure 5: She Toilets in Greater Hyderabad

Source: The Hindu

2. **Mobile Toilets in Pune**

Pune is the next city to embrace the idea. Instead of building new toilets, the Pune Municipal Corporation (PMC) decided to refurbish old buses that were about to be scrapped and turn them into mobile, women-friendly toilets. Each bus has five toilets, three of which are in the Indian style and two of which are in the western style. It also includes a shower with a water sensor and a sanitary napkin dispenser machine.

Another intriguing feature is that these buses are completely solar-powered and include a women's safety

Figure 6: Buses reuse for Toilets, PMC

Source: The Economic Times

feature in the form of a panic button, which acts as an alarm to report any threat inside the bus. These toilets are extremely safe to use because each bus has a security guard stationed there.

3. Smart Toilets in Kerala

Kerala is the most recent state to embrace the concept of She Toilets and put it into practice. Thiruvananthapuram Zoo opened its doors to the first-ever 'Smart She' toilet on its premises in 2017. This one differs from others because in addition to all the facilities present elsewhere, it also has a fully automated pre-flushing and flushing system, as well as modular features such as a sanitary napkin vending machine and a napkin incinerator.

Figure 7: Smart She toilet Kerla

Source: The Hindu

4. Sunidhi Toilets in Tamil Nadu

The Sunidhi toilets, which have opened in Tamil Nadu's Dindigul and Madurai, are for women and girls who have reached menarche. There are incinerators, napkin vending machines, and other amenities in the restrooms. Used sanitary napkins can be thrown into the incinerator, which will burn them. The ashes can be flushed.

Figure 8: Sunidhi Toilets in Tamil Nadu

Source: The Hindu

Despite the various steps taken by the government, the experience from the Millennium Development Goals demonstrates that States concentrate only on globally measured objectives such as the distribution of sanitary napkins and construction of toilets. While both are very important, the focus should not be only on them and a more holistic approach should be adopted.

The present policy framework is only effective to the extent of

creating infrastructure, which is rarely fully functional in the short run and hardly sustainable in the long run. The investments fail to ensure household water security even in the short run and the expenditures are limited to the construction of toilets while ignoring the waste management and disposal system. Moreover, the information, education and awareness campaigns have not been effective due to their poor designing to suit the low literacy level population.

The approach of menstrual hygiene management which is currently limited to sanitary napkins should also take into consideration the availability of adequate infrastructure, access to proper health education, tackling the taboo around menstruation and devising alternatives to sanitary napkins.

Women are more likely than men to want a toilet, but they are often limited in their ability to influence asset purchase decisions in the home. Women's limited influence on toilet construction is explained by factors such as household power hierarchies, women's lack of confidence in making decisions, and their financial dependence on men.

There is also a pressing need to broaden the discussion about toilet design for household toilets to include explicit considerations for women's and girls' preferences. Toilet design clinics established in Kenya by Water & Sanitation for the Urban Poor (WSUP), provide useful insights into a process that could be replicated in India to expand on the features that should be considered in toilets to make them more appropriate for women, girls, and children. In Kenya, women clinic participants were found to have more suggestions and very specific inputs on the type of floor (to allow for easy cleaning), location (to prevent the smell from entering the house), and the appropriate size and design for children, among other things.

RECOMMENDATIONS FOR GENDER INCLUSIVE PUBLIC AND COMMUNITY SANITATION

The current schemes for sanitation provide incentives for constructing toilets and some budget is allocated for creating awareness. However, the scheme does not take into account the needs of the marginalised sections, like women, toilets at the workplace, disabled people, etc. The sanitation ecosystem needs to integrate elements of inclusion and equity in the service chain. Socio-economic, and gender dynamics across the service chain result in inequalities in access to sanitation facilities and services.

Gaps in gender-sensitive public and community toilets can only be bridged with leadership from city governments/sanitary authorities, as well as innovation in planning and financing structures. Recognizing the gaps that make public or community toilets less accessible or unsafe for women, as well as programmes aimed at sensitising government officials, is critical, and must be accompanied by practical solutions to close these gaps.

Having already emphasised the importance of sanitation facilities and the gaps in the present policy, it is imperative to note that there is a need for proper legislation addressing the right to sanitation. Since various policies are running parallelly, there is a large policy gap due to overlapping jurisdictions. There has to be legislation setting out a comprehensive policy framework. There are currently no intrinsic drivers in the policies to encourage more female participation in sanitation interventions in India. The legislation should encourage the local governments, district governments and state machinery to include women participation at both policy and implementation level.

There should also be a mechanism for a grievance redressal system at a ground level since it is difficult and time-consuming for people to approach the courts for enforcing their right. The author recommends the appointment of a health and sanitation ombudsman for this purpose. An ombudsman is an official who is charged with representing the interests of the public by investigating and addressing complaints of maladministration or a violation of rights. It is a statutorily appointed neutral body to investigate complaints against a government functionary. In other words, the ombudsman is supposed to provide quick, neutral and cost-effective justice to an aggrieved complainant. Various countries such as Sweden, Finland, Denmark, etc have sector-specific Ombudsman to bridge gaps between the administration and public to ensure good governance.

Policies and plans must be revised, along with supporting financial instruments, institutionalised implementation, tracking, and assessment processes, and long-term data collection and indicator approaches that are interoperable with macro-level mechanisms. It is important to increase data and expertise ability at all levels to enable stakeholders to make well-informed decisions. The priority actions must be proposed to make urban planning systems gender-responsive under the larger umbrella of 'inclusive cities'.

Water and sanitation services bring a host of benefits for community development. They get girls back into school, women into employment, and improve health, dignity, wellbeing and independence (WaterAid, 2012). The sustainability of interventions requires continuous efforts to ensure safe sanitation for women.

Leveraging technology for data collection, monitoring, waste disposal, water-efficient toilet design etc. is an important factor for achieving the SDGs. Authorities need to be sensitive in not only constructing toilets but ensuring their functionality, so that clean toilets are available, especially girls during their menstrual cycle. The true realisation of the right to sanitation is achieved only when gender-responsive sanitation solutions are made to ensure health, safety, productivity, and gender equity.

CONCLUSION

The right to sanitation and hygiene is an essential component of the right to health. The right to sanitation, like all other rights, is extracted from Article 21 i.e. right to life. To ultimately attain the SDGs, India must make tangible efforts. Cities' physical and social infrastructure must be built in such a manner that they are fully inclusive and egalitarian. The gender-based provision must be prioritised to realise everyone's right to sanitation. Only when gender-responsive sanitation strategies are developed to ensure health, protection, efficiency, and gender equality can the right to sanitation be truly recognised.

Legal and policy interventions could go a long way in building equitable cities. The norm of separate toilets for women as protected in statutes such as the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, the Contract Labour (Regulation and Abolition) Act 1970, the Swachh Bharat Mission 2014 (SBM) etc contribute to the realisation of several rights of women. There are many other state-level initiatives to safeguard the privacy and dignity of women's sanitation needs. These initiatives address concerns about privacy, integrity, lack of knowledge, and sanitation infrastructure to some degree. However, there is still a long way to go in terms of meeting women's sanitation and hygiene needs.

Gender is not commonly considered a significant factor in urban space and infrastructure planning, according to the findings of this study. Gender and urban planning are treated as separate domains, as evidenced by current laws, regulations, strategies, and procedures on the ground. Gender equality, although recognized as a constitutional goal, but is generally not given priority in downstream policies and plans at urban or national levels. There is a huge gap between what is stated in the legal and policy framework and what is happening in the field. At the implementation stage, either women's rights and interests are ignored entirely or are "valued" in a way that suits society's patriarchal existence. This situation is incompatible with a number of women's rights, including the right to equality and the right to sanitation.

REFERENCES

Atlas of Gender and Development: How Social Norms Affect Gender Equality in Non-OECD Countries, Organization for Economic Co-operation and Development (OECD) (4 March 2010).

Consumer Education and Research Centre v. Union of India, (1995) 3 SCC 42

Guidelines for Swachh Bharat Mission (Gramin) (Oct. 2017) Ministry of Drinking Water and Sanitation, Government of India

Kenya Environmental Sanitation and Hygiene Strategic Framework, 2016-2020

Livelihoods & Natural Resource Management Institute, International Water & Sanitation Centre, Centre for Economic and Social Studies & Watershed Support Services & Activities Network, Sustainable Water and Sanitation Services: The Life-Cycle Cost Approach to Planning and Management (Routledge, London 2013)

Localising the gender equality goal through urban planning tools in South Asia-Centre for study of Social Science, Technology and Policy

Murli S. Deora v. Union of India & Ors., (2001) 8 SCC 765.

Realising the Human Rights to Water and Sanitation: A Handbook, Catarina De Albuquerque, The UN Special Rapporteur on the Human Right to Safe Drinking Water and Sanitation.

Sustainable Development Goals, UNDP India

Swachh Bharat Mission (Gramin), Menstrual Hygiene Management, National Guidelines (Dec. 2015), Ministry of Drinking Water and Sanitation, Government of India.

The Constitution of India, arts 14,15,21, 21A, 38, 47.

Virender Gaur v. State of Haryana, (1955) 2 SCC 577.

RECLAIMING THE EXISTING: A TOOL FOR URBAN RENEWAL

MS. MAITHILY G. VELANGI

"Core city areas are the ones which are more vulnerable to dereliction, neglect and there is a need to carve out some breathing spaces into the dense fabric. To initiate urban renewal in such areas, as it is seen through case studies, the existing natural systems should be revived."

Keywords: *reclamation, natural systems, urban renewal, infrastructure corridor*

Ms. Maithily G. Velangi (Maithily.v@bmsca.org) is Assistant Professor, BMS College of Architecture, Bengaluru

The paper focuses on reclamation of existing natural systems and infrastructural layers of city cores to give some relief and bring in some breathable open spaces which can not only be recreational entities but can also be looked at as connected series of open spaces forming networks for movement. While looking at two case studies, the paper brings in initial ideas of identifying potential networks in city of Belagavi, Karnataka. With .growing urban population and migration, the demand of habitable spaces has increased. While extensions of cities are still able to provide livable conditions, the city cores/ old areas of cities suffer degradation due to deterioration of built spaces and pressure on available land. Within this framework, providing essential open spaces to the people is important. This paper discusses the importance of identifying existing networks which can play multiple roles and fulfill the most needed quality open spaces.

INTRODUCTION

Today, cities are expanding exorbitantly at a faster pace, especially in the developing countries creating unlivable urban environment. Cities have condensed down to mere places of stay for everyday earning and commuting rather than places for living a healthy life. Citizens of urban areas often need to travel outside the city limits for recreation, relaxation or even to breathe comfortably. As the focus is on built environment, the unbuilt environment is neglected and does not fulfill the need for quality open spaces for the people. A city should be a place for living – a healthy life and not merely a place for accommodation. Indian civilization lays emphasis on public spaces within the city fabric that are closely knitted to ensure welfare and well-being of Indian culture and economics, and impart social character to Indian cities. These spaces, positioned themselves as main anchors of the cities and villages, be it a village square to a community well, from maidans to the small, shaded streets in dense urban fabrics. More often the presence of natural systems within the city gave opportunities for the

open spaces to be utilized by people for various activities. The geographical settings- a river, a network of lakes, an important geological formation, a coast, or a mountainous topography – give unique character to the places and opportunities to tap resources from vantage points that are the focal points around which city develops. With growth and expansion, cities. Loose original characters and the relationship of the core / old areas to their geography diminishes. Moreover, the overcrowding, densification, and renovations in the older areas of a city dilute the relation of the city to its surroundings. When a city loses its connection to the local geographical features and gets moulded by new construction tools, invariably it dilutes its connection to the existing natural systems. This in turn takes the city away from its potential open spaces and networks which otherwise would have added value to the city life.

Taking off from the idea of 'greenway systems' was first demonstrated by Sir F.L Olmstead in 1860, who recognized the great potential of the linear green space, which would provide continuous links between city parks while extending its benefits in neighbourhood areas. This idea was initialized when he was commissioned to design the campus of UC, Berkeley, where he created a greenway linking the college of California to the Oakland city, which was called the Park and Piedmont Way plan. This was one of the first boulevards that was intentionally designed. From here on, this concept evolved through various projects of larger scales which created a network of park systems which were vehicle-free ways for movement and connected various neighbourhoods of the city. As a result, what it gave back to the city was a series of quality open spaces at neighbourhood level which in turn connected to larger green areas of the cities. pedestrian/ bicycle friendly pathways for communicating across the city and an uninterrupted ecological corridor for movement of flora and fauna.

Looking at the studies of greenway systems and examples of their applications in inner city cores, this paper focuses on application of this concept in the Indian context as a tool for Urban renewal to add quality open spaces into core areas of the city of Belgaum, Karnataka. The study will also look at various examples as case studies across India and the world to strengthen the proposal.

IDENTIFYING THE POTENTIALITIES OF GREENWAYS IN THE INDIAN CONTEXT

Undoubtedly, we will find most of the Indian cities situated near an existing natural system for their water resource. Either they are existing networks of storm water streams which eventually meet the larger river downstream like in Delhi, Kochi etc., or the natural topography has led to a series of interlinked water reservoirs to serve the city eg. Bengaluru, Bhopal or Udaipur. Sometimes, it is the combination of both systems. One important character of these systems is that it commutes from one end to another end of the city and forms a continuous uninterrupted network. Another important, but a man-made system that provides such an uninterrupted network, is infrastructural corridors, like railway lines, service lanes, etc., which can also be looked at with a new lens. Identifying these networks and integrating them with the Master Plans of the cities, can open various ways to utilize these spaces in a positive manner without altering their operational functionality.

Case Study Summary: Delhi

Delhi, the capital of India, as it is laid today, is an

amalgamation of seven historic cities. When the new capital was built, as a result of the shift from the then Calcutta, the new layout was planned between the two most prominent natural features that today forms the Central axis, popularly known as the Central Vista, from the Aravalli Ridge on the west and the mighty Yamuna on its east. Sir Edwin Lutyens, during the planning of the new capital, adhered to the principles of the Garden city movement while the focus was given to flawless movement of carriages of officials then, which today makes way for automotive transport. Those commuters were ignored who may not have the privilege of owning automobiles or, afford public transport and will prefer to walk or cycle. The safe movement across the city for these commuters was compromised. Realizing the potentials that the city and its natural systems provide in adapting the greenway network, some of the authorities and organizations have ideated to create the network which will focus mainly on connecting the open spaces through a network which would be more pedestrian and bicycle friendly.

DUAC (Delhi Urban Arts commission) initiated the Delhi greenway planning project which assessed this pedestrian demand and proposed a network connecting through the open spaces in planned colonies, urban villages, nalah systems, major historical monuments and city forests and parks, right across from South Delhi to New Lutyens Delhi.

Another Delhi-based organization, Oasis Inc Design, initiated a Delhi Government project on reviving the Barapulla Nalah system, as an eco-mobility corridor offering critical connectivity to the city's new mass transit systems, adds another layer to this greenway network. Similarly, Aga Khan Trust initiated historic loop around Humayun's Tombs adds value to the network. When we look at all these three proposals, and many more to come on the map in the future, various potentials that the city provides emerge out. A contiguous green thread through the city, linking various areas promises a new identity to the city. Moreover, these networks are aligned well with the naturally exiting systems of water networks or vegetated corridors and are continuous.

Case Study Summary: Seoul

Cheonggyecheon, an urban stream cutting across the city of Seoul, was a clear water stream in history, which fell prey to the growing urbanization. Eventually, it was degraded into a mere drain with shanties and unmanaged constructions along its banks. Soon, it turned out to be a city sore that was covered with concrete and turned into a 6 km roadway around the late 1950s. However, by 2000, the highway reached its point of obsolescence. So in its historic decision, the city government took a risky yet strong approach to demolish the flyover and bring back the stream hidden under the concrete back to life, back to the city.

Today we see a long stretch of renewed stream with public engagement. It has given the city an identity by becoming an active public space with recreation opportunities while forming a contiguous movement corridor (Figure 1).

URBAN RENEWAL: CASE OF BELAGAVI, KARNATAKA

Belagavi or Belgaum is a city in the state of Karnataka located in its northern part along the Western Ghats. It is the administrative headquarters of the eponymous Belgaum division and Belgaum district. The Government of Karnataka has proposed making Belagavi the second capital of Karnataka and the city has also been selected in the first phase out of 20 cities, as one of the hundred Indian

Figue 1: Cheonggyecheon Stream: Before and After

(image source: www.https://www.landscapeperformance.org/)

cities to be developed as a smart city under Smart Cities Mission.

The city, covering an area of approx. 90 sq. mile, has three parts- the old city area along with the fort and its lake; the planned areas of the city, which are laid in a grid layout during the colonial era; and the lush green cantonment area, which was also established during the British rule. The National Highway-4 cuts the city in two halves while the southwestern railway line runs along the Highway. There are 4 railway crossing gates in main areas of the city.

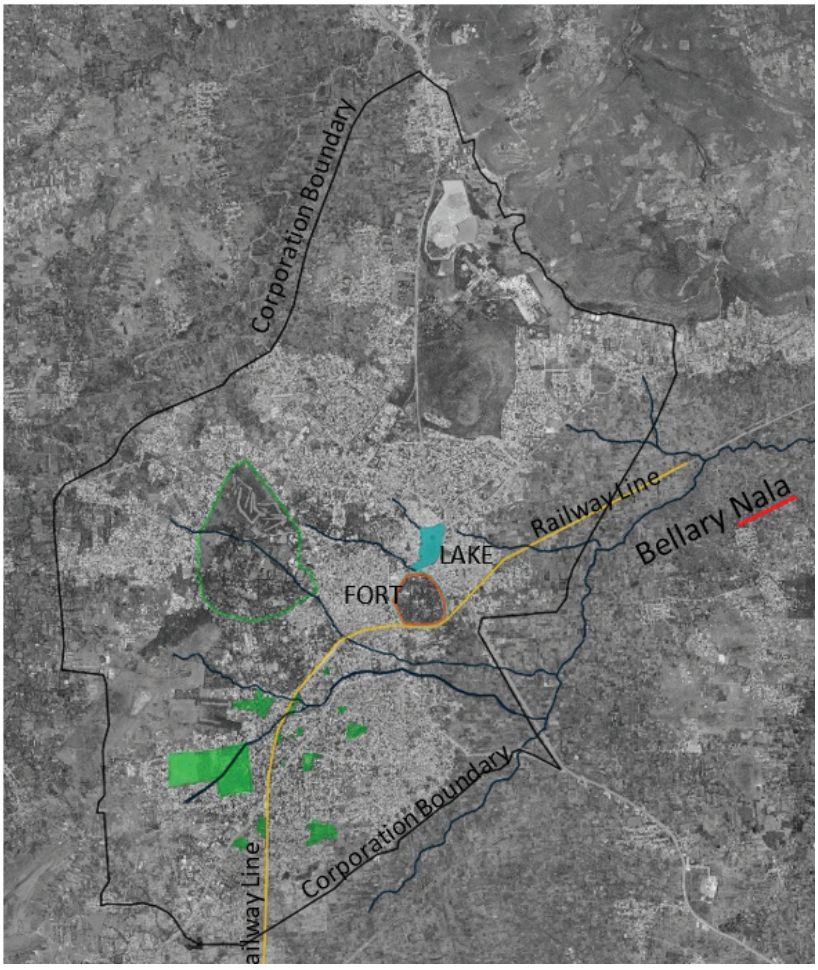
The city has seen immense growth in the last two decades from being a quiet, laid back city and an education hub to a bustling, commercially and industrially growing hub. With smart city projects and infrastructural projects taking off the city is under intense renovation. There is a shift seen in the socio-economic status which is a sign of development of the city. Other impacts are the changing preferences of the citizens in terms of consumerism, commute and recreation. The direct impact on the spatial city growth is the increase in the number of private cars which has led to discussions for solutions in transport infrastructure as the key focus of the development. The city and its roads, which were earlier pedestrian and bicycle friendly, are now unsafe for these modes of commuting. The open spaces are mere fragment portions of land, not serving the original purpose. With the city core getting denser to meet the growing demands of the city, as well as the citizens and adding new infrastructure to negotiate the growing traffic, little is left as quality open space. Moreover, the congestion has led to deterioration of public transport and inconvenience to pedestrians.

This urbanization and unplanned development have distanced the city from its inherent nature and identity. It has deteriorated the underlying systems, both natural and infrastructural and prevented people from connecting with the natural environment. The piecemeal solutions to various urban issues have disintegrated the underlying ecosystem & infrastructure rather than adopting a comprehensive whole city master plan approach. This has led to consequences in the last few years, the recent one being the flooding of the city in 2019 monsoons.

Natural system as a continuous network

Core city areas are the ones which are more vulnerable to dereliction, neglect and there is a need to carve out some breathing spaces into the dense fabric. To initiate urban renewal in such areas, as it is seen through case studies, the existing natural systems should be revived. The natural system, being the Bellary Nala, crosses across the city and has turned into a sewer from being storm water carrier of the city in older times. Many small tributaries which cut across the city to meet the Bellary Nalah are in a similar state. The images given at Figures 2 &3 indicate the system of connected Nalahs.

Figure 2: Google earth imagery of Belgaum city showing the Natural system network through the city.



(Source: Author)

Figure 3: Images showing the state of the Nalah within city limits

(Source: Author)

If the banks of these Nalahs are reclaimed and rejuvenated by taking necessary actions for water purification through biotech, there is a possibility to form a continuous green corridor connecting different neighbourhoods of this city while bringing the much-needed open space into its fabric. While strengthening the infrastructural corridors, it is also particularly

important to focus on ecology centric solutions other than anthropocentric ones. The revitalization of natural systems should be the focus and as the by-products of it, human needs shall be met.

The forgotten underlying infrastructural corridor

The other underlying infrastructural system that exists and is in degraded and un-used state, is the service lanes in the grid layout of certain areas which are contiguous corridors of 6m width running along the backyards of the residential plots. In the area of Tilakwadi in Belgaum city (Figure 4), the service lanes are existing along with the main roads throughout the neighbourhood. In the olden days, these were, used for services like distributing newspapers and other essentials, collecting garbage, etc. These also acted as thoroughfares. But with development and increased use of motorable roads which had access from the frontage of the plots, these lanes merely degraded down to being garbage dump lanes and called *'bhangibols'* (*bhangi* – a local name for garbage collectors) over the years and are now cleaned up in parts and used for parking (Figure 5).

Figure 4: Google earth image showing Tilakwadi neighbourhood within Belgaum city, which has a continuous network of service corridors (in YELLOW) alternating with main roads (in RED), currently defunct.

(Source: Author)

Figure 5: Images showing the state of the service corridors within city limit

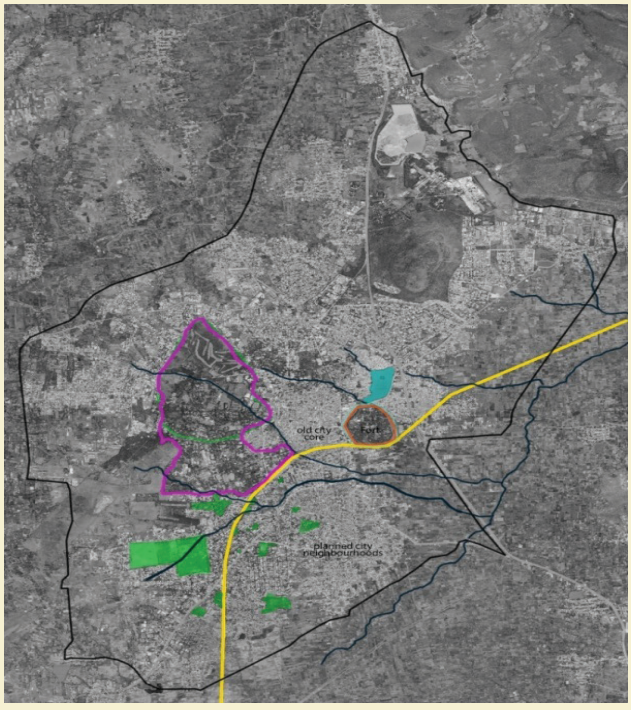
(Source: Author)

As part of ward development, these service lanes have been cleaned, but not maintained enough or put to functional use, thus lying-in ignorant state yet again. The potential of these lanes is yet to be identified. They should be designed and upgraded as pedestrian lanes which will connect the adjacent neighbourhoods.

The transportation corridor serving as pedestrian network

There is yet another opportunity to develop the unique element of Belgaum- the railway track running right across the city, as a pedestrian corridor, if well planned and executed properly. It is the southwestern railway line which enters the city from the south and reaches almost the centre before taking a right turn to exit the city from its eastern edge. It crosses the main areas from residential to commercial hubs. Since it has been inherently a part of Belgaum, the people are quite used to frequent closure of the railway gates. The main road of this linear city, is the NH 4, running along this railway line upto a certain extent, which serves as the spine to the city and connects various neighbourhoods. Hence, it is a popular road for morning and evening walkers and bicycle riders, apart from the everyday traffic. This interface of the railway track (Figure 6) and the areas surrounding it upto the main road can be used as a great land resource to be developed as a pedestrian corridor to be designed and landscaped while keeping safety from

Figure 6: Google earth image highlighting the Railway Track across the city (in YELLOW) *(Source: Author)*



the railway track in mind, such as by incorporating grade changes, green slopes and bio swales, transparent obstruction etc.

Currently, the railway buffers are being hidden off from the city by constructing tall boundary walls on either side of the railway track. This disconnects the city with the Railway corridor and with the city turning its back to the track, it will eventually be treated as a garbage dump, out of sight and out of mind. To prevent it from meeting this state, it is important to reconsider the decisions made for constructing walls and use this corridor space positively.

CONCLUSION AND WAY FORWARD

In dense city cores, with urban transformation and renewal of built and growing land values, it is difficult to allot land specifically for recreation. Hence the best way to revive these cores and make them livable within cities is to tap on existing parcels of land and deriving and reinstating lost networks between them, to claim the open spaces. Looking at existing infrastructure corridors and natural systems for this purpose can be the starting point. Redevelopment and rejuvenation will not only ensure the availability of public open space but will also add functional, ecological, as well as environmental value to the open space. This renewal will encourage people to be responsible partners in sustainable development, and as a result, city's living condition will improve. A happy city is a healthy city and happiness comes with livability.

REFERENCES

Asian Development Bank (2016), Development Asia: An initiative of Asian Development Bank, Case study: Revitalizing a City by Reviving a Stream 13 May 2016 (https://development.asia/case-study/revitalizing-city-reviving-stream)

DUAC Publication: City Level Projects, Delhi Greenways

(http://e.duac.org/images/pdf/4%20Delhi%20Greenways.pdf)

Bhaduri Amita(2016), Once a drain, now a sewer, India Water Portal | dated: 05.05.2016

(https://www.indiawaterportal.org/articles/once-drain-now-sewer)

Aga Khan Development Network (AKDN), Nizamuddin Urban Renewal initiative project, Aga Khan Trust, Aga Khan Development Network (AKDN).

HUDCO CSR initiative

Under HUDCO CSR initiative, 2 fully equipped Ambulance Vans were handed over by HUDCO Team to the Civil Hospital, Ahmedabad in an inauguration programme organized on 09.07.2021 through virtual mode presided over by Shri M. Nagaraj, Director (Corporate Planning), HUDCO.

GENERAL GUIDELINES: CHECKLIST FOR SUBMISSION OF ARTICLES

The following checklist should be used when preparing an article for submission. Please be sure to follow the specifications exactly and completely to ensure that your article is reviewed timely manner and any delays avoided further along in the publishing process should your article be accepted for publication.

1. The paper should be created using a word-processing program (such as Microsoft Word) and should be between 3,000 and 5,000 words in length. The file may be in .docx or.doc format.
2. The paper is typewritten, double-spaced, and formatted to print on 8.5" x 11" (or A4) size paper. It is written in the third person in a clear style, free of jargon.
3. The first page of the article includes the following:
   i. the paper's title; and
   ii. an approximately 200-word abstract that emphasizes the paper's contribution to the field and its practical architectural/ planning social/ economic implications.
   iii. the name(s), position(s), professional or academic affiliation(s), and email address(es) of the author(s), as well as the full postal address of the correspon-ding author;
4. The body of the paper should include the following:
   i. an introduction to the subject,
   ii. background information,
   iii. discussion of procedure,
   iv. results,
   v. conclusions,
   vi. implications for practice and advancement of research,
   vii. references,
   viii. acknowledgments (optional; if funding for the research was received from non-personal sources, the sources must be identified in this section), and
   ix. an autobiographical sketch.
5. Please ensure that:

i. References are complete, have been arranged alphabetically by author surname and checked for accuracy.

ii. Reference citations in the text are referred to by author name and year. If there are more than two authors, the name of the first author followed by ", et al." has been used.

iii. References contain the following information, in the order shown: names of all contributing authors (last name followed by first initial), date of publication, title of article, names of editors (edited books only), title of journal or book, volume and issue numbers (journals only), location and name of publishing company (books only), and inclusive pages (journals and articles in edited books).

iv. Figures/ pictures/ graphs submitted are:
   a. Large enough to be readable when reduced to fit the journal page size (approxi-mately 5.25" x 8.25").
   b. A brief caption is provided for each figure/ picture/ graph.
   c. The figure is cited in the text.
   d. Please ensure that scanned images are of a high resolution to ensure good quality printing (not less than 640 x 480)

v. All tables are included either in the original manuscript file or as a separate Microsoft Word document and have been checked to ensure that they can be easily reproduced on the journal page size approximately 5.25" x 8.25").
   a. A brief caption is provided for each table.
   b. The table is cited in the text

6. If your paper is accepted for publication, you will be provided with information on where to send the hard copies of any figures if required.
7. The manuscript and any table/picture files should be sent via email to hsmishelter@gmail.com ONLY original works neither published nor under review elsewhere will be considered.

Touching lives with affordable homes

HUDCO - Promoting housing for EWS and LIG category

- HUNNY – HUDCO Nav Nagar Yojana for developing sustainable habitats
- HUDCO's Rent-to-Own Scheme • Senior Citizens' Homes
- Programme Assistance to State / ULBs for development of housing and urban infrastructure

HUDCO – Leading the way

As India's premier techno-financial institution and a Mini-Ratna-1 Company, with the mandate of 'Profitability with Social Justice', HUDCO is leading the way in pioneering Sustainable Habitat for the EWS, enabling holistic urban development, facilitating inclusive economic growth & realizing an ambitious target of one million houses per annum.

HOUSING | INFRASTRUCTURE | CONSULTANCY SERVICES | RESEARCH AND TRAINING | BUILDING TECHNOLOGY

hudco

HOUSING AND URBAN DEVELOPMENT CORPORATION

(A Govt. of India Enterprise) CIN: L74899DL1970GOI005276

HUDCO Bhawan, Core-7-A, India Habitat Centre, Lodhi Road, New Delhi - 110 003.

Tel: 011-24649610-23, 24627113-15 Fax: 011-24625308 Visit us at : www.hudco.org

Design & Printed at Viba Press Pvt. Ltd., 9810049515