PRACTICE NOTE

Our Journey with the City: Deciphering WRI India Ross Center's Influence in Bengaluru

WRI-INDIA.ORG

CONTENTS

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EXECUTIVE SUMMARY

HIGHLIGHTS

- The World Resources Institute's (WRI) Ross Center for Sustainable Cities (starting with its origins as EMBARQ India), has maintained a presence in Bengaluru since 2010. It has served as a key change agent for sustainable development, starting with mobility and moving more broadly to urban development and related services such as energy and water. The long-term engagement across multiple sectors and scales makes Bengaluru one of the WRI Ross Center's "deep dive" cities.

- This study uses a mixed-methods approach to understand the Center's influence in Bengaluru and the effectiveness of its deep dive approach, learn from its experience, and analyze its role in catalyzing citywide change.

- Its data-led approach and strong technical skills, combined with a deep understanding of the local context, have established the Ross Center, and now WRI India, as an independent, knowledgeable, and trusted advisor in Bengaluru. Success factors include flexibility and sustained physical presence, demonstration of impact through on-ground projects, innovative and evolving formats for stakeholder engagement, and the ability to leverage relationships and partnerships for ecosystem change. Challenges continue to be presented by a rapidly growing city, political and bureaucratic changes, alignment among stakeholders, and the short time frames of both funders and stakeholders.
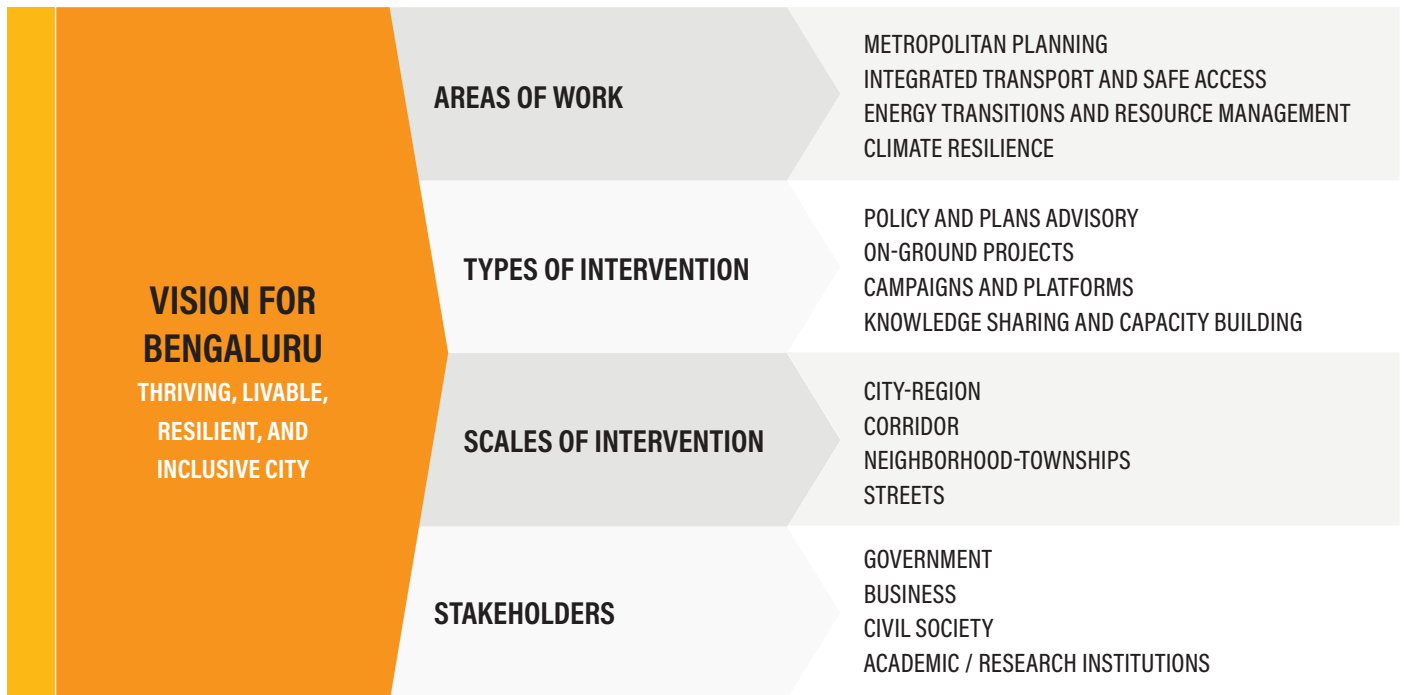
BACKGROUND

We at the WRI Ross Center for Sustainable Cities believe that "diving deep" in a particular region can help us effectively achieve our goals at scale by enabling us to focus on long-term and multi-sectoral engagement that transcends individual project funding and political/bureaucratic turnover, thus facilitating citywide, transformational change. Our work in Bengaluru, the capital of Karnataka state in southern India, exemplifies the Ross Center's deep dive strategy.

We began our engagement in the city as EMBARQ India in 2010, and a formal office was established the following year. In partnership with key public transport agencies, our early efforts focused on catalyzing and helping implement strategic projects in sustainable transport and transit-oriented development (TOD). These engagements helped forge strong, lasting relationships with these agencies and build our credibility as a trusted knowledge partner and advisor. In 2014–15, as we transitioned from EMBARQ India to the WRI India Ross Center for Sustainable Cities (WRII-RC), the scope and approach of our work also expanded to encompass other sectors, scales, stakeholders, and types of intervention (see Figure ES-1).

THE DEEP DIVE RESEARCH APPROACH

To better understand the effectiveness of the WRII-RC's deep dive work in Bengaluru, the authors of this paper used a mixed-methods approach to capture its experiences and learn from them, and analyze whether and how the deep dive approach has helped catalyze citywide change in Bengaluru. The team in WRI India, based in Bengaluru, contributed the bulk of the research and rich historical detail included in this note, with methodological support from the WRI Global office based in Washington, DC. The authors draw on Steffen Janus's (2017) model for "capturing and learning," which involved identifying the range of events and projects carried out in Bengaluru over time. Researchers in WRI India dug into a repository of documents and conducted in-depth interviews with staff members. The authors layered qualitative analysis and subjective understanding onto quantitative data (key impact/influence metrics) from individual projects. This included evaluating the city's context, its key challenges, and the evolution of program strategy, and mapping the range of stakeholders/actors we have engaged with in Bengaluru, allowing us to paint a full, yet evolving, picture of the Ross Center's citywide influence. The detailed methodology used for this practice note is described in an accompanying practice note that

VISION FOR BENGALURU **THRIVING, LIVABLE, RESILIENT, AND INCLUSIVE CITY**	AREAS OF WORK	METROPOLITAN PLANNING INTEGRATED TRANSPORT AND SAFE ACCESS ENERGY TRANSITIONS AND RESOURCE MANAGEMENT CLIMATE RESILIENCE
	TYPES OF INTERVENTION	POLICY AND PLANS ADVISORY ON-GROUND PROJECTS CAMPAIGNS AND PLATFORMS KNOWLEDGE SHARING AND CAPACITY BUILDING
	SCALES OF INTERVENTION	CITY-REGION CORRIDOR NEIGHBORHOOD-TOWNSHIPS STREETS
	STAKEHOLDERS	GOVERNMENT BUSINESS CIVIL SOCIETY ACADEMIC / RESEARCH INSTITUTIONS

Sources: WRI authors.

preceded this study and was based on the Center's deep dive work in Mexico City (Martínez et al. 2021).

OUTCOMES OF THE WRII-RC'S WORK IN BENGALURU

Ecosystem Engagement across Sectors, Scales, Stakeholders, and Types of Intervention

The WRII-RC's vision for Bengaluru is that of a thriving, livable, resilient, and inclusive city built on sustainable development principles. Working across four broad interconnected areas, it has supported on-the-ground (OTG) pilot projects at the street, neighborhood, or corridor levels and also long-term initiatives related to governance reforms, visioning, plans, and policy advisories (on a range of sectoral/cross-sectoral issues) at the metropolitan and regional levels. Figure ES-1 captures (at a high level) the WRII-RC's ecosystem engagement in Bengaluru and indicates how the whole is greater than the sum of its parts.

Addressing Traffic Congestion and Mobility

The WRII-RC has supported the modernization efforts and systemic upgrades conducted by public transport agencies (bus, metro rail) in Bengaluru to improve operational and financial efficiencies, service coverage, quality, and, ultimately, their ridership and mode shares. Broadly, our work has led to tangible improvements in the following areas:

- **Public transport access, last mile connectivity, and multimodal integration:** Our team helped the city bus agency rationalize their operations and implement new trunk and feeder services along a few arterial road corridors (the Bangalore Intra-city Grid [BIG] Bus Network), metro rail corridors, and stations, demonstrating benefits and a scale-up methodology. We also facilitated tie-ups with private entrepreneurs and start-ups to provide feeder services to major bus stops/terminals and metro stations. The Station Access and Mobility Program (STAMP) Challenge fostered innovative data- and tech-enabled market solutions for last mile connectivity and mode integration with the

metro rail, with three out of five winners piloting their services. Post-implementation evaluations found that these interventions helped induce a significant shift from private to shared paratransit and public mass transport modes.

- **Data-driven planning:** With our support, the city bus agency has institutionalized processes to manage high-quality data for monitoring, planning, and decision-making. We have helped systematize and improve methods of data collation (on operations, performance, and crashes), procure new technology (intelligent transport and passenger information systems), and develop tools/toolkits for data analyses, and have advised them on their Open Data or Sharing policy, which was implemented.

- **Financial sustainability:** With our assistance, the bus agency secured financial support from the state and national governments for improving and augmenting their services. This included waivers in the form of loan interest subvention and motor vehicle tax exemptions, as well as grants for procuring new buses and implementing measures to make buses safer for women and road users. In addition, the fare restructuring based on our recommendations has benefited both the agency and commuters.

- **Safety:** We have helped the city bus agency prioritize the safety agenda and make its buses safer for bus and road users, especially women passengers. Through various activities and engagements, our team helped identify and improve safety features at bus stops/terminals and in public buses, and promote safe driving practices.

- **Vehicle technology:** By helping the bus agency develop a comprehensive strategy and roadmap, we are supporting its efforts to optimize fleet electrification and reduce emissions, fuel consumption, and operating costs in the long run.

Addressing Urban Development and Sprawl

Our team has supported government agencies and local communities in preparing plans and project proposals focused on improving safe access and livability at the neighborhood level. These include metro station accessibility plans with development regulations based on the tenets of TOD, as well as neighborhood improvement plans and prioritized projects based on a community-led participatory process. In several cases, public agencies have secured funds and allocated budgets to implement these proposals.

We have also provided knowledge advisories on legal, city planning, and governance reforms as well as strategic interventions to manage urban expansion at the metropolitan level. This includes suggestions for a comprehensive revision of the Karnataka Town and Country Planning Act and restructuring the municipal corporation for improved administration of Bengaluru. Our inputs have influenced certain plan/policy decisions and actions taken by the government. Across our areas of work and expertise, we also provided detailed recommendations on a range of sectoral/cross-sectoral issues and the city's growth strategy that informed the revision of Bengaluru's master plan.

Addressing Resource Management and Inefficiency

The Energy program has focused on enabling holistic and inclusive electricity sector planning by integrating renewable energy (RE) and energy efficiency (EE) considerations. We helped establish the Karnataka Electricity Governance Network of consumer and civil society groups in the state and built their capacities, enabling them to effectively engage in the electricity sector's decision-making processes.

Efforts have also been directed toward overcoming policy, regulatory, and market barriers to RE and EE uptake in various consumer categories. Through the Green Power Market Development Group India, our team has helped several large corporates/industrial enterprises in the city and state, including the Bengaluru International Airport Limited, procure solar power. The group also successfully advocated for a supportive policy regime to facilitate investments in RE, which greatly boosted solar power capacity in the state. In partnership with Technology Informatics Design Endeavour, we launched the VidyutRakshaka (VR) program in Bengaluru with the objective of reducing the electricity demand-supply gap through consumer-led voluntary actions for EE and

conservation. We worked with residential communities and the utility to pilot and scale up efforts to reduce the electricity consumption of household and common area services through no- or low-cost interventions. The next step integrated EE with RE measures, through the promotion of rooftop solar for residential consumers in the city.

Using an integrated urban water management approach, we also developed a program to help cities better manage their water resources by identifying risks and city-specific solutions for increasing resilience. The City Water Assessment Framework (CWAF), designed to model all aspects of urban hydrology, has been used to carry out a preliminary analysis for Bengaluru and neighboring Chikkaballapur town.
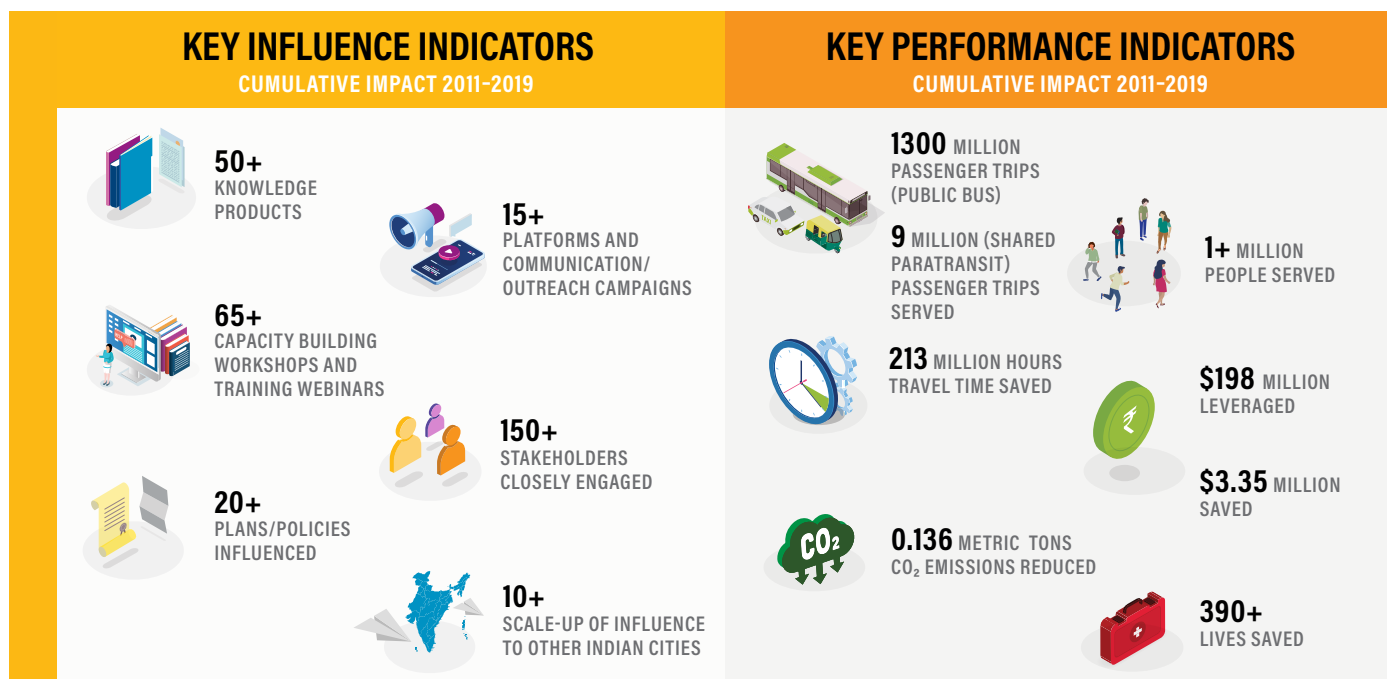
Platforms

Over time, the Cities program has created and successfully leveraged several platforms to engage with the stakeholder ecosystem; forge complementary, strategic partnerships; foster innovation; and scale up progressive practices.

Some adopted a Challenge format to identify and accelerate innovative solutions in various sectors and also to create new models for public-private participation in service delivery. These include the Neighborhood Improvement Partnership Challenge (NIPC), which encouraged community-led projects, and STAMP, Better Bus, and CityFix Labs India challenges, which advanced promising data- and tech-enabled market solutions for last mile connectivity to metro rail, improved the quality of public bus systems, and drove resource efficiency (energy/water/waste), respectively. Other platforms such as the Developers Dialogue seek to engage domain experts and real estate developers in the city to reimagine and build sustainable townships. Our Bus Karo platform has served as a space for peer-to-peer learning and to further deepen our engagement with bus transport agencies in Bengaluru and Karnataka. Since 2016, we have also hosted Unlock Bengaluru, an annual convention and dialogue on sustainable development pathways that is designed to support coalition building and partnerships for our work in the city.

Figure ES-2 captures our cumulative project impact and influence (at a high level) in numbers, illustrated

Figure ES-2 | **Cumulative Project Impact and Influence (2011–2019)**

KEY INFLUENCE INDICATORS
CUMULATIVE IMPACT 2011–2019

50+ KNOWLEDGE PRODUCTS

15+ PLATFORMS AND COMMUNICATION/ OUTREACH CAMPAIGNS

65+ CAPACITY BUILDING WORKSHOPS AND TRAINING WEBINARS

150+ STAKEHOLDERS CLOSELY ENGAGED

20+ PLANS/POLICIES INFLUENCED

10+ SCALE-UP OF INFLUENCE TO OTHER INDIAN CITIES

KEY PERFORMANCE INDICATORS
CUMULATIVE IMPACT 2011–2019

1300 MILLION PASSENGER TRIPS (PUBLIC BUS)

9 MILLION (SHARED PARATRANSIT) PASSENGER TRIPS SERVED

1+ MILLION PEOPLE SERVED

213 MILLION HOURS TRAVEL TIME SAVED

$198 MILLION LEVERAGED

$3.35 MILLION SAVED

0.136 METRIC TONS CO_2 EMISSIONS REDUCED

390+ LIVES SAVED

Notes: The cumulative impact numbers (key performance indicators) are representative of what can be attributed to on-ground projects across workstreams over a span of nine years. They include actual and estimated numbers (indicating a potential impact on project implementation).
Sources: WRI authors.

through our key performance and influence indicators, respectively.

FINDINGS

Utilizing the WRI Ross Center's "Theory of Change" to Address Systemic Challenges

The lack of robust data and evidence to visualize urban issues at different scales, governance challenges, and unclear power and accountability hierarchies has hampered decision-making and the realization of the envisaged outcomes in Bengaluru. Moreover, long-term systemic changes require persistence and alignment of stakeholder interests, which are difficult to achieve during periods of rapid growth, change, and political/bureaucratic turnover. Over the past decade in Bengaluru, the WRII-RC has played a crucial role in bringing in data, domain knowledge, and technical expertise (both local and global) to create awareness and build the capacities of various government and civil society stakeholders, as well as to inform decisions (on policies, plans, and budgets) and practice (on-ground projects). We identified gaps in knowledge sharing and capacity, and attempted to fill them.

Four Factors That Helped the WRII-RC's Institutional Growth

- **Expansion of the WRII-RC's work within each sector, across sectors, and across scales by employing data, tools, and platforms**: Working across many areas of urban expertise, the WRII-RC offers an integrated approach to pressing sectoral and cross-sectoral issues faced by the city. We have worked at different scales and on long-term initiatives related to governance, visioning, plans, and policy advisories at the metropolitan and state levels. We have focused on using data-driven narratives and evidence to build a case and inform discourse and decision-making. This approach has also enabled us to stay objective and build credibility across the board. Knowledge products shared through our website and platforms have been instrumental in communicating knowledge and building the capacities of our partners and stakeholders. These include Bus Karo, STAMP, NIPC,

Safe Access Manual and Toolkit, TOD Financing Modules, and the CWAF, although most were developed with a wide range of cities in mind. STAMP began in Bengaluru and was later replicated in Hyderabad, Kochi, Delhi, Mumbai, and Nagpur.

- **Flexibility within the deep engagement approach:** The WRII-RC's pilot projects in the city have been valuable in developing methodologies and proof of concepts, demonstrating the how-to's, and setting precedents. They also helped establish our value proposition and credibility. Our physical presence and deep engagement in Bengaluru have allowed us the flexibility to stay closely engaged with our many partners and consistently work toward implementation/outcomes, extend and leverage our networks to work synergistically and enter other sectors, quickly respond to emergent opportunities, engage with the larger stakeholder community, and participate in the broader imagination of the city. It has also given us opportunities to work in other cities/towns in Karnataka and in state-level initia-tives. Our experience allows us to not only scale similar efforts to other cities and states but to also inform policies or programs at the national level.

- **Stakeholder engagement—leveraging rela-tionships and partnerships for ecosystem change:** Perhaps one of the richest findings of this research was the breadth of the WRII-RC's ecosystem engagement. As our work in Bengaluru has grown, so has the range and number of actors we have engaged with and, in several cases, built close working rela-tionships with. We have brought in a science-based and nuanced understanding of subjects to help improve the capacities of various stakeholders and inform discourses, particularly among the thought leaders and opinion makers in the city, through a bottom-up approach. Given our credibility in the ecosystem, we are invited to participate in various conversations and initiatives, and our opinion on important urban issues is regularly sought. The extensive nature of this ecosystem and our ability to utilize it to further our work has been key to expand-ing our influence and advancing the public discourse on urban sustainability.

- **Wide and evolving range of formats:** Given the scale and complexity of the challenges faced by

fast-growing Bengaluru, finding projects where the WRII-RC can act as a catalyst and build on multiplier effects is essential for achieving an impact. We have engaged with stakeholders in the ecosystem in different ways to spur long-term transformative and systemic change. We actively engaged with citizens through campaigns and projects that help change their perceptions, mindsets, and behavior; for instance, Bus Day and VR. We have also built robust initiatives based on complementary partnerships; for example, our Challenge platforms with tech entrepreneurs and Developer Dialogues. Our long-standing working relationships with various government agencies and our sustained presence in the city serve as the foundation of our deep dive approach in the city.

Learnings from Addressing Challenges and Enabling Outcomes

- **Political economy and governance:** Despite good intentions, it is difficult to work around vested interests, especially those that have significant economic implications for stakeholders. Moreover, long gestation periods and legacy issues around governance hinder the implementation of initiatives intended to deliver systemic change. Our engagements have taught us that we need to go beyond crafting policy and plans, and help the city to structure well-designed, viable projects that can secure allocations. Only when we engage in the discourse on city budgets can we expect to influence program/city/political priorities.

- **Establishing credibility**: It takes time and effort to establish credibility with all stakeholders, especially the government, and the entry points can seem limited. Our presence in the city and work with its key agencies (those that have the funds and responsibilities) for over a decade has helped us build trusted relationships and gain a nuanced understanding of the city. Over time, our independence and our data-driven approach to problem-solving have made us a sought-after partner for influencers and agencies seeking to transform the city.

- **Partnerships for greater impact:** There are areas of work and functions that we do not directly engage in because our organizational focus and structure do not allow it. For the whole to be greater than the sum of its parts, it is important to establish partnerships with various actors early in the process. The envisaged outcomes can then be systematically planned and will be equitable and sustainable. The right type of communication, effective public relations, and capacity building of stakeholders are crucial to implementing systemic change.

- **Communicating with donors/funders**: Given the long gestation period required for transformative change, it is important to establish milestones and robust performance indicators and communicate the achieved outcomes, especially to donors. Alongside developing pertinent knowledge/communication pieces, we need to be agile in engaging with donors, to educate them about the scope and necessity of patient capital for resolving important issues.

1. INTRODUCTION

## WHAT IS THE WRI DEEP DIVE EXPERIENCE?

The World Resources Institute (WRI) is a nonpartisan global research organization working at the intersection of development and the environment. We are recognized for our evidence-based research that informs government policy, business strategy, and civil society action around key global challenges: climate, energy, food, forests, water, sustainable cities, and the ocean. To scale up successful policies and practices, we facilitate coalitions and work with partners to implement and build on our recommendations/ solutions. We work toward being both a think tank and a "do-tank," which is embodied in our theory of change: "*count it, change it, scale it.*"

The WRI Ross Center for Sustainable Cities, born in 2014 from the Center for Sustainable Transport (EMBARQ), exemplifies this theory of change at work. With this transition, the scope and approach of programmatic work evolved, expanding to encompass other sectors and scales of intervention in the urban domain. Under this umbrella program, the city-specific work in India is now led by the WRI India Ross Center for Sustainable Cities (WRII-RC). Apart from India, the Ross Center has international offices in five other countries (see Figure 1).

Deep dive cities constitute an integral part of the program's strategy for achieving its goals at scale: to galvanize action that will help cities in developing countries around the world grow sustainably and provide an improved quality of life to all its citizens. We define deep dive cities as those having a portfolio of projects that extend beyond one sector and over a period of at least five years, typically coupled with the physical presence of a WRI office. The deep dive experience

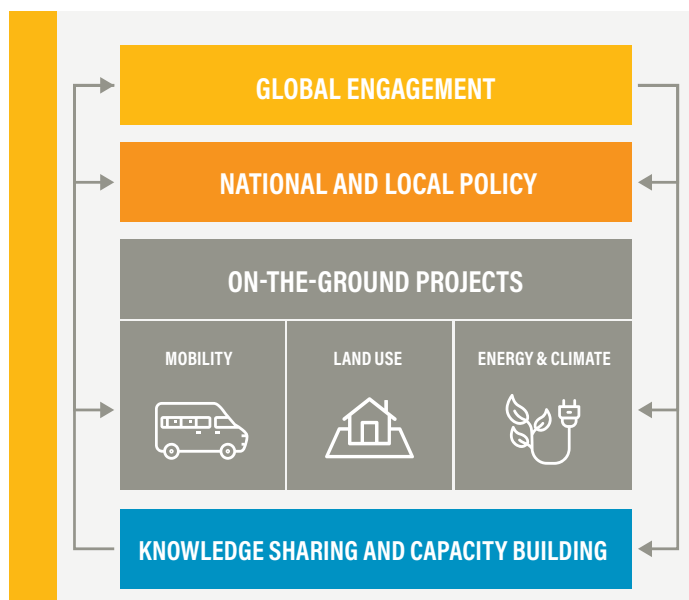Figure 1 | **WRI Ross Center International Offices**
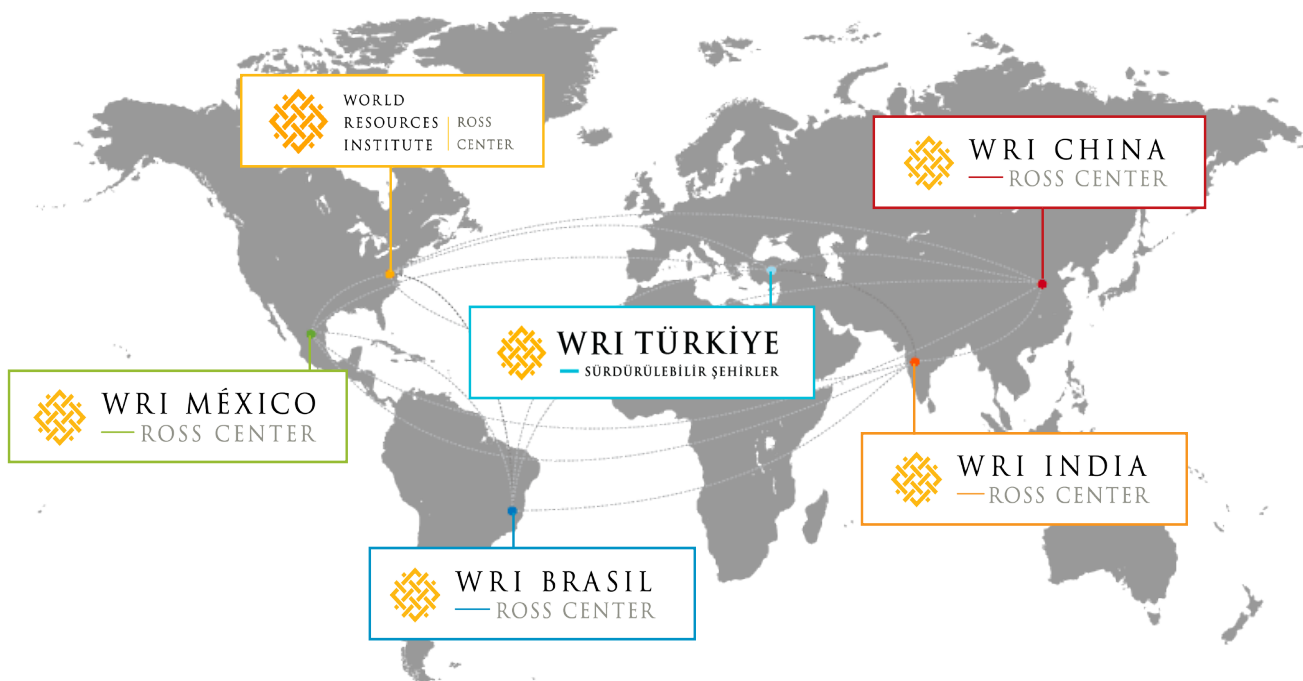
Notes: WRI India, established in 2011, has four associated programs driving on-ground transformative change: Energy, Sustainable Landscapes and Restoration, Climate, and its largest program, Sustainable Cities.
Sources: WRI Ross Center for Sustainable Cities (https://wrirosscities.org/).

offers multidimensional and nuanced insight that is both extensive and intensive. It gains as much value from initiatives that did not succeed as from the ones that did, and the lessons here are as important as the outcomes. Through the deep dive, we derive a greater contextual understanding of the sectors and ecosystem we engage with, establish relationships of trust, and exert long-lasting influence on the city's development.

The year 2020 marked 10 years of engagement with the city of Bengaluru for the WRII-RC (previously EMBARQ India). In this time, we have worked across multiple sectors, pursuing a long-term vision of sustainable urban development, and deployed a variety of strategies for influence and impact. These include analytical research and knowledge sharing, stakeholder engagement and capacity building, on-the-ground (OTG) demonstration projects, plans, and policy advisories aligned with the WRI Ross Center's theory of change (see Figure 2). This study seeks to capture a deep dive decade of work, growth, learning, and influence for the WRII-RC in Bengaluru.

Figure 2 | **Four Components of WRI Ross Center's Theory of Change**

GLOBAL ENGAGEMENT

NATIONAL AND LOCAL POLICY

ON-THE-GROUND PROJECTS

MOBILITY

LAND USE

ENERGY & CLIMATE

KNOWLEDGE SHARING AND CAPACITY BUILDING

Sources: WRI authors.

WHAT DOES THIS "DEEP DIVE" RESEARCH HOPE TO ACHIEVE?

This research is part of a pilot effort to develop a methodology for documenting and assessing the Ross Center's work, impact, and influence in its deep dive cities. The specific objectives of this study are the following:

■ Record, process, and learn from the deep dive experience (successes and failures) in Bengaluru.

■ Evaluate the WRII-RC's role and influence in advancing broader change[1] at the city level. To do this, two key criteria were considered: "relevance" of the different approaches and engagements in the context of the city and the program's strategy or mandate, and the "effectiveness" of the results in achieving the envisaged impact.

The activities undertaken, obstacles faced, results achieved, and lessons learned in a deep dive city and how they informed our work along the way have seldom been documented to provide a comprehensive bird's-eye view. Although some of these aspects are captured in our knowledge and communication products as well as in our donor reports, they provide a fragmented view as each product/report is typically limited to information about a single project or a particular set of projects. In contrast, this deep dive research builds on the opportunity to explore more dimensions of our work and assess the achieved outcomes at a citywide scale.

The WRI Ross Center, following the practices of its predecessor EMBARQ, has historically analyzed project impact and reported on "outcomes"[2] through its key performance/influence indicators (KPIs/KIIs; see Table 1). In this paper, we strive to go beyond individual project-level indicators to gauge our influence at the city level. This effort furthers WRI's growing commitment as an organization to monitoring, evaluation, and learning.

It is important to present this knowledge so that it can serve as a foundation for other deep dive city initiatives, both internally and externally. This study will hopefully help guide other such programmatic efforts, substantiate the Ross Center's value proposition for potential funders and partners, and add value to its project portfolio.

Table 1 | Key Performance Indicators (KPIs) and Key Influence Indicators (KIIs)

KPIs FOR ON-THE-GROUND PROJECT IMPACT	KIIs FOR INFLUENCE ACTIVITIES
People served	Number of knowledge products produced and viewed/downloaded
Lives saved	Number of communication products produced and viewed/downloaded
Resources saved (travel time, energy, water, money, etc.)	Number of people trained
Emissions avoided (CO_2, particulate matter)	Number of plans or policies influenced
Money leveraged (investment)	Number and type of stakeholders engaged

Notes: This is an illustrative list and should not be considered exhaustive.
Sources: WRI authors.

Such considered reflection and stocktaking can also help improve the way we work and signpost the most effective ways to influence a city's development patterns. There is no time like the present to drive forward the Center's strategy, as the environmental risks and developmental challenges posed by rapid urban growth require urgent responses. We hope that this study will help improve the program's strategy for catalyzing "systemic or transformational" change in its deep dive cities.

METHODOLOGY

To address the above-mentioned research objectives, we build on the five-step approach to institutional learning developed by Steffan Janus of the World Bank (Janus 2017). These steps of identification, capturing, validation, formatting, and use in learning provide a partial structure for this study, although we have adapted and expanded it for our purpose with additional analytical steps, as described below:[3]

■ **Identification of engagements:** As an initial step, we identified and mapped a whole range of engagements (events/projects) conducted in Bengaluru over time. This helped us trace the trajectory of our work against the backdrop of an evolving city, institutional and program strategy, and emerging opportunities. It also helped us distinguish various types of projects ranging from research and OTG implementation or policy focused to those involving partnerships or coalition building, using various

formats such as innovation challenges and more/less successful projects. This opportunity was used to examine a much broader range of projects than initially planned.

■ **Capturing information from key resources:** The next step involved determining what types of documents and knowledge can be used as information sources about how we work toward transformation in deep dive cities and, in particular, what we achieved in Bengaluru. These included various knowledge and communication products, donor and status reports, outcome and strategy documents, and other external sources (e.g., media articles). We dug into our archives and conducted extensive interviews with current and former staff members (see Section A1, Appendix A) to draw out a more holistic and richer picture of our work and experiences in Bengaluru. We also collated testimonials of government and nongovernment partners that were captured in the course of the work and for donor reporting. These resources were used to gather information on the WRII-RC's engagements and operational experience: the why, what, where, how, and with whom? What were the challenges along the way in realizing project or strategic goals, missteps and lessons learned if any, and outcomes and evidence of our impact or influence?

■ **Analysis and storytelling:** To further address the second objective of this research, we layered qualitative analysis and subjective understanding onto quantitative data. This is critical given that we are

looking at citywide and not just project-by-project impact. It included an appraisal of Bengaluru's context and key challenges, as well as the evolution of the program strategy and approach guiding our work in the city. The relevance and effectiveness of our engagements were evaluated within this context. Project timelines and their spatial distribution in the city were mapped to help us decipher how individual projects fit together and within broader trends to contribute to a more sustainable city, and also assess their overall effects, at the systemic and/or city level. We also attempted to aggregate project KPIs and KIIs to present the WRII-RC's cumulative impact and influence at the city level. Another key element is the ecosystem analysis, which maps the range of stakeholders/actors we have engaged with and worked with in Bengaluru. Maps and graphics are used to support the narrative.

- **Validation:** This was done formally in the standard WRI review process upon completion of the manuscript, but also intermittently, in an iterative manner, as the research moved along. Drafts were shared with project and workstream leads to validate the information and how it was put together. The formal process included reviews by key internal staff and program heads, the WRII-RC's government/nongovernment partners, and external stakeholders.

- **Formatting and learning:** This step involved the design and production of the publication, the steps of which are standard for all WRI knowledge products, and the development of derivative communication products that can be used to engage with key audiences—both internal and external—about our work process, outcomes, and learning. It includes applying the lessons in our future work and will also feed into the expansion of our deep dive work program.

LIMITATIONS

This research was difficult because we were applying these methods in a post-hoc manner. We faced the challenges of lack of data, staff turnover, and non-digitized documents, and often had to rely on the memory of current and former staff members.

To address the second objective of our research (that is, evaluating the WRII-RC's role and influence in advancing broader change at the city level), we attempted a

quantitative accessibility analysis to measure the change in access to opportunity (with jobs in the formal sector used as the proxy) and thereby capture the impact at the transport corridor level. However, we could not include this analysis as the lack of data and our assumptions/estimations produced skewed results from which no rational inferences could be drawn.

There are, of course, limitations on what we can conclude about the WRII-RC's contribution to city-level change through such an assessment. The complexity of a city changing over time, with a revolving set of actors, and an organization growing from a transport- and project-focused initiative to a full-scale international office makes measuring the citywide impact difficult. This is therefore not a complete impact analysis, but it contributes to understanding the Center's role and actions, and their effects, at the city level. Further research is needed, as well as careful documentation, monitoring, and evaluation of ongoing projects, to better quantify and attribute the impact. Moreover, this effort depended almost entirely on internal analysis and views, and would have included an independent external assessment and validation had sufficient funds and time been available. This could be considered the next step for future research.

CONTENT OVERVIEW

This practice note is presented in eight sections. Section 1 introduces the study, outlining its objectives, scope, and methodology. Section 2 contextualizes the Ross Center's work in Bengaluru and the evolution of the program. Section 3 details our foundational project—the BIG Bus Network—and other work related to the city bus system. Section 4 describes our engagement with urban development plans and policies at the neighborhood and metropolitan scales. Section 5 outlines our work around bringing efficiencies in the clean energy and water management space. Section 6 highlights various platforms for building partnerships and scaling innovative solutions and progressive practices. Section 7 describes our work in Karnataka state beyond Bengaluru. Section 8 presents our conclusions and insights. Appendices A–E contain additional details on our work related to the city's bus system (summarized in Section 3) and other research/knowledge products not discussed in the main body of the report.

2. CONTEXT

BENGALURU, INDIA'S SILICON VALLEY

Bengaluru, the capital of Karnataka state, is India's fourth most populous city according to 2022 estimates (Review 2022). Once famous as the "Garden City of India" and a "Pensioner's Paradise," by the late 1990s the city had gained an international reputation as the "Silicon Valley of India" as it led the nation's information and biotechnology revolution. Since then, it has grown into one of the four largest technology clusters in the world (Patil et al. 2015) and is home to 35–40 percent of India's start-up ecosystem and software/technology exports (*Bangalore Mirror* 2018). Attracting a major share of foreign direct investment and contributing an estimated gross domestic product of US$110 billion (in 2017), Bengaluru is India's fourth-largest metropolitan economy and is expected to be among the world's fastest-growing metropolitan economies in the years to come (Haritas 2017; DownToEarth 2018).

This explosive growth has driven a corresponding increase in population and urbanized area. Between 2001 and 2011, Bengaluru's population increased from 5.9 million to 8.4 million. With a growth rate of 44 percent, it ranked the highest in its class in the world (Patil et al. 2015). Given the rapid outward spread of the city, in 2007, the erstwhile municipal area of 226 square kilometers was amalgamated with 7 city municipal councils, 1 town municipal council, and 110 villages to form the new, enlarged Bruhat Bengaluru Mahanagara Palike (BBMP). In its new avatar, the BBMP covers an area of 710 sq. kms. making it the largest municipal corporation in India. The Bengaluru Metropolitan Area (BMA) of nearly 1,300 sq. km is today home to over 13 million people, with the population projected to exceed 20 million by 2031. However, the planning and management of scarce resources, as well as public investment in critical infrastructure, have fallen far short of the city's breakneck pace of growth and the demands of its residents.

Over time, several functions and civic services—previously under the ambit of the municipal corporation—have been progressively delegated to specialized parastatals of the state government. For instance, there are separate agencies for city planning and development, housing and slum redevelopment, roads and various transport systems, power, water supply and sanitation utilities, lake conservation, and so on (Table 2). As a result, multiple city and state government authorities exist at the metropolitan level with their own jurisdictions and functional autonomy (i.e., governing laws, mandates, plans, and budgets), typically operating in silos, with little coordination between urban planning and development processes.

Without a cohesive vision and approach to sustainable development, Bengaluru finds itself struggling with the fallout: primarily, growing traffic congestion, haphazard sprawl, worsening access to destinations and mobility of people and goods, strained essential infrastructure, and environmental degradation. These problems in turn reduce productivity, inhibit resource and economic efficiencies, and consistently lower the quality of life in the city.

In 2019, although Bengaluru was ranked the "most dynamic city" in the world by the Jones Lang Lasalle City Momentum Index, it was ranked 149 (out of 231) on the Mercer's Quality of Living Index.

For Bengaluru to sustain its economic growth and competitive edge (its appeal for investors and talent alike), it is imperative for it to ensure a resource-secure future and improved livability for its citizens. There is thus a pressing need in all sectors to shift from the status quo and adopt effective sustainable practices that can scale quickly.

EVOLUTION OF BENGALURU AS WRI INDIA ROSS CENTER'S DEEP DIVE CITY

Entry as EMBARQ India

Founded in 2002, WRI's EMBARQ initiative focused on research and OTG action to make sustainable transport a reality in cities across its global network spanning Brazil, China, India, Mexico, and Turkey. EMBARQ's first engagement in Bengaluru was in 2007, when our team was invited by the chief secretary, Government of

Table 2 | Key Government Agencies and Their Responsibilities

SECTOR	GOVERNMENT AGENCIES	RESPONSIBILITIES AND KEY FUNCTIONS
Urban Planning and Development	Bangalore Metropolitan Region Development Authority (BMRDA)	Planning, coordination, and supervision of orderly development in the Bangalore Metropolitan Region (BMR), with 11 local planning areas and authorities, including Bangalore Development Authority (BDA), Bangalore Mysore Infrastructure Corridor Area Planning Authority (BMICAPA), and Bangalore International Airport Area Planning Authority (BIAAPA).
	BDA	Planning, regulation, and development of areas under its jurisdiction, encompassing the Bruhat Bengaluru Mahanagara Palike (BBMP) area.
	BBMP	Administrative body responsible for developing the city and providing and maintaining civic amenities. It oversees building regulations, licensing, trade, education, health, sanitation/hygiene, water bodies, parks and trees, etc.
Transport	Directorate of Urban Land Transport (DULT) and Bengaluru Metropolitan Land Transport Authority (BMLTA—proposed)	Responsible for overseeing (coordinating the planning and implementation of) all urban land transport initiatives in urban/local planning areas of the state such as managing the State Urban Transport Fund, developing policies and guidelines, mobility plans, projects related to non-motorized transport (NMT), public transport, and traffic management, public outreach, and capacity-building initiatives. The BMLTA under the DULT has been proposed as an empowered Unified Metropolitan Transport Authority for Bengaluru.
	Bangalore Metro Rail Corporation Limited (BMRCL)	A joint venture of the central and state governments, BMRCL is a Special Purpose Vehicle (SPV) responsible for executing the Bangalore Metro Rail Project.
	Rail Infrastructure Development Company (Karnataka) Limited (K-RIDE)	A joint venture of the state government and the Ministry of Railways, K-RIDE is an SPV responsible for executing projects such as the flagship Bengaluru Suburban Rail Project.
	Bangalore Metropolitan Transport Corporation (BMTC)	A State Transport Undertaking, the BMTC is the sole public bus transport provider serving the Bengaluru Metropolitan Area (BMA) and beyond.
Infrastructure (Water/Power) Supply)	Bangalore Water Supply and Sewerage Board (BWSSB)	Responsible for providing adequate potable water supply and sewerage facilities in the BBMP area. Undertakes projects/schemes.
	Karnataka Urban Water Supply and Drainage Board (KUWSDB)	Responsible for providing adequate potable water supply and drainage facilities in all urban areas of the state except in the BBMP area. Undertakes projects/schemes.
	Bangalore Electricity Supply Company Limited (BESCOM)	Responsible for reliable and quality power supply and distribution in eight districts of the state, including the BMA within the Bengaluru Urban District. Undertakes projects/schemes.
Environment/ Natural Resources	Karnataka Lake Conservation and Development Authority (KLCDA)	Responsible for the restoration and maintenance of lakes, tanks, and wetlands in the state.
	Karnataka Groundwater Authority (KGWA)	Responsible for monitoring and regulating the groundwater quantity and quality in the state.
	Karnataka State Pollution Control Board (KSPCB)	Responsible for monitoring and regulating water, air, and noise pollution in the state and enforcing other rules/notifications related to environment protection, waste management, etc.

Sources: Based on information obtained from the respective agency websites and collated by WRI.

Karnataka (GoK), to conduct a multi-stakeholder workshop and review the freshly prepared Draft Comprehensive Traffic and Transportation Plan for the city. With inputs from national and international experts, we provided recommendations to refine several components of the plan.

EMBARQ India was formally established the following year in 2008, with its office headquartered in Mumbai, India's most populous metropolis and commercial capital. Guided by the EMBARQ strategy to "catalyze and help implement sustainable transport projects," EMBARQ India's early engagements in the country were carefully chosen strategic projects that could become exemplars for other cities to learn from and emulate. Given the Center's expertise and focus on bus systems, initial efforts under our *Bus Karo* program[5] included providing technical support to the flagship Janmarg Bus Rapid Transit System (BRTS) in Ahmedabad, before collaborating closely on two projects, the BRTS in Indore and the city bus system in Bengaluru.[6]

Initial Engagements: Forging Partnerships with Key Transport Agencies in Bengaluru

The Bangalore Metropolitan Transport Corporation (BMTC), established in 1997, is the sole public bus transport provider for the metropolitan area. A relatively young and lean agency, it had charted an impressive journey of growth and performance over its first decade to become the only profit-making state transport undertaking (STU) in the country. It was a front-runner in adopting new technologies and implementing measures to continually modernize and improve its services. Perceived as a progressive leader among its peers, major reforms or upgrades deployed by the BMTC had significant potential to influence the quality of bus systems across India. The BMTC's stature, receptivity, and the high replication/scaling prospects were some of the strategic considerations for entering into a partnership with it in 2010. As EMBARQ India, we began our engagement remotely at first, with staff based in the Mumbai office. The objective was to support systemic improvements through a citywide bus route rationalization exercise.

Subsequently, EMBARQ's interest expanded from its central focus on sustainable transport to encompass allied areas, and in 2011, it began work under the new Urban Development and Accessibility (UDA)

workstream in India. In the same year, EMBARQ India opened an office in Bengaluru and signed a Memorandum of Understanding (MoU) with the Directorate of Urban Land Transport (DULT), set up under the Urban Development Department (UDD), GoK. The Directorate is responsible for coordinating the planning and implementation of all urban land transport initiatives in the state. Under the MoU, our team worked closely with the DULT over a three-year period, providing knowledge and technical support with planning and design interventions related to three upcoming mass rapid transit systems: the pilot bus rapid transit (BRT) corridor and metro rail project in Bengaluru and the BRT in Hubli-Dharwad. In partnership with key transport agencies—the BMTC, DULT, Bangalore Metro Rail Corporation Ltd. (BMRCL), and Hubli-Dharwad BRTS Co. Ltd. (HDBRTS)[7]—we commenced work on pilot projects to demonstrate the case for data-driven bus operations planning, transit-oriented development (TOD), and safe access.

EMBARQ India received a multi-year grant in 2012, allowing it to continue and build upon the foundational work in Bengaluru by hiring staff, expanding the office, and deepening its engagement across sectors. With new projects added to the portfolio, engagement with government/nongovernment stakeholders also expanded to include the BBMP, private sector businesses (real estate developers, corporates), and civil society. WRI's electricity governance work in India also began in 2010–11, through initial engagements with the southern states of Karnataka and Tamil Nadu, laying the ground for WRI India's Energy program.

From EMBARQ India to the WRI India Ross Center for Sustainable Cities

The evolution from EMBARQ India to the WRII-RC in 2014 marked a significant shift in the scope of work and approach. Under the expanded program, a new workstream—Urban Efficiency—was added, encompassing work related to energy, water, and building efficiency in the city's space. The Center's new deep dive strategy for Bengaluru was formulated to cover engagements across our three workstreams: Integrated Transport, Urban Development, and Urban Efficiency. The use of more data- and evidence-based decision-making at different scales was emphasized to strengthen its "creating impact with OTG demonstration

projects and scale-up" approach. This evolution in strategy derived from the program's past work experience and learning in cities, including Bengaluru, which shed light on the following:

- **Key challenges faced by our cities:** Traffic congestion, sprawl, resource inefficiency, finance, and governance and planning frameworks.

- **Issues at different scales:** Some problems need to be understood and addressed at the neighborhood/local scale and others at the metropolitan/regional scale.

Since 2010, the Sustainable Cities program has been assisting Bengaluru in making informed decisions on land use and infrastructure, including transport and energy, which typically have a 40- to 100-year lock-in effect. The program has endeavored to bring data, knowledge, and technical expertise to build capacities and provide inputs to policies and plans. Along with several key stakeholders, the team has also helped implement OTG projects that promote sustainable and inclusive development in Bengaluru.

OVERVIEW OF ENGAGEMENTS IN BENGALURU

Figures 3–5 illustrate the WRII-RC's portfolio of projects in Bengaluru over time, their geographical location and spread, and our engagement with various stakeholders in the city.

Over the years, the WRII-RC's work has evolved and expanded within sectors (under our three workstreams) and across sectors, scales, and types of intervention (see Appendix B). Starting with a focus on BRT, bus systems, accessibility, and TOD, our work gradually grew to include metro rail and multimodal integration (MMI), road safety, managing urban expansion in the city region, bringing efficiencies in the space of clean energy and, subsequently, water management. The Center has

supported OTG pilot projects at the neighborhood or corridor levels and also long-term initiatives related to governance reforms, visioning, plans, and policy advisories (on a range of sectoral/cross-sectoral issues) at the metropolitan, regional, and state levels. Programmatic work has been reinforced and expanded by creating platforms that foster innovation and build partnerships, as well as through our core knowledge-sharing and capacity-building activities.

Figure 4 presents a spatial mapping of the WRII-RC's on-ground pilot projects and their scale-up in the city. These are at the community/township, neighborhood/ward, and corridor levels and, as can be seen, are spread out across the city. Although these locations were chosen based on project-specific criteria and have emerged organically over time, the map reveals where different interventions overlap or come together spatially. This provides an opportunity to identify synergies and build upon, or connect, our work, across future or concurrently running projects.

Figure 5 maps the WRII-RC's engagement with government and nongovernment stakeholders or actors in Bengaluru, categorized by whether they are city-, state-, or national-level entities. It also highlights key institutional partners with whom we have significant or long-standing engagements, often through formal MoUs. The types and number of the organizations and individuals we have engaged with have grown hand in hand with the expansion of our project portfolio across sectors and scales.

Together, these figures help present a broad picture of the Center's work, and network, at the city level. They also provide an orientation and structure for the discussion that follows. The next few sections present our programmatic work in response to the key challenges faced by the city, its evolution within and across workstreams, in Bengaluru and beyond, concluding with an effort to capture the cumulative impact and influence of our projects.

Figure 3 | Project Timeline Across Workstreams

Year	INTEGRATED TRANSPORT	URBAN DEVELOPMENT		URBAN EFFICIENCY	CROSS-SECTORAL	
2010	Bus — Bangalore Intracity Grid (BIG)					
2011		Indiranagar Station Accessibility Plan & Development Control Regulations (SAP-DCR)		Karnataka Electricity Governance Network		
2012	Bus — Outer Ring Road Bus Rapid Transit (ORR BRT) Proposal		Sustainable Mobility Design Practices in Indian Townships			
2013		Hosur-Sarjapur Road Layout Neighborhood Improvement Plan (HSR-NIP)		GPMDG India launch; CollabSolar Project		
2014	Bus — BIG Bus Network Scale-up	SAP-DCRs Scale-up	Karnataka Town and Country Planning Act Revision	Electricity Sector - Integrated Resources Planning		
2015	Bus — Financial Sustainability (fleet augmentation, fare restructuring, tax exemptions)		Bruhat Bengaluru Mahanagara Palike (BBMP) Restructuring Phase 1	Strategic Projects – Whitefield, Ring Roads, BIAAPA Master Plan	VidyutRakshaka (VR) Phase 1; Residential Rooftop Solar	
2016	Bus — Safety (women, bus and road safety)		Bangalore International Airport Ltd. (BIAL) Solar Project	City Water Assessment Framework + Pilots	Unlock Bengaluru - Inaugural Conference	
2017	Bus — Data (ITS, open data policy + monetization, analytics tool); Metro Feeder Bus services	Station Access and Mobility Program (STAMP)	BBMP Restructuring Phase 2	VidyutRakshaka Scale-up (VR Lite, VR for Aggregators)	Developers Dialogue	Karnataka Vision Plan 2025
2018	Metro — STAMP Challenge Scale-up	Bus — Electric Buses Transition Roadmap	Bengaluru Revised Master Plan 2031 Inputs			
2019	Bus — Vision Plan; Mobility and Accessibility Program	Bus and Metro — Complementary Services and Mode Integration	Integrated Regulatory Framework for Transit-Oriented Development (TOD) in Bengaluru	Renewable Energy Procurement - Green Tariffs		
2020	NMT — Sustainable Urban Mobility Accord; National Challenges	Road Safety — Safer Streets and Mobility; Safe Routes to School	Evaluating Potential Benefits of Bangalore Metro and TOD	Data Portal and Greenhouse Gas Inventory for Bengaluru		

■ INTEGRATED TRANSPORT   ■ URBAN DEVELOPMENT   ■ URBAN EFFICIENCY   ■ CROSS-SECTORAL

Sources: WRI authors.

Figure 4 | **Spatial Distribution of Projects in Bengaluru**

Bengaluru
International Airport

Legend:
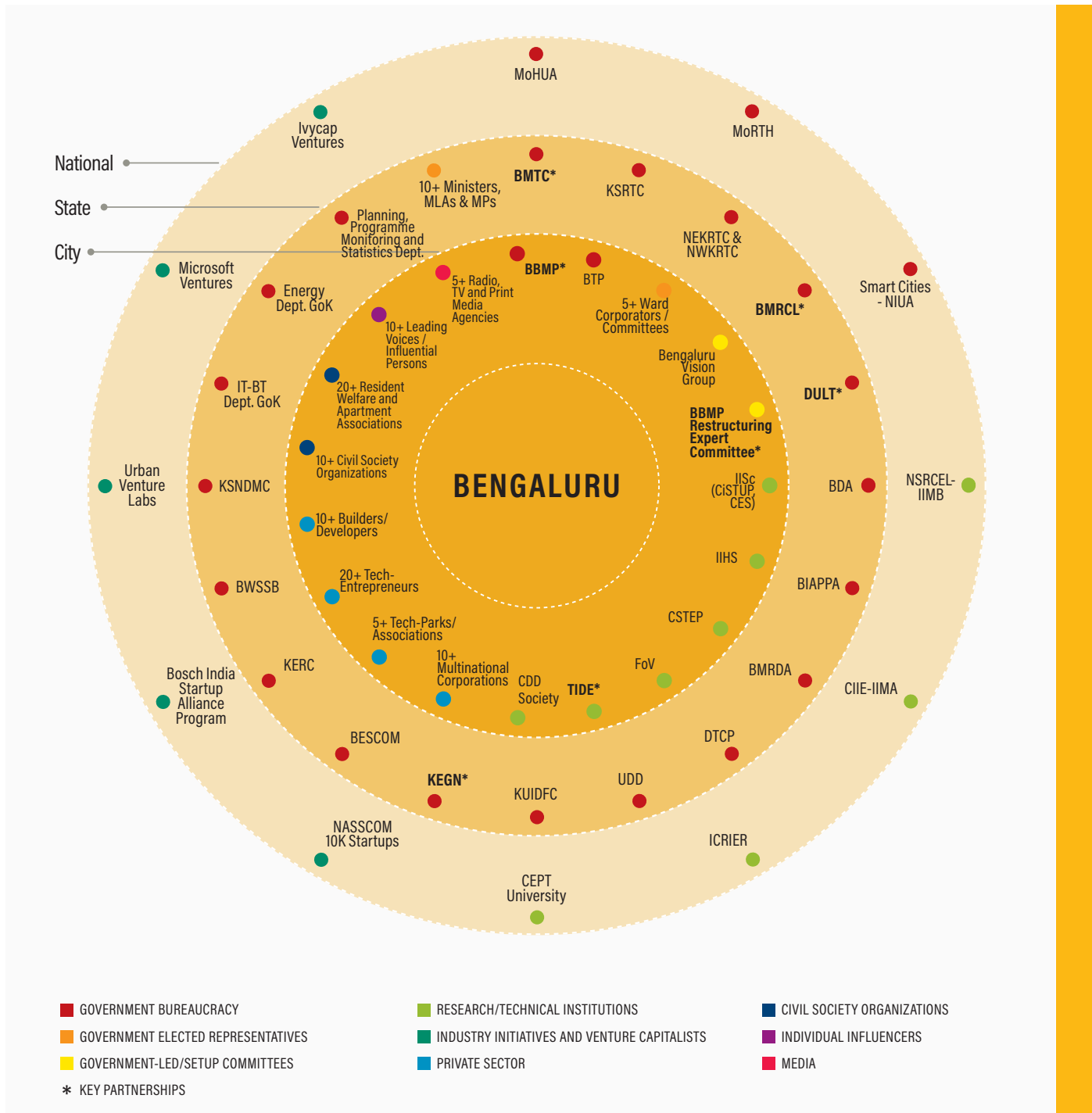
- BDA boundary
  - Draft RMP 2031
- BBMP boundary
  - Safer Routes to Schools analysis
  - BBMP Restructuring
  - CWAF analysis
- BMTC bus network
- BIG Bus trunk routes
- ORR BRT proposal
- ORR pop-up bicycle lane
- Ph 1 – Ph 2 metro network
  - Bus-Metro complementarity analysis

- Baiyappanahalli - STAMP pilot project
- STAMP scale-up metro stations
- Nurturing Neighborhoods pilots
- BIGRS safe intersection pilots
- Indiranagar - SAP-DCR pilot project
- SAP-DCR scale-up metro stations
- Townships - mobility design audit pilots
- HSR-NIP pilot project
- NIP Challenge project areas
- BIAL Solar project
- VR for Aggregators - pilots

Distribution of VR households
(number of households)

- 1-20
- 21-60
- 61-120
- 121-160
- 161-362

Notes: See list of abbreviations on page 69.
Sources: WRI authors.

Figure 5 | **Stakeholder Ecosystem Engagement**

National
State
City

MoHUA
Ivycap Ventures
10+ Ministers, MLAs & MPs
BMTC*
KSRTC
MoRTH
NEKRTC & NWKRTC
Planning, Programme Monitoring and Statistics Dept.
Microsoft Ventures
Energy Dept. GoK
5+ Radio, TV and Print Media Agencies
BBMP*
BTP
5+ Ward Corporators / Committees
Smart Cities - NIUA
BMRCL*
10+ Leading Voices / Influential Persons
Bengaluru Vision Group
DULT*
IT-BT Dept. GoK
20+ Resident Welfare and Apartment Associations
BBMP Restructuring Expert Committee*
BDA
NSRCEL-IIMB
10+ Civil Society Organizations
IISc (CiSTUP, CES)
Urban Venture Labs
KSNDMC
BENGALURU
IIHS
10+ Builders/ Developers
BIAPPA
BWSSB
20+ Tech-Entrepreneurs
CSTEP
5+ Tech-Parks/ Associations
BMRDA
CIIE-IIMA
KERC
10+ Multinational Corporations
FoV
Bosch India Startup Alliance Program
CDD Society
TIDE*
DTCP
BESCOM
KEGN*
KUIDFC
UDD
ICRIER
NASSCOM 10K Startups
CEPT University

- ■ GOVERNMENT BUREAUCRACY
- ■ GOVERNMENT ELECTED REPRESENTATIVES
- ■ GOVERNMENT-LED/SETUP COMMITTEES
- ■ RESEARCH/TECHNICAL INSTITUTIONS
- ■ INDUSTRY INITIATIVES AND VENTURE CAPITALISTS
- ■ PRIVATE SECTOR
- ■ CIVIL SOCIETY ORGANIZATIONS
- ■ INDIVIDUAL INFLUENCERS
- ■ MEDIA
- ＊ KEY PARTNERSHIPS

Notes: See list of abbreviations on page 69.
Source: WRI authors.

3. ADDRESSING MOBILITY AND TRAFFIC CONGESTION

CONTEXT AND RELEVANCE

In recent decades, Bengaluru has seen an exponential increase in motorization rates. The factors driving this increase are rapid urbanization and spatial spread, rising income levels, and the lack of adequate public transport facilities to serve the growing demand (TERI 2008; Fok et al. 2014; Revi et al. 2014). Although national policy directives and city-level plans developed between 2005 and 2011 outlined several proposals for land use–transport integration and transport infrastructure provision, implementation has been slow due to various reasons such as lack of public resources and capacity, political economy considerations, and procedural delays.

Despite Bengaluru having one of the most extensive and well-run public bus systems in the country, its mode share has fallen over the years because competing modes have become less expensive, faster, or more convenient (Table 3). Buses still serve the maximum number of commuter trips—about 4.5 million daily— and remain the workhorse when it comes to public

transportation. However, the city bus system has not seen the investment it requires for continual augmentation and enhancement of its services.

Although a significant proportion of commuters in the city walk, the supporting infrastructure is woefully inadequate. A 2011 study noted that the city had few safe pedestrian crossings and no segregated cycle lanes, and about 40 percent of the surveyed roads had no paved footpaths. Where they do exist, they are often encroached upon, poorly built, and inadequately maintained (UMTC 2011).

Phase 1 of Bengaluru's metro rail project, spanning 42 km, was approved in 2006 and progressively operationalized between 2011 and 2017. However, its average ridership of about 0.4 million passengers per day (*Times of India* 2018) is considerably lower than expected, accounting for less than 4 percent of the total number of motorized trips. Although the network and capacity are set to expand, the challenges of safe access to stations, last mile connectivity, and MMI remain. Many other proposals for new arterial roads and bus- and rail-based mass transit systems[8] have not yet materialized.

Table 3 | **Population, Vehicular Growth, and Mode Shares (1991–2021)**

YEAR	BBMP POPULATION	BBMP POPULATION CAGR	REGISTERED MOTOR VEHICLES	REGISTERED MOTOR VEHICLES CAGR	MOTORIZED MODE SHARE: PRIVATE TWO- AND FOUR-WHEELERS	MOTORIZED MODE SHARE: PUBLIC TRANSPORT (BUS+METRO)
1990–91	4.3 million	3.7%	0.6 million	9.2%	25%	60%
2000–01	5.9 million	3.7%	1.5 million	9.2%	42%	49%
2005–06	6.7 million	3.7%	2.5 million	9.2%	40%	46%
2010–11	8.4 million	3.7%	3.7 million	9.2%	47%	42%
2015	10.1 million	3.7%	6.1 million	9.2%	45%	48%
2021[a]	12.7 million	3.7%	8.5 million	9.2%		

Note: CAGR = compound annual growth rate.
[a] Population (municipal area) for 2021 is estimated based on data from World Population Review (Review 2022).
Sources: TERI 2008; UMTC 2011; BDA 2017; iDeCK 2019; Philip 2020.

In recent years, the city has taken some steps to facilitate tech-enabled shared mobility solutions and implement pedestrian-friendly, road redesign projects, and public bicycle-sharing schemes in certain pockets. However, these efforts are yet to see wider adoption.
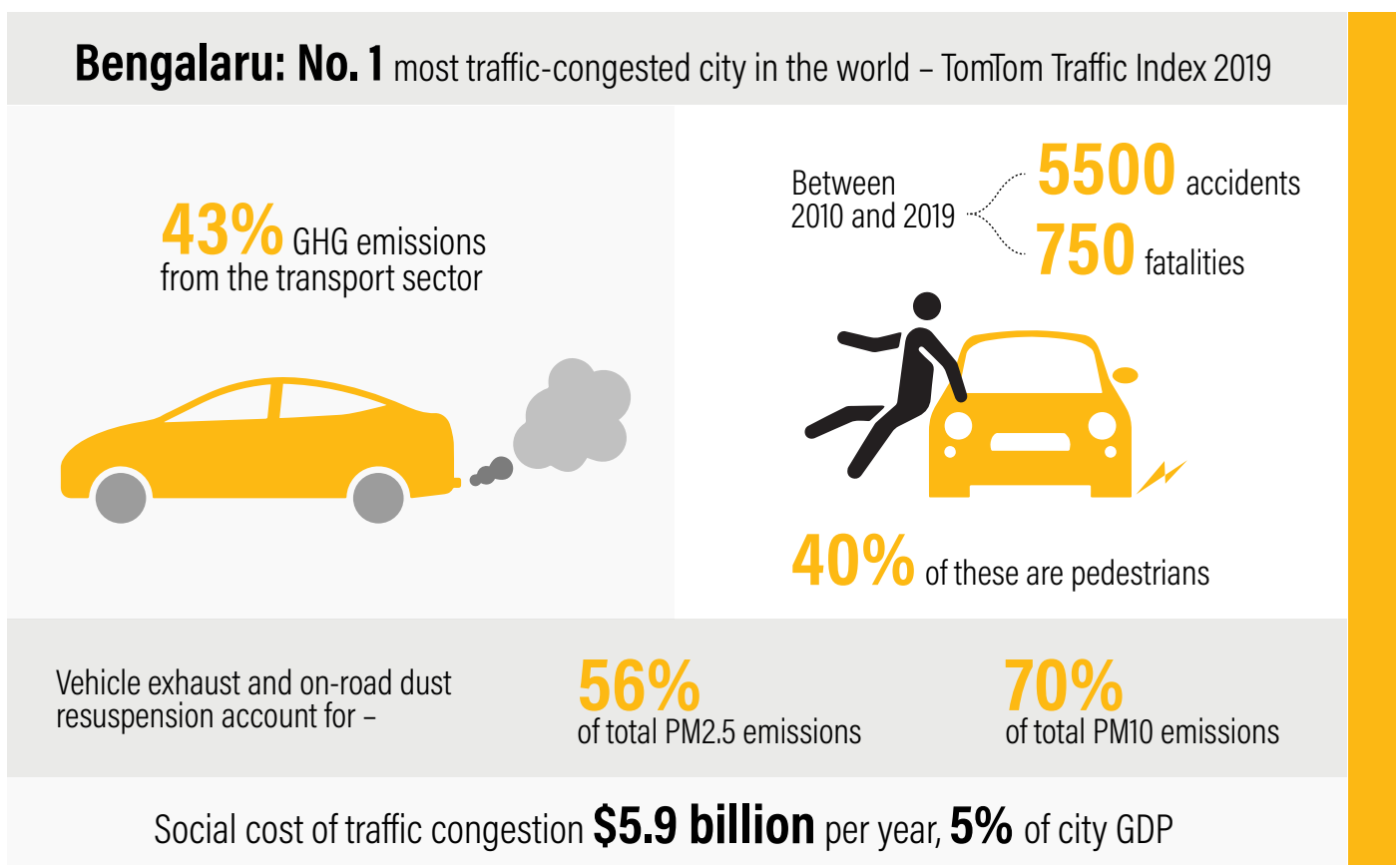
Meanwhile, vehicular numbers have continued to surge (Table 3),[9] contributing to growing traffic congestion and associated negative externalities. In Bengaluru, the transport sector is the highest contributor to greenhouse gas emissions and air pollution. The number of crash-related injuries and fatalities is significantly high, and road safety is a major concern (see Figure 6).

The WRII-RC's response to Bengaluru's transportation problems under our Integrated Transport workstream is guided by the *Avoid-Shift-Improve* approach[10] with a focus on the Shift and Improve components as the basis of our strategy. Over the past decade, our team has forged successful partnerships with key public transport agencies in the city and played an instrumental role in supporting various modernization efforts and systemic upgrades undertaken by these agencies.

In Bengaluru, public transport is primarily provided by its city bus system run by the BMTC. Improving its service quality and patronage is thus central to promoting sustainable mobility and alleviating congestion in the city. We began our engagement with the BMTC in 2010, under the Bus Karo program. Broadly, we have worked toward improving public bus transport access and efficiency, including last mile connectivity and MMI; financial sustainability; data-led planning; safety; and vehicle technology aspects of public buses, as described below.

Figure 6 | **Transport Sector Impacts in Bengaluru**

Bengalaru: No. 1 most traffic-congested city in the world – TomTom Traffic Index 2019

43% GHG emissions from the transport sector

Between 2010 and 2019 — **5500** accidents — **750** fatalities

40% of these are pedestrians

Vehicle exhaust and on-road dust resuspension account for – **56%** of total PM2.5 emissions **70%** of total PM10 emissions

Social cost of traffic congestion **$5.9 billion** per year, **5%** of city GDP

Sources: Ramachandra et al. 2015; The New Indian Express 2018; BTP 2022; Guttikunda et al. 2019; The Footpath Initiative 2019; Tom Tom Traffic Index 2019.

PUBLIC BUS TRANSPORT ACCESS AND EFFICIENCY

The BIG Bus System

Opportunity

The BMTC manages one of the most extensive bus networks and operations in the country. However, even with continual fleet and service expansion, it is unable to keep up with the demands of a rapidly growing population and urbanized area. Continuing with its conventional "direct or destination-oriented" service model[11] meant that as the city and the number of origin-destinations grew, the number of bus routes also grew organically and exponentially over time.[12] This resulted in an increasingly complex system that made planning and navigation difficult, apart from operational inefficiencies, redundancies, and poor service levels, especially in the outer suburbs and peripheral areas. Common concerns reflected in several news articles, mobility studies, and user surveys conducted between 2005 and 2011 (WSA 2009; RITES 2011; UMTC 2011) pointed to the need for improved frequency, reliability, speed, access to bus stops (especially in the outer areas), and lower fares to improve patronage and arrest its declining mode share.

Recognizing that many of these issues stemmed directly from underlying deficiencies with the conventional model of service planning and network expansion, members from civil society organizations (Mapunity and Praja RAAG) approached the BMTC and convinced the management to pilot test a "direction-oriented" service[13] model. Starting in February 2009, the BMTC steadily introduced direction-oriented bus services under the banner of the Bangalore intra-city grid (Big). Big10 buses operated on 10 radial roads connecting the city center to outlying suburbs, while the Big Connect and Big Circle operated on circular routes within and along the Outer Ring Road (ORR), providing inner-city and cross-suburban connections, respectively (see Figure 7). Aligned with high-demand arterial movement corridors, they formed a basic grid for running high-frequency buses that were also given a visually distinct identity. Steadily increasing passenger patronage and profits made this initiative a successful experiment in

urban bus system restructuring in India (Navya 2011; Subramanium 2011).

The BMTC's interest in using data-driven techniques for performance monitoring and operations planning provided an ideal entry point and opportunity for the WRII-RC. In December 2010, our team conducted a study to assess the performance of BMTC's Big10 services and suggest measures for improvement. We gathered data and conducted wide-ranging analyses on four select Big10 routes. A report of the findings and suggestions was presented to the BMTC (EMBARQ India 2011a). Our experts also conducted two capacity-building workshops for over 70 staff and senior officials from the BMTC and the DULT, introducing advanced techniques of performance monitoring, planning, scheduling, and marketing of bus operations. Based on this, plans were made to institute a data collection program within the BMTC and hold additional sessions to explore the use of these techniques in day-to-day operations, with training and guidance from the WRII-RC.

Our study showed that although Big10 services were successful in enabling a shift from personal modes, which increased ridership and revenues for the BMTC, there was scope for achieving greater operational efficiencies and service levels. Although the Big10 had emerged as a strong supplementary network, it still operated alongside the conventional services, which reduced the effectiveness of the new system and carried forward core issues related to the older services. We recommended that the BMTC further optimize and strengthen the Big10 system by piloting a comprehensive "corridor improvement plan" before scaling up to all arterial corridors.

Our team also drew upon the BMTC performance data to estimate emission savings from public bus services in Bengaluru and captured the findings in a research paper (Prabhu and Pai 2012). The modeled scenarios showed a significant reduction in carbon emissions and indicated that route rationalization, high-quality infrastructure, and bus priority measures that move performance levels toward those seen in BRTS could achieve significant mode shifts while reducing service kilometers, and thus emissions, even further. These studies, recommendations, and workshops were well received by the BMTC, and the WRII-RC took the initiative to drive the step-up efforts.

Figure 7 | **Schematic of Proposed Big Bus Routes**

C-ROUTES

D-ROUTES

C ROUTE	K1 ROUTE
D ROUTE	K2 ROUTE
B3 ROUTE	K3 ROUTE
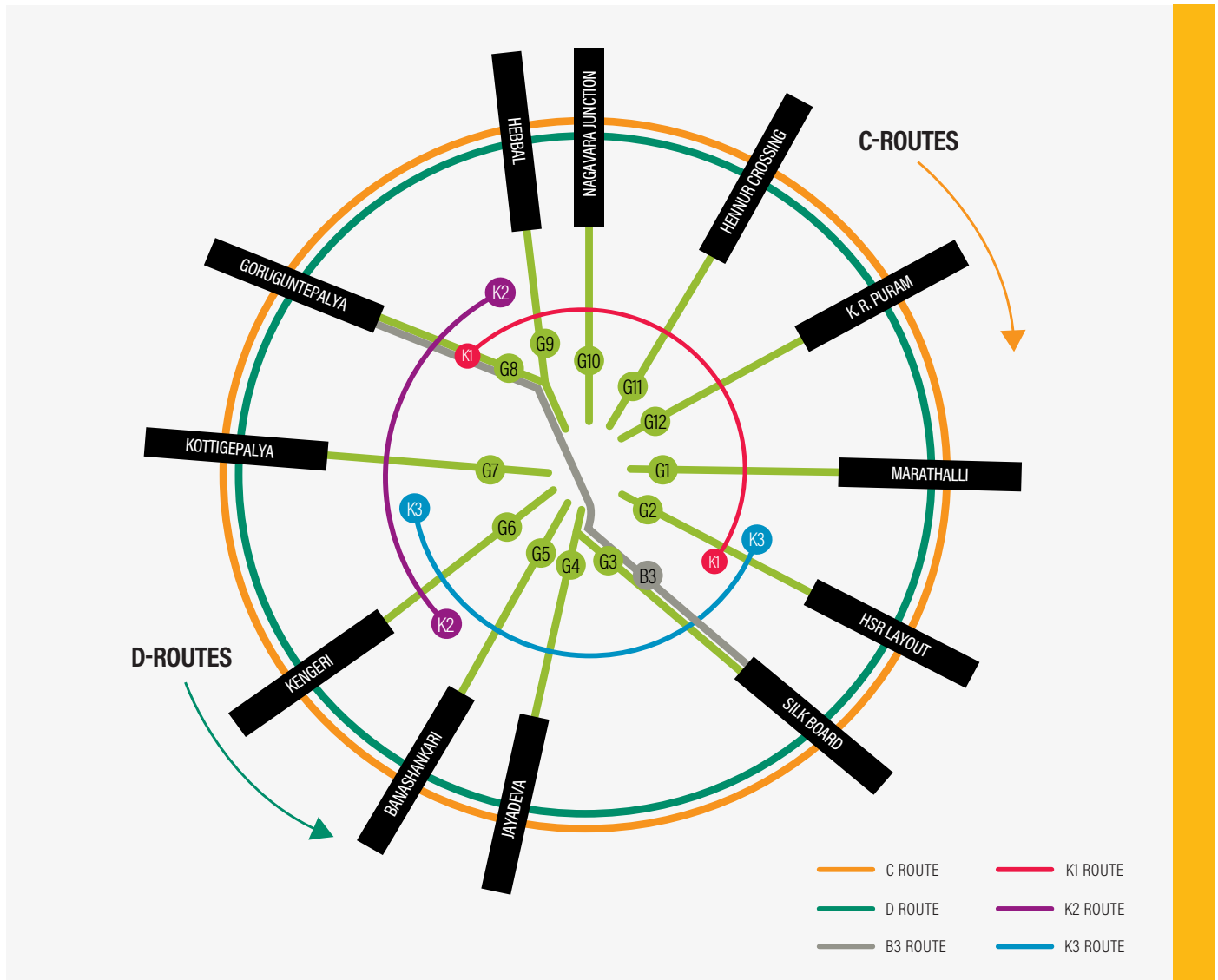
Sources: Mapunity and Praja RAAG.

Objective and Strategy

To encourage a shift to public bus transport and increase its mode share in the city, our team proposed a systemic reorganization of BMTC's services—through a citywide route rationalization exercise—to substantially improve their overall efficiency and quality.[14] Building upon the earlier Big10 model, the new and improved BIG Bus network was conceived as an integrated direction-oriented system of trunk and feeder routes, with high-frequency services.

Actions

Securing buy-in from the BMTC was a long and iterative process involving active engagement with its officers and case-building exercises. Theoretically, the proposed new system promised substantive benefits, but it was initially met with reservation, skepticism, and even opposition from within the BMTC, as it was commonly believed that passengers do not like to make transfers.

Our team conducted primary surveys at select locations on Hosur Road, a national highway and one of the

busiest arterial corridors in the city, to assess the prevailing situation and identify gaps, issues, and potential challenges related to transfers.[15] The findings and recommendations of this study were crucial in assuaging concerns and finally convincing the management at the BMTC of the need for, and viability of, the new system. Our team proposed that the BIG Bus trunk and feeder services be supplemented by other upgrades. These included safe and comfortable transfer facilities at major intersections, rationalized and integrated fares to eliminate transfer penalties, simplified route numbering and unified branding, and passenger information aids for ease of understanding and use. Together, they would comprise an integrated and seamless transfer-based bus system, much like the metro (see Figure 8).

Pilot on Hosur Road

Hosur Road was chosen for the pilot "corridor improvement" project, and we worked closely with the BMTC, supporting them on all aspects of planning and implementation. Our team supervised the collection of data, field surveys, and analyses for the route and schedule rationalization for the corridor. The impact of transitioning to the new system was estimated through a modeling exercise, which showed significant gains in efficiency and service quality. The number of routes and average wait times could potentially be reduced by half while maintaining the same service coverage area and resources (buses, staff). Thereafter, our staff participated in working sessions with the BMTC to finalize all aspects of the approved plan for the pilot corridor, such as operational details, fare structuring, design of transfer facilities, the new branding scheme, route numbering system, and maps.

Intermediate Outcomes

- Nearly three years after beginning our engagement with the BMTC, the BIG Bus project finally came to fruition. In September 2013, the BIG Trunk services (replacing the earlier Big10 services) along Hosur Road were launched by the chief minister and transport minister in a grand ceremony.

- This was followed by the launch of the specially procured midi-buses providing frequent feeder services that connected remote locations and villages to the high-frequency trunk services along Hosur Road.

- The BMTC also introduced a new ticketing system using electronic ticketing machines to eliminate transfer penalties (*The Hindu* 2016).

- For the Hosur Road Corridor Improvement Project with the BMTC, EMBARQ India was named joint winner of the "2012 Volvo Sustainable Mobility Award," received from the Principal Secretary (Transport), GoK.

"The feeder services would cater to about 0.18 million people residing in 77 villages off Hosur Road with a frequency of 30 minutes, which had been about 3 hours for direct services to the city center."
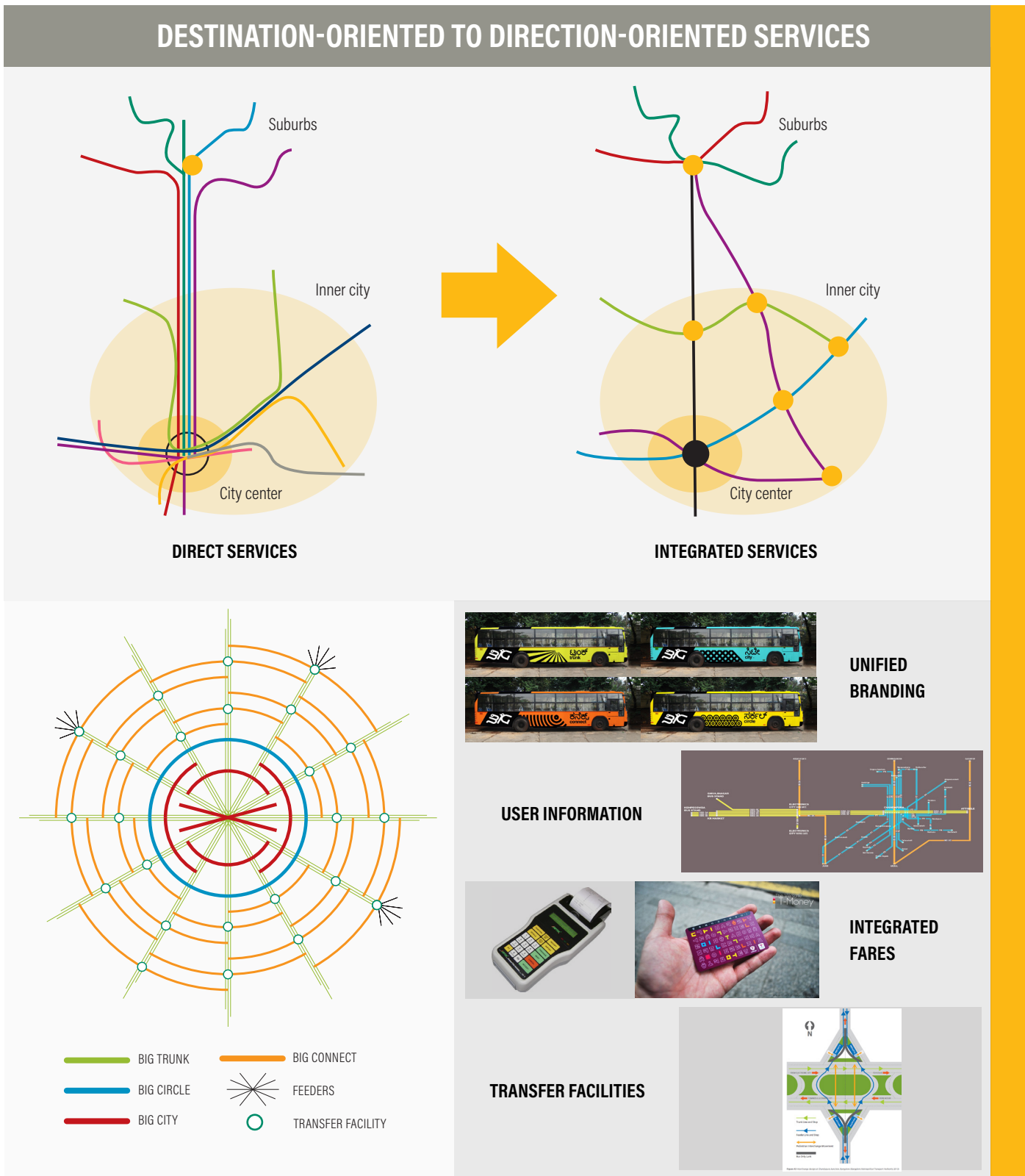*– Mr. Anjum Parvez, Managing Director, BMTC*

Final Outcomes: Impact and Influence

With anecdotal evidence to back up growing ridership and revenues on the pilot corridor, the BMTC was encouraged to expand this effort to other radial arterial roads. Our team developed a toolkit to scale up the "corridor improvement" methodology and subsequently supported BMTC staff with its planning and implementation on two additional corridors (Vasudevan and Mulukutla 2014).

- In August 2014, our team conducted a commuter survey[16] to evaluate the performance of the new system. Our findings showed that the trunk services were very successful in attracting new users, with 50 percent shifting from private or paratransit modes as a direct result of the service quality improvements of the new system: higher frequencies, good-quality buses, and user-friendliness. However, it found that the feeder services were underperforming due to lack of awareness among the public and gaps in service coverage, connectivity, and syncing of frequencies with demand. Their performance was also suboptimal as transfer facilities, fare integration, and user information/communication aids were not yet fully developed. Most users nevertheless said they would recommend the services and supported their expansion.

- In 2015, our team helped the BMTC implement the BIG Bus trunk and feeder services on yet another corridor, taking the count to 4 of the 12 radial arterials[17] in the city. These higher-frequency services substantially reduced wait times (by one-half to one-sixth) for commuters from peri-urban areas.

Figure 8 | **The BIG BUS System**

DESTINATION-ORIENTED TO DIRECTION-ORIENTED SERVICES

Suburbs

Inner city

City center

DIRECT SERVICES

Suburbs

Inner city

City center

INTEGRATED SERVICES

BIG TRUNK

BIG CIRCLE

BIG CITY

BIG CONNECT

FEEDERS

TRANSFER FACILITY

UNIFIED BRANDING

USER INFORMATION

INTEGRATED FARES

TRANSFER FACILITIES

Notes: BIG = Bangalore Intra-city Grid.
Sources: Vasudevan and Mulukutla 2014.

With high-level political and institutional backing for the project, the BMTC was in the process of procuring new buses and sought our continued support in scaling up the effort to other arterial corridors. When expanded citywide, the BIG Bus system was expected to serve approximately 750 million passenger trips and save 25 million commuting hours each year.

Working closely with the BMTC and providing technical support throughout the process, the WRII-RC played an integral role in catalyzing the reforms that marked the first successful bus route reorganization in a major Indian city. The development of an effective framework for the transition of an established bus network from a "destination-oriented" toward a "direction-oriented" model was a game changer for urban bus transport in India, particularly for large cities. We documented and disseminated the BIG Bus case study and corridor improvement methodology through publications, blogs, media articles, Bus Karo, and other training workshops. Following Bengaluru's example, Chennai's Metropolitan Transport Corporation implemented our recommendations for bus route reorganization on a major arterial corridor, and more recently, Gurgaon has also successfully undertaken a similar exercise at the city scale.

Challenges and Learning

Our deep engagement with the BMTC on the BIG Bus project—over a five-year period and through multiple changes in the BMTC leadership—laid the foundation for a strong, enduring working relationship. It helped gain their goodwill and establish our credibility as a valued knowledge partner.

The project, however, faced certain fundamental hurdles in the process toward implementation and scale-up. A major challenge throughout was the lack of high-quality data for evaluation and planning. To overcome this, our team undertook several primary and secondary studies for data collection and analyses at various stages of the project. Our methods were systematized and shared with BMTC staff, whom we also trained to conduct these exercises internally and regularly going forward. However, inadequate resource capacity (manpower and funds) within the BMTC still posed a challenge to scaling the BIG Bus network across the city.

Another significant factor that delayed implementation on additional corridors was the unavailability and slow procurement of the new buses needed to replace the older ones that had to be retired. Progress on other components such as deploying the Intelligent Transport System (ITS) to aid operations planning and fare integration and developing passenger information aids and transfer facilities were also significantly slowed down due to procurement-related issues and lack of inter-agency coordination.

The challenges we identified and faced through the initial years of engagement with the BMTC led us to work on other related facets of the system. In the years following—that is, 2015 onward—our team has continued to support them on various fronts, as outlined in the following sections (for details, see Appendix C).

FINANCIAL SUSTAINABILITY

Financial sustainability is key to the health of any agency and its ability to continually augment and enhance its services to keep pace with growing demands. The WRII-RC has supported the BMTC's efforts to improve its operational and financial efficiencies and helped it secure government grants and waivers. On various occasions, our team has used data-driven research to help it draft compelling proposals and present a strong case for financial support from the government. In particular, we have helped it augment its bus fleet, obtain tax exemptions, and restructure fares:

- In 2015, our team engaged with the highest levels of political leadership to secure approval for the procurement of 3,000 new buses. The case for more buses was pitched to the chief minister in a high-level meeting. The GoK has since sanctioned an estimated $77 million for buying 1,500 buses, with the remaining to be leased under a public-private partnership (PPP) model (which is not yet implemented).

- Based on our research (WRII-RC 2017b, 2019a) and support, the BMTC made a successful bid to seek relief from direct taxes. The GoK exempted them from paying $18 million in motor vehicle tax in 2016–17, which was extended to $15 million for 2017–18, $14.9 million for 2018–19, and $9.87 million for 2019–20.[18]

- Our recommendations for fare restructuring (WRII-RC 2017a) adopted by the BMTC in 2017 helped rationalize and reduce fares for shorter trips, while also reducing the problems of pilferage by staff and receiving change for commuters. This reform benefits the agency as well as passengers, who pay the highest fares in the country, especially for the first few stages.

"The exemption will be a big relief to BMTC as it is in a precarious financial condition."
– Dr. Ekroop Caur, Managing Director, BMTC

DATA-LED PLANNING

The WRII-RC has helped the BMTC improve and institutionalize the process of gathering and managing high-quality data for performance monitoring and operations planning. Building on past efforts, our team has accomplished the following:

- Assisted the BMTC in adopting an integrated ITS and passenger information system—the first of its kind in the country—that was launched in 2016

- Developed a "data analytics tool" to optimize services and helped BMTC technical staff use it (WRII-RC 2019b)

- Conducted a study to explore the potential of transit data monetization (WRII-RC 2019d), convened stakeholder discussions on sharing the BMTC's data, and provided inputs to its Open Data Policy; in early 2020, the BMTC announced its decision to share real-time data for noncommercial purposes

LAST MILE CONNECTIVITY AND MMI

To extend the reach and accessibility of mass transit networks, the WRII-RC has supported efforts to boost last mile connectivity and MMI, which is recognized as a critical gap and issue in the city, in the following ways:

- We have aided the integration of bus and metro services by helping the BMTC reduce redundancy, rationalize their operations along metro corridors, and plan feeder bus services around five metro stations in the city (WRII-RC 2019c). This is being extended to other stations using the scientific, data-driven design framework we developed.

- Our team has facilitated conversations between the BMTC and private sector entrepreneurs to provide

feeder services to major bus terminals and BIG Bus trunk routes. This led to a tie-up with Bykerr (a city-based start-up) in 2018 to provide last mile connectivity to passengers using its airport services, as a pilot exercise.

- We have also shared our knowledge (case studies/best practices) of smartcard-based integrated fare systems with the BMTC. The system was introduced on a trial basis, but it is currently not in operation; fresh efforts toward a common mobility card are under way.

SAFETY

The WRII-RC has supported the BMTC in two specific areas to improve the safety aspects of their services, women's safety, and bus road safety, as follows:

- In 2015, our team conducted a study on the safety concerns of women users of BMTC buses and convened a multi-stakeholder workshop on women's safety in public transport in Bengaluru. The following year, we helped the BMTC develop a proposal for utilizing the Government of India's (GoI's) Nirbhaya Fund, which led to a grant of $8.3 million to make its bus service safer for women. Several measures outlined in the proposal have been implemented (Kakal and Chadha 2015; Mulukutla et al. 2016).

- We have also facilitated hackathons to find innovative, tech-enabled solutions for improving women's safety in public transport and public spaces in the city (WRII-RC 2015, 2017d).

- In 2015, our team analyzed the BMTC's crash data and helped it develop scientific crash data collection formats and a customized driver training manual. We also conducted "train the trainer" workshops for over 50 BMTC staff to equip them with better content on and insights into safe driving practices. We also created communication material for a bus and road safety campaign.

- Our team also assisted the BMTC in a pilot exercise to retrofit standard (larger) rear-view mirrors in buses plying their most crash-prone routes. Following its success, the BMTC issued a tender to procure standard rear- and front-view mirrors for 500 buses, and in principle agreed to retrofit all their buses.

- The WRII-RC is using these experiences to scale up similar efforts with other STUs and mainstream the bus safety agenda at the national level.

VEHICLE TECHNOLOGY

In 2013, our research helped the BMTC understand the effect of BS-IV buses (central-government-mandated fuel emission standards) on fuel efficiency and finances (Fok et al. 2014). The WRII-RC is currently supporting BMTC's fleet electrification efforts to reduce emissions, fuel consumption, and operating costs in the long term in the following ways:

- In 2018, we helped the BMTC and Cell Propulsion—a winner of the "Better Bus" Challenge (WRII-RC 2018a)—develop, customize, and pilot test the solution, an electric powertrain kit, which involved retrofitting their diesel buses and converting them to electric buses. Compared with purchasing new electric buses, this technology can potentially halve the cost of transitioning to an electric fleet.

- Our team is designing a strategy and roadmap to help the BMTC achieve optimum bus fleet electrification.

PUBLIC OUTREACH

The WRII-RC has supported the BMTC with several communication and public outreach efforts. Our team provided technical and creative assistance for publicizing the BIG Bus services and safety campaigns, reviving the "Bus Day" event designed to encourage bus patronage, as well as with setting up and maintaining (for a period) the BMTC's social media platforms.

KNOWLEDGE SHARING AND CAPACITY BUILDING

Over the past decade, the WRII-RC has conducted several knowledge-sharing, training, and capacity-building sessions for BMTC staff and management, as part of specific projects and initiatives. We have also facilitated hackathons, visioning, and design-thinking workshops for the BMTC, apart from several stakeholder engagements/meetings.

At the same time, our research, demonstration projects, and the progressive practices of the BMTC (and other STUs in Karnataka) have been captured and shared extensively through various avenues and with a wide-ranging audience. Many Bus Karo workshops conducted in partnership with the BMTC and KSRTC served as platforms to advance the discourse, as well as our engagement, on a range of pertinent issues and initiatives to improve public bus systems in the country (WRII-RC n.d.).

In 2020, our team helped the BMTC develop a long-term vision plan and strategies to meet their potential transport demand over a 15-year time frame (WRII-RC 2021b). The plan also recommends measures to decarbonize and to arrest the declining mode share of the public bus system.
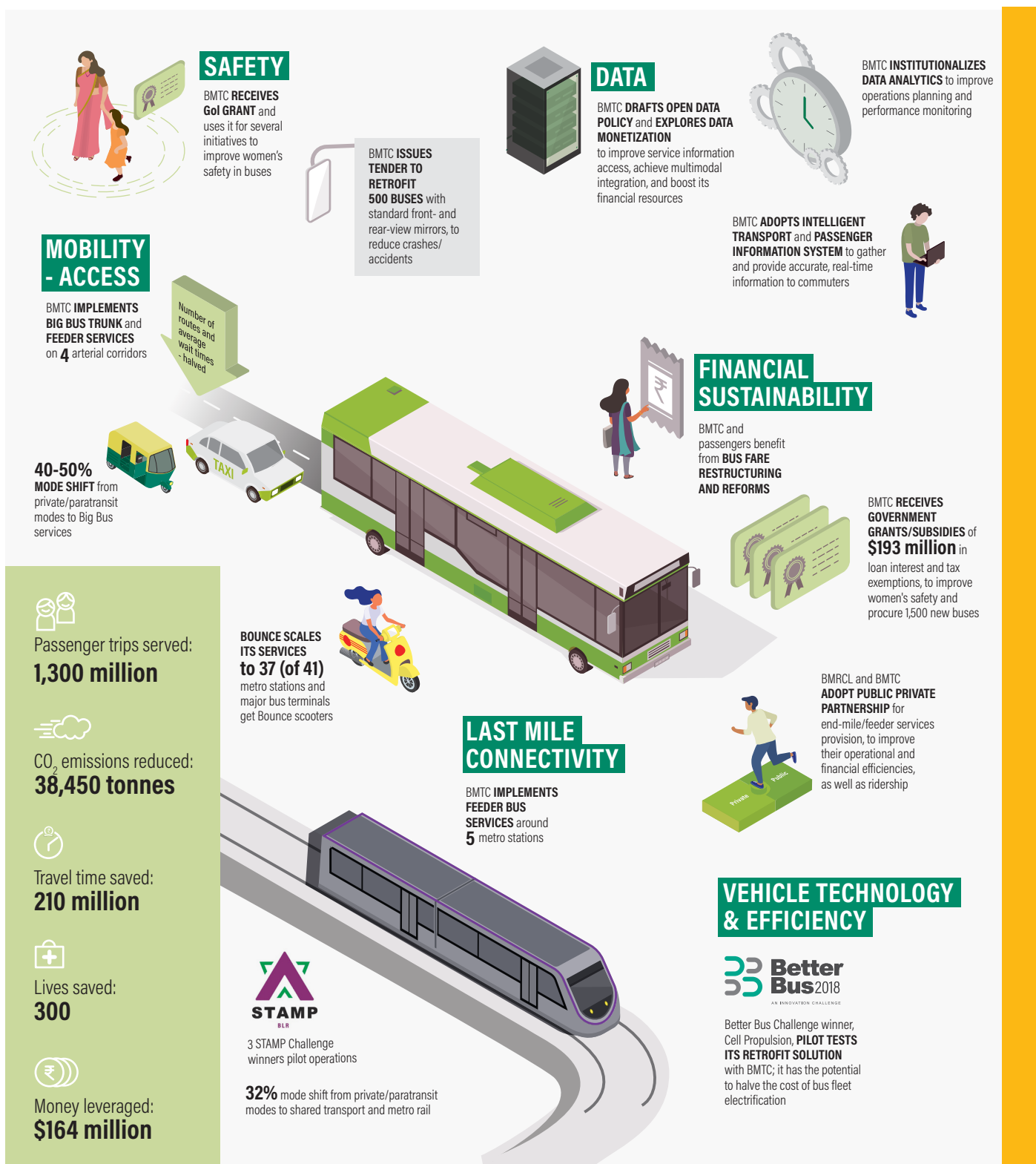
The WRII-RC's deep, decade-long engagement with the BMTC has helped manifestly improve the efficiency and quality of city bus services (see Figure 9). It has also served as a testing and learning ground, maintaining the BMTC's position as a pioneering outfit and a model for other bus transport agencies to emulate. Box 1 presents an overview of our engagement with the pilot BRT corridor in Bengaluru.

NON-MOTORIZED TRANSPORT AND ROAD SAFETY INITIATIVES

Since 2020, our team has been working closely with the DULT and other stakeholders, providing technical support on various efforts related to improving non-motorized transport (NMT) infrastructure, public spaces, and road safety in the city.

Building upon its "Cycle Day" initiative, the DULT launched the Sustainable Urban Mobility Accord. The aim was to engage with communities in Bengaluru and help them develop proposals for improving walking and cycling facilities, safe access to schools, public transport usage, and public spaces in their neighborhoods. Our team is part of the technical task force overseeing its implementation. We have helped build the capacity of communities to adopt a data-led approach to formulating their proposals (DULT 2020a).

Figure 9 | **Integrated Transport: Cumulative Impact 2011–2019**

SAFETY

BMTC **RECEIVES GoI GRANT** and uses it for several initiatives to improve women's safety in buses

BMTC **ISSUES TENDER TO RETROFIT 500 BUSES** with standard front- and rear-view mirrors, to reduce crashes/accidents

DATA

BMTC **DRAFTS OPEN DATA POLICY** and **EXPLORES DATA MONETIZATION** to improve service information access, achieve multimodal integration, and boost its financial resources

BMTC **INSTITUTIONALIZES DATA ANALYTICS** to improve operations planning and performance monitoring

BMTC **ADOPTS INTELLIGENT TRANSPORT** and **PASSENGER INFORMATION SYSTEM** to gather and provide accurate, real-time information to commuters

MOBILITY - ACCESS

BMTC **IMPLEMENTS BIG BUS TRUNK** and **FEEDER SERVICES** on **4** arterial corridors

Number of routes and average wait times - halved

40-50% MODE SHIFT from private/paratransit modes to Big Bus services

FINANCIAL SUSTAINABILITY

BMTC and passengers benefit from **BUS FARE RESTRUCTURING AND REFORMS**

BMTC **RECEIVES GOVERNMENT GRANTS/SUBSIDIES** of **$193 million** in loan interest and tax exemptions, to improve women's safety and procure 1,500 new buses

BOUNCE SCALES ITS SERVICES to 37 (of 41) metro stations and major bus terminals get Bounce scooters

Passenger trips served:
1,300 million

CO_2 emissions reduced:
38,450 tonnes

Travel time saved:
210 million

Lives saved:
300

Money leveraged:
$164 million

BMRCL and BMTC **ADOPT PUBLIC PRIVATE PARTNERSHIP** for end-mile/feeder services provision, to improve their operational and financial efficiencies, as well as ridership

LAST MILE CONNECTIVITY

BMTC **IMPLEMENTS FEEDER BUS SERVICES** around **5** metro stations

VEHICLE TECHNOLOGY & EFFICIENCY

Better Bus 2018
AN INNOVATION CHALLENGE

Better Bus Challenge winner, Cell Propulsion, **PILOT TESTS ITS RETROFIT SOLUTION** with BMTC; it has the potential to halve the cost of bus fleet electrification

STAMP BLR

3 STAMP Challenge winners pilot operations

32% mode shift from private/paratransit modes to shared transport and metro rail

Notes: Bounce is a Bengaluru-based start-up.
BMRCL = Bangalore Metro Rail Corporation Limited; BMTC = Bangalore Metropolitan Transport Corporation; GoI = Government of India; STAMP = Station Access and Mobility Program.
Sources: WRI authors.

Bengaluru's master plan and mobility plan (Revised Master Plan [RMP] 2015 and Draft Comprehensive Traffic and Transportation Plan [CTTP]) had proposed a citywide network of BRT corridors, and in 2011, the Government of Karnataka (GoK) allocated funding for the pilot, along the eastern loop of the ORR. Over a three-year period between 2012 and 2014, the WRII-RC in its capacity as knowledge partner and technical advisor worked closely with the Directorate of Urban Land Transport and the Bangalore Metropolitan Transport Corporation to develop the pilot bus rapid transit (BRT) project. Our team helped them prepare conceptual and detailed project proposals (EMBARQ India 2014a) and liaise with government and financing agencies to obtain funding for the project. In early 2015, the German KfW Development Bank in principle approved a noncommercial loan of up to €200 million for the Outer Ring Road (ORR) BRT corridor.[a]

By then, though, the metro was being analyzed as an alternative to the BRT on the same corridor. Amid much speculation and debate around the two options, the WRII-RC engaged in a host of communication and outreach activities, including inviting global experts for consultations with decision-makers and facilitating public consultations to build wider consensus and support for the BRT project.

The project, however, remained a hard sell for many in the government. In December 2016, the GoK finally decided to drop the BRT project in favor of the proposed metro rail along the ORR. Although we brought evidence, domain knowledge, expertise, and influential voices to weigh in on the deliberations, our efforts were unable to change mindsets and decisions, with political considerations overwhelming technical arguments (for details, see Appendix D).

We, however, turned the failure into an opportunity and deepened our engagement with the Bangalore Metro Rail Corporation Limited to improve last mile connectivity to the metro system and achieve multimodal integration through the Station Access and Mobility Program (STAMP [see Section 6]).

Notes: a. As the ORR BRT project was not taken forward, the loan of €200 million was not received.
Sources: WRI authors.

Under the pan-India Nurturing Neighborhoods Challenge, our team is helping the DULT and the Bengaluru Smart City Limited (BenSCL) implement pilot projects in two wards, such as developing a child-friendly transit station, pocket parks, public space around a maternity hospital, and amenities in *anganwadis* (creches) (NIUA 2022). Under the India Cycles4Change Challenge, our team collaborated with the DULT, BBMP, Bengaluru Traffic Police, and local communities to develop the proposal for a 17-km "pop-up" bicycle lane along the southeastern stretch of the ORR. This included preparation of communication materials for outreach and tactical design interventions for Kadubeesanahalli Junction to improve the safety of cyclists. The success of this project led BenSCL to develop (with assistance from the WRII-RC) permanent NMT facilities for three model roads in the city's central business district (DULT 2020b).[19]

Other efforts toward making streets safer for vulnerable road users include speed and crash data analysis along high-risk corridors and around schools and transit stops; blackspot mitigation, safer intersection–street design, and school zone safety improvements; and development of safe mobility guidelines, policies, and capacity-building initiatives. Our team is also developing a Web-based visualization tool and action plan for stakeholders to ensure safer commutes for schoolchildren (WRII-RC 2021a).

4. ADDRESSING URBAN DEVELOPMENT AND SPRAWL

CONTEXT AND RELEVANCE

Since the early 2000s, growth in Bengaluru's population and built area has primarily occurred in the city's outer suburbs and peripheries, spurred by development along its arterial roads and in far-flung locations (such as the International Airport and Special Economic Zones).[20] Rampant land cover/land use changes and haphazard sprawl in the city region have not only impacted the environment adversely but also led to significant inefficiencies in urban management and service delivery.

While the population in the BMA (BDA area) grew from 4.5 million to over 10 million between 1990 and 2015 at the rate of 3.2 percent (CAGR) per year, the urbanized area expanded from 155 sq. km to 559 sq. km, adding an average 16 sq. km per year in the same period. Figure 10 shows that rapid urbanization is also occurring beyond the BDA limits in the metropolitan region.

Although the municipal boundary was extended in 2007, there was no clear roadmap for the extension of public infrastructure. As a result, areas beyond the ORR, where over half of Bengaluru's population now lives, lack adequate essential services. This has compelled reliance on more expensive and poorly regulated private or self-provisioning services. Numerous large, gated townships (20–500 acres) coming up on the outskirts are designed to be automobile dependent, relying on diesel-fueled power and borewells or water tankers.

Further, several problems with the existing governance and planning frameworks have hampered integrated and sustainable development in the city region. Various forms of centralized control (including national/state government programs), along with a multiplicity of government agencies with unaligned jurisdictions, overlapping functions, and uncoordinated processes, have resulted in unclear power and accountability hierarchies (see Figure 11).

The 74th Constitutional Amendment Act of 1992 called for the devolution of powers and functions from state governments to urban local bodies. However, this has not happened effectively in Bengaluru (as in most of India). Nearly three decades on, major planning and executive and financial authority over city matters remain with the GoK. Over time, several functions and civic services—previously under the ambit of the municipal corporation—were progressively delegated to "specialized" parastatals of the state government. The BBMP is headed by a state-government-appointed bureaucrat (Commissioner), and the city's Mayor heading the BBMP Council is also nominated (and not directly elected by citizens), having very limited powers and a one-year term. As a result, elected representatives of the state and central government wield greater power over local development, though it is not their direct mandate.

In addition, current legal and institutional frameworks do not enable integrated planning at different scales (local to regional) that can be meaningfully informed by relevant data/evidence and stakeholder participation. This, combined with poor interagency coordination and execution, has resulted in disjointed and unsustainable development, often falling short of the desired quality-of-life outcomes.

The WRII-RC's urban development work engages with the city at various scales and across multiple sectors such as mobility, waste, water, and energy. We piloted on-ground projects at the neighborhood and ward levels, and also advised government agencies and ad hoc committees set up for legal, planning, and governance reforms at the metropolitan level. This section discusses our work at two scales of progression: neighborhood and metropolitan. The first focuses on the livability of urban neighborhoods, from government-administered wards to walled-off townships serviced privately under relaxed government mandates. The second focuses on planning to manage urban sprawl at the metropolitan scale and interventions for instituting good governance.

Figure 10 | Bengaluru's Urban Sprawl (1990–2015)

—— HIGHWAYS	▢ BUILT-UP AREA ADDED IN 1990	▢ BUILT-UP AREA ADDED BY 2010
—— BBMP BOUNDARY	▢ BUILT-UP AREA ADDED BY 2000	▢ BUILT-UP AREA ADDED BY 2015
—— BDA BOUNDARY		
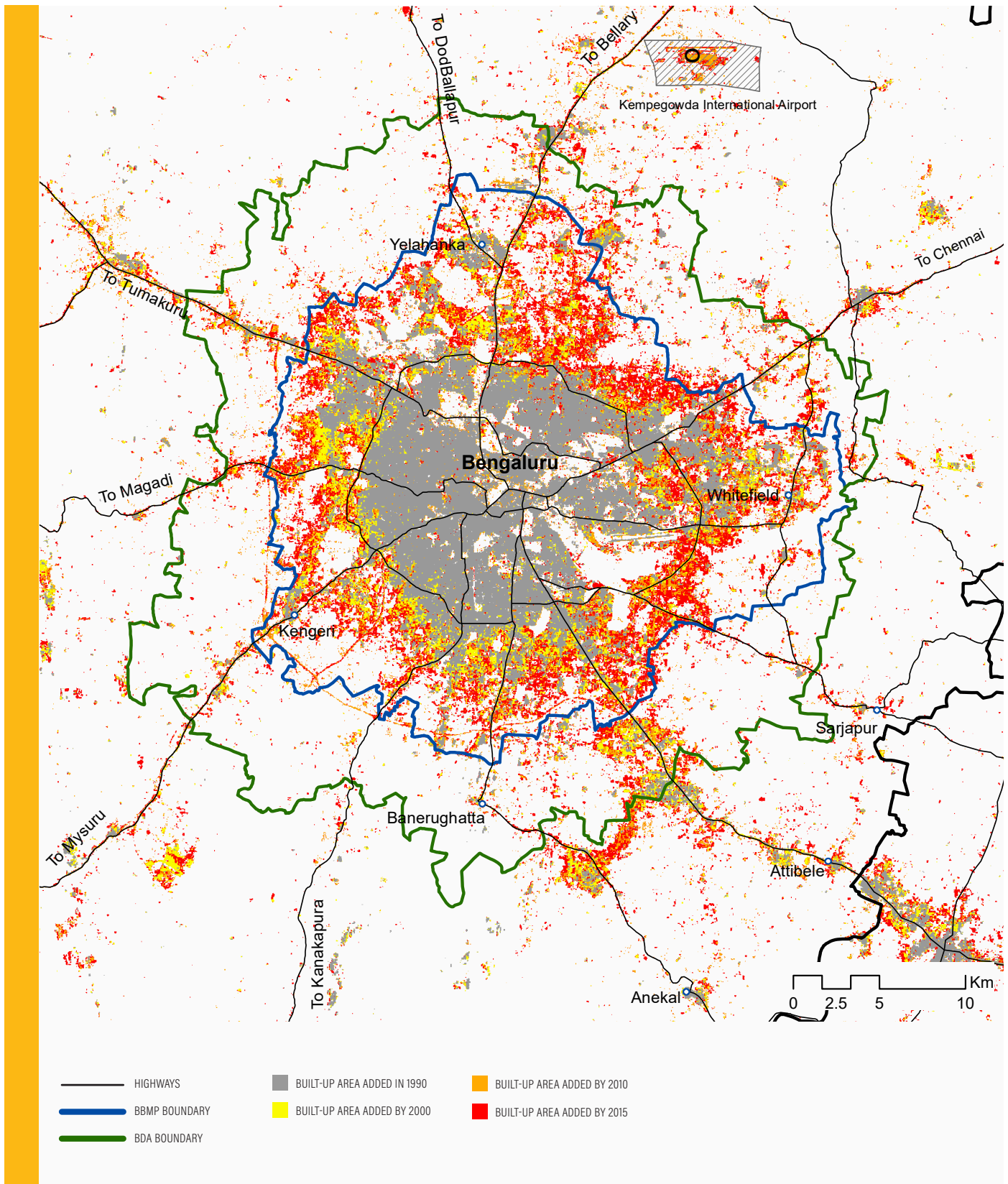
Notes: BBMP = Bruhat Bengaluru Mahanagara Palike; BDA = Bangalore Development Authority
Sources: WRI India 2020.
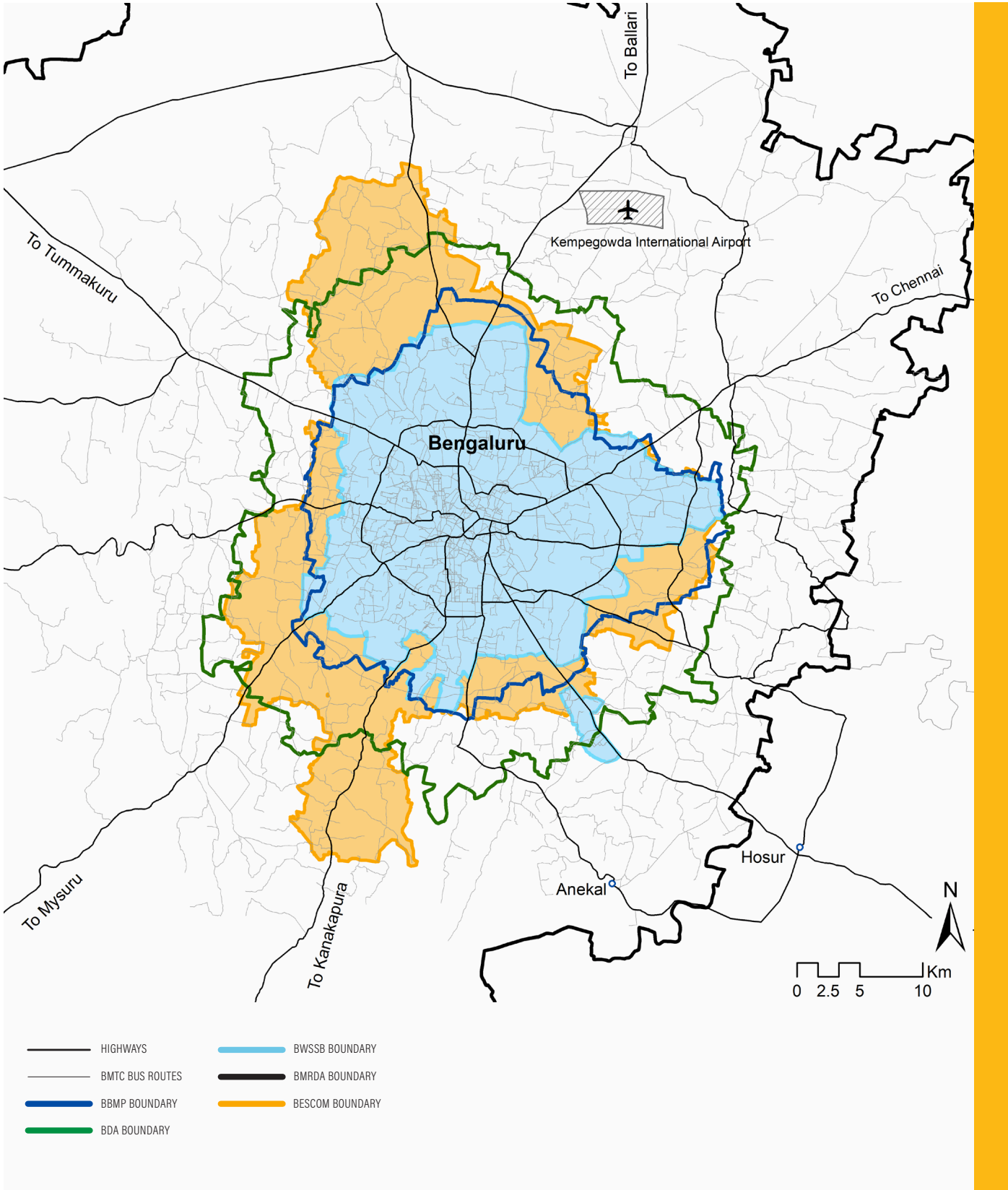
Notes: BDA = Bangalore Development Authority; BESCOM = Bangalore Electricity Supply Company; BMRDA = Bangalore Metropolitan Region Development Authority; BMTC = Bangalore Metropolitan Transport Corporation; BWSSB = Bangalore Water Supply and Sewerage Board.
Sources: WRI India 2020.

LIVABLE NEIGHBORHOODS

Our UDA work in the city began in 2011. With Phase 1 of the metro rail becoming operationalized, an opportunity emerged to implement the tenets of TOD to improve safe access and livability in the station areas along mass transit systems. Through an MoU, we entered a three-year partnership with the DULT to support them with urban planning and design interventions on two pilot projects: the Indiranagar Metro Station Accessibility Plan in Bengaluru and a public space design project at Navanagar, on the Hubli-Dharwad BRT corridor.

Our work on metro station accessibility opened further opportunities, with the corporator of the HSR ward engaging with us to pilot a neighborhood improvement plan (NIP). Based on the "HSR-NIP" exercise, the WRII-RC was invited into a consortium to scale this bottom-up concept of neighborhood improvement for the whole city. India's first-ever Neighborhood Improvement Partnership Challenge, NIPC, was launched to foster a collaborative partnership between public, private, and civil society organizations to bring in neighborhood-level improvements (for details, see Section 6).

TOD: Station Accessibility Plans and Development Control Regulations

Objective and Strategy

Recognizing the fact that station areas are high-intensity zones prone to traffic conflicts, our team worked closely with the DULT to devise a robust roadmap for improving safe access and creating vibrant, livable neighborhoods along the metro rail system that are market friendly as well as inclusive.

A developed, inner-city neighborhood undergoing rapid transformation around the Indiranagar metro station (along the first operational stretch) was chosen as a pilot project for demonstration. It comprised two parts: developing a Station Accessibility Plan (SAP) and supportive, area-specific Development Control Regulations (DCRs) for the station area.

"In the face of rapid urbanization, Bengaluru is recognizing the need to invest in high-quality mass transit systems to meet the increasing transport demand. While this is good, it is important for us to think comprehensively about station areas and ensure

connectivity, so that commuter experience can be made safer and more convenient."
– Ms. V. Manjula, Commissioner, DULT, GoK

Actions

After extensive studies and stakeholder consultations, our team formulated safe access design proposals and regulations for the Indiranagar metro station area. The project and methodology, captured in three reports, was accepted and endorsed by the DULT (EMBARQ India 2011b, 2013, 2014c).

From 2013 to 2016, the WRII-RC also helped the DULT scale up the pilot exercise to 10 other metro stations (out of 40) in the Phase 1 network. We provided technical guidance to the DULT consultants who prepared the SAP-DCRs. Our team stayed engaged beyond the MoU period (ending in 2014), reviewing and providing feedback on the plans.

The WRII-RC published the Safe Access Manual capturing the above experience and describing other global cases and best practices, suggesting comprehensive strategies to develop safe access to mass transit stations in Indian cities (Shah et al. 2014). This was subsequently turned into an interactive tool for stakeholder engagement and participatory planning. The toolkit has been tested and used on various occasions with different audiences in Bengaluru and elsewhere in India, and was made freely available online (WRII-RC 2018e).

Outcomes: Impact and Influence

The SAP-DCRs have helped guide the NMT infrastructure improvements in station areas as well as our inputs to national and city-level policies as follows:

- An outlay of $15 million was secured from the BBMP (government-budgeted funds under the Nagarotthana scheme) to implement footpath improvements in station areas. Out of about 200 km, 100 km of the NMT network was identified for implementation, based on the SAPs.

- The BBMP, through its TenderSURE (Complete Streets) program, is also expected to implement our street design recommendations for the Indiranagar station area.

- The project helped focus attention on the important issue of safe access in station areas and city neighborhoods and laid the foundation for several road redesign and NMT infrastructure improvement projects that followed.

- The SAP-DCRs are expected to inform statutory and process-related provisions for operationalizing the TOD Policy prepared by DULT. These provisions deal with revision of the city's master plan based on a holistic TOD strategy, TOD typology mapping and phasing, and preparation of TOD Zone Plans and differential regulations.

- The WRII-RC's work on the SAP-DCRs, the Safe Access Manual, and Toolkit has been used extensively, both nationally and internationally, to build the capacity of various stakeholders involved in the design and implementation of street infrastructure. We used the SAP approach for our inputs to the National TOD Policy and Metro Rail Policy, prioritizing designs that emphasize pedestrian safety and an inclusive public realm around stations.

Box 2 presents an overview of our continuing engagements with government authorities in Bengaluru.

Neighborhood Improvement Plan for HSR Layout

Objective and Strategy

In 2013, the WRII-RC, working closely with local communities and their elected representative, undertook to prepare a NIP for HSR Layout (HSR-NIP) to improve the safety, sustainability, and quality of life in the neighborhood. Another prime objective of this exercise was to develop a methodology for creating such participatory neighborhood (or ward) plans with prioritized projects that could be applied across the city, while ensuring contextual responsiveness.

After the pilot project, the WRII-RC planned to develop a program for training stakeholders of other city neighborhoods and wards to help them develop NIPs. Embodying the spirit and directive of the 74th CAA, this exercise would be the first of its kind in the city and a

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Box 2 | **Synergizing Land Value Capture and Transit-Oriented Development**

The WRII-RC has worked extensively on knowledge creation and capacity building around TOD financing. In early 2017, our team conducted a capacity-building workshop on business model frameworks for TOD financing for staff from the Bangalore Metro Rail Corporation Limited (BMRCL), Bangalore Metropolitan Transport Corporation (BMTC), and Directorate of Urban Land Transport (DULT). The following year, we conducted research on land value capture (LVC) mechanisms for financing TOD in India.[a] The findings were discussed in a high-level ideation laboratory at our annual Connect Karo conference in April 2018, which brought together key actors involved in operationalizing TOD—financing institutions, developers, and government agencies—from various Indian cities. We subsequently conducted a study that examined the operational and proposed LVC mechanisms in Bengaluru. After extensive analysis, we recommended how the mechanisms and development regulations can be structured to optimize LVC and improve the public realm in station areas. The study was recently published as a practice note.[b]

As part of our commitment to helping city agencies create accessible and livable transit-oriented neighborhoods, we continue to support the DULT and BMRCL with respect to TOD, MMI, and LVC planning along mass transit corridors. Since 2019, our team has provided inputs and suggestions for the development of an integrated policy and regulatory framework for enabling TOD in Bengaluru, several of which have been accepted and incorporated into policy documents. This effort entailed identifying gaps and conflicts within existing city policies and plans and harmonizing them to enable TOD in Bengaluru. Our team provided inputs for the revision of the Draft Revised Master Plan 2031 for Bengaluru (2018), Draft Bengaluru TOD Policy (2019, 2021), Draft Bengaluru Metropolitan Land Transport Authority Bill (2020), and Draft Parking Policy for Bengaluru (2020). The principles underlying differential TOD regulations and frameworks for incentivizing plot amalgamation and redevelopment through TOD as well as for preparing and approving TOD Zone Plans, schemes, and projects were also developed and proposed. We also conducted two assessments on the potential impacts and benefits of TOD along the metro network in Bengaluru that were instrumental in the sanctioning of financial assistance (by a multilateral bank) for the new Phase 2A-2B metro lines.

The BMRCL has now engaged the WRII-RC as technical advisors for enabling TOD and MMI along this corridor. Our team is currently developing knowledge products on opportunities for increasing job densities and assessing resource efficiency potential (water, energy, and waste sectors) in Bengaluru's TOD zones.

Notes: a. WRII-RC 2018b. b. Dhindaw et al. 2021.
Sources: WRI authors.

major step toward the creation of holistic "Ward Vision Plans" or "Local Area Plans" in the future. The larger aims were the following:

- Develop a framework for instituting an inclusive, ground-up process to envision and plan city neighborhoods or wards, operationalizing good governance practices.

- Make local authorities "people-facing" to improve transparency and accountability.

- Empower and build the capacities of citizens and government agencies to engage in collaborative planning and implementation.

- Make city-building processes more participative and responsive to different local contexts and community needs.

"We are introducing a novel Neighborhood Improvement Program for HSR Layout—a 'never-before' done exercise," Ms. Latha Murthy, Corporator, HSR Ward No. 174.

Actions

Based on a series of activities in 2013–2014, including primary/secondary studies and stakeholder consultations, our team formulated and finalized the HSR-NIP. Detailed proposals for public transport and safe access (NMT) networks, public space design, green habitats, and wayfinding were accepted by the ward corporator and used to prioritize HSR ward budget allocations. The process or methodology adopted by the WRII-RC in developing the HSR-NIP and the project itself was described in a report (Maiti et al. 2015). The team also oversaw the implementation of proposals within the neighborhood (described below).

Outcomes: Impact and Influence

- In 2014, the BBMP apportioned $2.6 million and re-engineered six key road intersections in HSR Layout to improve pedestrian safety.

- In addition, the DULT and BBMP developed 7 km of bicycle paths to facilitate safe cycling.

- The BMTC deployed their Chakra feeder bus services in the neighborhood, which were being piloted in a few localities across the city. Estimated to have a ridership of about 20,000 daily passenger trips, these feeder services were part of the BIG Bus route rationalization exercise on Hosur Road being concurrently conducted by our Transport team. Based on the HSR-NIP and subsequent NIPC exercise, our team turned the model into an interactive tool for stakeholder engagement and participatory planning to help identify and prioritize community projects for neighborhood improvement (WRII-RC 2017c). In 2017, the WRII-RC in collaboration with Citizens for Sustainability (a citizens group in Bengaluru) conducted a NIP workshop, using the toolkit to help identify projects for BBMP wards 18 and 19 that could potentially improve the lives of the over 70,000 residents of those wards.

METROPOLITAN PLANNING AND GOVERNANCE

Between 2014 and 2017, the GoK engaged the WRII-RC in the capacity of a knowledge partner, seeking advice on the revision of the Karnataka Town and Country Planning Act (KTCPA) 1961 as well as on restructuring the BBMP, to improve planning and governance in Bengaluru. These statutory frameworks are critical from the perspective of institutionalizing (and thereby scaling) good practices and processes in city building.

Our research on various aspects related to the management of urban expansion and procurement of land for public purposes helped inform intermittent advisories on integrating the increasingly fragmented city and easing the implementation of major road infrastructure projects. In November 2015, as part of the advisory group to the Expert Committee for BBMP Restructuring, our team was invited to make a presentation at a high-level meeting attended by the chief minister, Bengaluru development minister, other ministers, and senior bureaucrats from various departments. Here, we presented our analyses and recommendations on the key city planning and development issues confronting the government.

Revision of KTCPA 1961

Objective and Strategy

The KTCPA, which governs urban planning processes in the state, had become outdated. Although it had undergone small, piecemeal amendments over time, it needed a complete overhaul to make it current and effective. Recognizing this, the Directorate of Town and Country Planning (DTCP, under the UDD), GoK, enlisted our technical support in undertaking a comprehensive revision of the KTCPA.

"The revised KTCP Act needs to synchronize planning of all urban areas in the state. Considering the rapid expansion of bigger cities, it is essential to plan the regions around them for better management of growth." – *Mr. Aijaz Ahmed, Additional Director, DTCP, GoK*

Actions

Our team's studies adopted an iterative process to identify both the current planning challenges and ways to address them through legislative reforms. This included an analysis of growth trends and issues faced by various urban areas in the state; consultations with DTCP officials on challenges with the current planning paradigm; and a review of best practices in planning legislation reforms and model laws per guidelines issued by the national government. We convened numerous workshops and discussions with DTCP officials, institutions, and domain experts on the appropriate regional planning approach for large cities such as Bengaluru. Based on the assessment, a spatial planning framework for the state, including introduction of various scales of plans and a detailed regional planning framework, were prepared and submitted to the DTCP for incorporation in the revised act.

Outcomes and Influence

■ Although the KTCPA final revision is still pending, the studies and analyses conducted during this exercise served as an excellent foundation for the BBMP Restructuring Expert Committee engagement that followed.

■ This research also formed the basis of our proposals for the Urban Development and Transport sectors of GoK's Karnataka Vision Plan 2025.

Recommendations for BBMP Restructuring

Objective and Strategy

In September 2014, the GoK constituted a three-member high-powered Expert Committee to lay out a roadmap for restructuring the BBMP to improve Bengaluru's urban management. The aim was to reimagine the city's governance and administration across the municipal corporation and multiple parastatal agencies (operating in silos).

Actions

The BBMP Restructuring Expert Committee invited the WRII-RC to present the analyses carried out for the KTCPA revision exercise on the challenges of urbanization and its management. This helped us make the critical case for looking beyond just the BBMP boundary and convince the Committee to adopt a broader city-region approach. Thereafter, we were engaged by the Committee as a key knowledge partner to support their exercise.

Our team structured the spatial/non-spatial information collected from multiple government agencies and private institutions,[21] analyzed urbanization patterns and associated issues in Karnataka state and Bengaluru, and provided technical inputs from a planning and governance perspective. All our inputs were incorporated in the Expert Committee's first "Way Forward" report, which was accepted by the chief minister (Patil et al. 2015).

Recognizing our valuable contribution, the Expert Committee requested additional technical support from the WRII-RC after they were reinstated for a second, extended term up to 2017. In this subsequent phase, our team worked on four major areas: Introducing Scales of Plans and Strategic Planning, Municipalization Strategy for Urban Expansion, Land Procurement Mechanisms for Public Purpose, and Framework for Bangalore Spatial Information Center. Each module discussed the issues, recommendations, and strategies for implementation. Our inputs were incorporated into the Expert Committee's reports, which were published and submitted to the UDD, GoK (Patil et al. 2017). Our research from this exercise was further developed into knowledge products on mechanisms for urban land management, implementation of strategic road infrastructure projects, and development

strategies for urban villages (Mathews et al. 2017, 2018; Bharadwaj 2018b).

"WRI India provided innovative, insightful ideas and new models for Bengaluru's governance, strategic planning across scales and an orderly way to integrate overgrown villages on the periphery into the extended city. A seminal contribution, their inputs were part of the Committee's recommendations to the Government."
– Mr. V. Ravichandar, Member, BBMP Restructuring Expert Committee

Outcomes and Influence

- The final set of Expert Committee reports with our recommendations were accepted in principle by the GoK. Subsequently, these were resubmitted and presented to the new government that came into power in May 2018.

- As of 2019, the GoK had given effect to some proposals, such as decentralizing the city's administrative setup for better governance. The government plans to set up a state-level committee to review the recommendations and ascertain which can be taken forward for implementation.

- Whereas the new government was in favor of a single municipal corporation, the new BBMP Act 2020 focuses on zonal decentralization, a key recommendation of the Restructuring Committee. Further, the idea of centralization at the apex city level is taking shape through the setting up of a Central Coordination Committee (across city agencies) by the GoK.

Box 3 presents an overview of our engagement with other strategic spatial projects in the Bangalore Metropolitan Region.

The outcomes of our engagements under the Urban Development workstream are highlighted in Figure 12.

Box 3 | Strategic Spatial Projects: Whitefield, International Airport Area, and Ring Roads

The credibility we succeeded in building around urban planning and governance led the Government of Karnataka (GoK) to invite us to offer data-led inputs on other development issues and strategic (by "strategic" we mean integrated cross-sectoral schemes with potential for transformative change or significant impact at the zonal, corridor, or metropolitan scale) projects being considered by it. Taking the example of Whitefield and the adjoining Outer Ring Road (ORR)—the city's poorly planned, sprawling, and congested information technology (IT) hub and growth corridor—we highlighted the critical need for augmenting the transport infrastructure by, for example, providing public access through large gated campuses; designing safe, complete streets; improving junctions, road geometry, and traffic management; augmenting all forms of public transport and multimodal integration; developing alternate routes to the airport; and addressing urban villages through local development plans.

In another instance, the Bengaluru International Airport Area Planning Authority (BIAAPA) area around the international airport was experiencing speculative urban growth characterized by haphazard, under-serviced developments beyond the planned conurbation area that threatened to degrade water bodies and green cover. Our team suggested a proactive, holistic planning approach involving a mid-term revision of the BIAAPA Master Plan and parts of the Bangalore Metropolitan Region Development Authority (BMRDA) Structure Plan. This was to enable town planning schemes (TPS), village development plans, and natural resources management. Following our recommendation, the BIAAPA floated an Expression of Interest to receive bids for revision of the BIAAPA Master Plan 2021, ahead of time.[a] In addition, the BMRDA called for bids to prepare village development plans for nearly 6,000 villages in the Bangalore Metropolitan Region.

Lastly, to improve city-region connectivity and alleviate traffic congestion, a series of ring roads have been envisaged in the metropolitan region, including the Peripheral Ring Road (PRR) and Satellite Town Ring Road (STRR) around Bengaluru. In 2016, the WRII-RC was invited by the Bangalore Development Authority to provide technical inputs for identifying appropriate mechanisms for implementing the PRR. We researched and presented alternative good practices for efficient and equitable access to land and integrated area development along the PRR. For the 200-km-long STRR, based on our recommendations, the government decided to invoke certain TPS provisions of the Karnataka Town and Country Planning Act and adopt an "area planning approach" using land readjustment methods rather than compulsory acquisition alone for developing the road. Accordingly, 1 km on either side of the STRR was declared the "influence zone," and the GoK constituted a special STRR Planning Authority under the BMRDA to facilitate planning and implementation.[b]

*Notes:* a. Bharadwaj 2018a. b. Prakash 2016.
Sources: WRI authors.

Figure 12 | **Urban Development: Cumulative Impact 2011–2019**

LIVABLE NEIGHBORHOODS

The Municipal Corporation (BBMP) **ALLOCATES $15 MILLION TO UNDERTAKE 100 KM OF NONMOTORIZED NETWORK IMPROVEMENTS** based on HSR-NIP safe access design proposals

The city bus agency (BMTC) **DEPLOYS FEEDER BUS SERVICES;** BBMP **UPGRADES SIGNAGE, RE-ENGINEERS 6 MAJOR ROAD INTERSECTIONS AND DEVELOPS 7 KMS OF CYCLE TRACKS** based on HSR-NIP proposals, to improve road safety and accessibility in the neighborhood

The Neighborhood Improvement Plan for HSR Ward (HSR-NIP) ✓
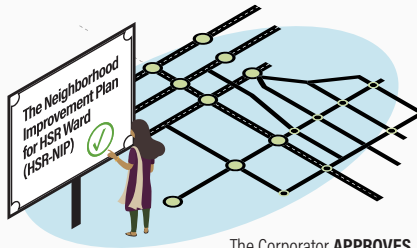
The Corporator **APPROVES HSR-NIP** and uses it to prioritize projects and budget allocations

People served:
1 million

CO_2 emissions reduced:
23,175 metric tons

Lives saved:
60

Money leveraged:
$34 million

The Directorate of Urban Land Transport **PREPARES SAFE ACCESSIBILITY PLANS AND DEVELOPMENT CONTROL REGULATIONS FOR 10 METRO STATIONS**

SUPPORT

APPROVALS

FUNDING

12 WINNERS of India's first Neighborhood Improvement Partnership Challenge **SECURE BBMP APPROVAL AND FUNDING SUPPORT TO IMPLEMENT THEIR PROJECTS;** their projects range from mobility, environment, and public space/safety improvement to resource efficiency and management (water, energy, waste)

MANAGING URBAN EXPANSION

The BBMP Restructuring Expert Committee **INCORPORATES RECCOMENDATIONS ON:**
- Introducing Scales of Plans and Strategic Spatial Planning for Bengaluru
- Municipalization Strategy Addressing Urban Expansion and Urban Villages
- Land Procurement Mechanisms for Public Purposes
- Framework for Bengaluru Spatial Information Centre

The Directorate of Urban Land Transport and Bangalore Metro Rail Corporation **INCORPORATE SUGGESTIONS ON POLICY-REGULATORY FRAMEWORKS FOR ENABLING TRANSIT-ORIENTED DEVELOPMENT** along Phase 2A-2B metro corridors and the city

STATION AREA PLANS

BLR CITY

The Satellite Town Ring Road Planning Authority and the Bengaluru Development Authority consider **ALTERNATIVE MECHANISMS TO MOBILIZE LAND** and an integrated **"AREA DEVELOPMENT APPROACH" TO DEVELOP TWO MAJOR RING ROADS** to improve city and regional connectivity
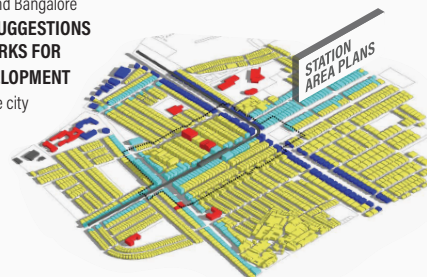
Bangalore International Airport Area Planning Authority floats Expression of Interest for **REVISION OF ITS MASTER PLAN 2021,** based on our reccomendation

The Karnataka Town and Country Planning Act 1961

The Directorate of Town and Country Planning **INCORPORATES RECOMMENDATIONS ON SPATIAL PLANNING SCALES AND FRAMEWORKS,** for revision of the KTCPA, 1961

Bengaluru Metropolitan Region Development Authority floats Expression of Interest for **PREPARATION OF VILLAGE DEVELOPMENT PLANS FOR 6,000 VILLAGES** in the Bengaluru Metropolitan Region

When implemented, these plan and policy revisions would potentially impact and benefit over 30 million urban residents in Karnataka state and over 3 million rural residents in the BMR

Sources: WRI authors.

BUILDING ON URBAN DEVELOPMENT: CROSS-SECTORAL ENGAGEMENT

Inputs into Bengaluru's Revised Master Plan 2031

In November 2017, the BDA published the Draft Revised Master Plan (RMP) 2031 for Bengaluru, inviting objections and suggestions before finalization. The WRII-RC submitted detailed comments and suggestions on a wide range of sectoral/cross-sectoral issues spanning our areas of expertise and work, such as urban planning and design, integrated transport, energy, water, data management, and governance. This drew from our work in the city and beyond over the past decade and lessons or best practices. Following this, our team was invited to in-person meetings with the BDA's Commissioner, senior officials, and project consultants, where we presented and discussed our inputs and recommendations.

However, finalization of the RMP 2031 was delayed for various reasons, and very recently, the new state government, dissatisfied with the existing plan, has decided to revise it again. Through a current consulting assignment for the DULT and BMRCL on the preparation of an integrated policy-regulatory framework for TOD implementation in Bengaluru, we provided the RMP revision team with detailed suggestions regarding the scope of work. These include incorporating a holistic TOD strategy and integrated planning and implementation frameworks that also enable local area plans to be prepared.

5. ADDRESSING RESOURCE MANAGEMENT AND INEFFICIENCY

Rapid urbanization and suburban sprawl pose a major challenge to the sustainable management of natural resources and efficient and equitable provision of basic services such as power and water supply.

ENERGY

Context and Relevance

Bengaluru is the largest power consumption center in Karnataka, accounting for about a third of the state's total power demand (BDA 2017). Energy demand in the city has been growing, with domestic consumption increasing at the fastest rate.[22] The Bangalore Electricity Supply Company Ltd. (BESCOM), which serves the metropolitan area, has been struggling to meet even the present peak demand, and an estimated 30 percent of the population lacks access to affordable and reliable electricity (Dhindaw 2016). This has led to the use of diesel generators and inverters across the city. Moreover, conventional energy planning has tended to focus on the supply side, relying heavily on fossil fuels. Currently, the utility gets 78 percent of its electricity from thermal power, 13 percent from renewables, 6 percent from hydro power, and the rest from other bilateral sources.[23] Thus, growing demand, inequitable energy access, and continued overreliance on non-renewable sources pose a challenge to the adequate supply of clean energy to the city's residents. Although the state government has outlined progressive policies, regulations, and targets[24] for promoting renewable energy (RE), particularly solar; energy efficiency (EE); and conservation, widespread adoption by consumers and advocacy by BESCOM are still in the early stages.

WRI's electricity work in India began in 2010–11, coinciding with the initiation of EMBARQ India's engagement with the BMTC and the setting up of the office in Bengaluru. The program identified three key areas of intervention:

- Identify and overcome policy, regulatory, and market barriers to accelerating the growth of clean energy in India.

- Integrate RE and EE considerations into electricity sector planning and uptake by utilities and consumers.

- Build the capacity of civil society organizations to effectively engage in the electricity sector's decision-making processes.

The initial interventions were focused at the state level, given that in India the bulk of electricity sector planning and policy and regulatory decisions are taken at that level. We began work in the states of Karnataka and Tamil Nadu, given the conducive conditions for RE initiatives and our office in Bengaluru. Over time, we also conducted several projects in the city to introduce energy efficiency measures and increase the RE (specifically solar) mix in BESCOM's sources/supply and its uptake among various consumer categories.

Karnataka Electricity Governance Network (KEGN)

Objective and Strategy

A preliminary effort, building upon the earlier Electricity Governance Initiative (EGI) work in India,[25] was the formation of the KEGN, a network of consumer and civil society groups working in the electricity sector in Karnataka. The objective was to help build their capacities to engage with policymakers, regulators, utilities, and other relevant actors to promote transparent, inclusive, and accountable decision-making in the sector.

Actions and Outcomes

In 2014, WRI India worked with the KEGN on a study that focused on integrated resources planning (including RE+EE) and identified suitable options to bridge the electricity demand–supply gap in Bengaluru. As part of this exercise, the team engaged with key government stakeholders to ensure accountability (Dixit et al. 2014). In addition, we coauthored a paper and two reports with our partners (WRI India et al. 2015; WRI

India et al. n.d.). This research and advocacy by the KEGN was key to ensuring that decisions made in the electricity sector reflected public interests.

More recently, our team has deepened its engagement with the KEGN, co-organizing and presenting at workshops on EE- and RE-related issues in the state.

Green Power Market Development Group (GPMDG), India

Objective and Strategy

In January 2013, WRI India, in partnership with the Confederation of Indian Industry, launched GPMDG India in Bengaluru. An industry-led initiative, it is aimed to rapidly increase the share of RE in the overall energy consumption of large commercial and industrial establishments. More recently, this initiative has been expanded to include industrial parks and clusters. Several major companies in Bengaluru also joined the initiative and committed to exploring ways to increase their RE use.[27]

Actions

- **2013:** WRI India's first RE demand aggregation project, CollabSolar, was launched. It aggregated the demand for on-site solar photovoltaic (PV) systems from six corporate buyers in Bengaluru, combining their RE procurement into a single bid to achieve economies of scale and reduce transaction costs. The valuable insights and lessons from the experience were described in a working paper (Thanikonda et al. 2015) and informed the next iteration of demand aggregation projects with large industrial/business parks and urban residential complexes across four Indian states.

- **2014:** GPMDG participated in Karnataka's regulatory hearings to support off-site solar procurement and petitioned for a stable and predictable policy regime to facilitate investments in RE. Following this, the Karnataka Electricity Regulatory Commission (KERC) passed a landmark order for solar power generators, waiving off-grid usage charges for a period of 10 years from the date of commissioning. A sector-transforming move, it resulted in addition of over 1,000 MW of new solar capacity in the state by March 2018.

- **2016:** WRI India worked closely with the Bengaluru International Airport Ltd. (BIAL) to help it meet an initial 40 percent of its electricity needs by installing 17 MW of solar power capacity. The team developed unique and useful tools that helped BIAL navigate various bids and negotiations with vendors before signing contracts for three solar projects, which were commissioned in 2017. Across Karnataka, GPMDG India has successfully facilitated RE projects (solar PV + wind) worth 110 MW.

- **2019:** The group provided recommendations for KERC's draft discussion paper on utility-driven business models to scale up rooftop solar power in the state. When finalized, these regulations can enable utilities gain from the expected growth of solar power in Karnataka.

GPMDG India is currently looking to work with similar initiatives launched by other nongovernmental organization (NGO) partners to coordinate efforts and present a united front when approaching corporate India.

Rooftop Solar: Residential Sector

Objective and Strategy

The GoK had a goal of 400 MW of grid-connected rooftop solar PV by 2018, though this is yet to gain momentum in the residential sector. WRI India has been working toward the adoption of rooftop solar PV in Bengaluru.

Actions and Outcomes

Our team interviewed key stakeholders in the market as part of a study to identify barriers to BESCOM's net-metering program that were preventing wider scale-up. The resulting working paper offered initial recommendations and was discussed with BESCOM to help it map the way forward (Martin and Ryor 2016). We continue to help the utility balance their business models with RE and engage with them, particularly through participative regulatory forums.

Further, to understand the experiences of residential consumers and the challenges they face when installing rooftop solar PV systems, the team conducted another study through household surveys and stakeholder workshops across five Indian cities, including Bengaluru (Devi et al. 2018).

Energy Efficiency and Conservation: Residential Sector

Objective and Strategy

In late 2015, WRI India collaborated with Technology Informatics Design Endeavour (TIDE) India, a grassroots NGO based in Bengaluru, and launched the VidyutRakshaka (VR) program in the city. A pioneering initiative in the country, it attempted to reduce the electricity demand-supply gap through consumer-led voluntary actions for EE and conservation.

Actions and Outcomes

In the first phase of the VR program, two residential communities in the city were chosen for the pilot exercise. Household-level energy use assessments were carried out by TIDE, and customized no-cost or low-cost recommendations were provided to reduce consumption and monthly electricity bills.[28] A unique aspect of the program was the use of behavior-changing nudges, including neighborhood or ideal consumption comparisons and personalized tips based on the participants' assets, usage, and socioeconomic standing. In the process, the program also generated disaggregated-data-based evidence on residential consumption patterns and the impacts of such energy conservation programs. The pilot exercise demonstrated an average savings potential of 17 percent in monthly electricity consumption for half the participating households. Encouraged by this, it was decided to scale up VR in partnership with BESCOM to over 3,000 participating households in Bengaluru and about 500 each in the cities of Mysore and Chennai. TIDE is now implementing VR Lite at a larger scale (a utility subdivision with about 20,000 consumers) to encourage a culture of EE and conservation, long-term behavior changes, and sustained savings to bring down the city's average consumption.

As an extension of the program, an initial energy assessment was carried out in 10 apartment complexes across Bengaluru. The study, which has been described in a working paper (Malaviya et al. 2019), indicated that each facility could save 8–12 percent of their common area/services electricity usage and costs through no- or low-cost interventions. It also found that rooftop solar PV could meet the complete energy needs of common services in almost all the apartment complexes. A toolkit was prepared based on the collected data and shared with the participating apartment complexes to enable them to monitor and save electricity. The VR platform created by TIDE is an open-source portal that residential consumers can access to benchmark their electricity consumption and get recommendations to manage, plan, and save (TIDE n.d.).

Outcomes: Impact and Influence

The Energy team's efforts over the years have encompassed different types of interventions across scales to increase RE+EE uptake: engaging at the state level to influence policies, planning, and regulations, as well as at the campus/township and building levels, and addressing (city- and consumer-) specific challenges through pilot projects followed by scale-up. To inform policy and decision-making and catalyze the market for RE and EE, a range of knowledge and communication products have been developed and shared online. Resources and new business models developed by GPMDG have helped several businesses in India, including Bengaluru and Karnataka, define appropriate targets and procure RE. The team has also engaged extensively with stakeholders across the ecosystem, building the capacities of both state and non-state actors and forging successful partnerships to influence and achieve outcomes (see Figure 13).
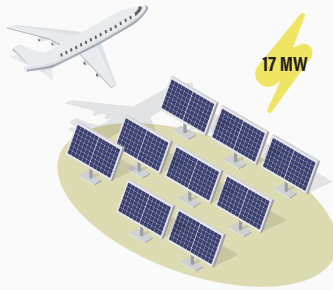
WATER

Context and Relevance

Bengaluru's water demand is set to increase, and so are water-related risks such as scarcity and flooding. This is due to changes in land cover and microclimate, as well as the slow adoption of sustainable solutions backed by appropriate infrastructure. Recently, Bengaluru has been in the news for being among the world's top 11 cities most likely to run out of drinking water and requiring evacuation (BBC News Service 2018; Sheth 2020).
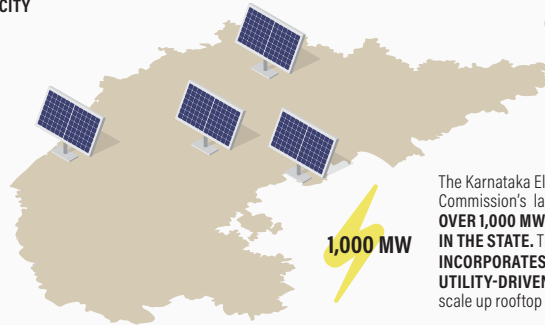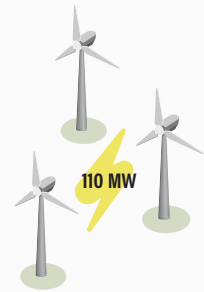
Figure 13 | **Urban Efficiency—Energy—Cumulative Impact 2017–2019**

RENEWABLE ENERGY

The Green Power Market Development Group India **FACILITATES RENEWABLE ENERGY PROJECTS OF 110 MW IN KARNATAKA**

110 MW

17 MW

The Bengaluru International Airport Ltd. **INSTALLS 17 MW OF SOLAR POWER** capacity to meet **40% OF THEIR ELECTRICITY NEEDS**

The Karnataka Electricity Regulatory Commission's landmark order results in **OVER 1,000 MW OF NEW SOLAR CAPACITY IN THE STATE.** The Commission also **INCORPORATES RECOMMENDATIONS ON UTILITY-DRIVEN BUSINESS MODELS** to scale up rooftop solar power in the state

1,000 MW

The VidyutRakshaka (VR)* pilot demonstrates an **AVERAGE SAVINGS OF 17%, GOING UP TO 23%, IN MONTHLY ELECTRICITY CONSUMPTION** of households

17–23% SAVINGS

ENERGY CONSERVATION AND EFFICIENCY

People served:
25,000

CO_2 emissions reduced:
74,900 metric tons

Money saved:
$3.35 million

The VR for Aggregators pilot demonstrates an **AVERAGE SAVINGS OF 10% IN MONTHLY ELECTRICITY CONSUMPTION** of common areas in large apartment complexes

10% SAVINGS

VR LITE WINS THE 2018 URBAN INNOVATION CHALLENGE - DESIGN BENGALURU AWARD. It aims to facilitate a culture of energy efficiency/conservation and sustained electricity savings at the city level

DESIGN BENGALURU AWARD

URBAN INNOVATION CHALLENGE 2018

GOOD GOVERNANCE

Research and advocacy by the Karnataka Electricity Governance Network **PROMOTE TRANSPARENCY, INCLUSION, AND ACCOUNTABLE DECISION-MAKING** in the electricity sector, to reflect public interests

TRANSPARENCY

INCLUSION

ACCOUNTABLE DECISION-MAKING
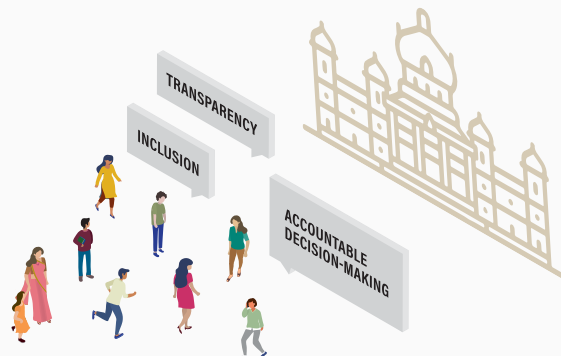
*Notes: *The VidyutRakshaka initiative has been developed and executed in partnership with TIDE.*
Sources: WRI authors.

The primary source of potable water for the city is the Cauvery River, a distant and legally disputed source. Pumped across 100 km and over a height of 350 m, Bengaluru's public water supply system is the costliest in India (*India Today* 2015).[29] However, nearly half of this precious water is "non-revenue," lost to leakage and pilferage. The 2011 census figures also reveal that nearly 30 percent of the population within BBMP limits (and many more beyond) do not have access to piped water supply and sewerage, given the slow progress in extending these networks beyond the erstwhile municipal area. Although the city receives plentiful rainfall during the year, harvesting is extremely limited. The demand-supply gap is largely met through groundwater, which has depleted rapidly due to overextraction (Driver 2020).[30]

Over time, the growing dependence on imported water supply from distant sources has gone hand in hand with the neglect and deterioration of the city's interconnected network of tanks and lakes that had sustained it for centuries (up to the 1930s). Several studies have shown a sharp decline in their numbers, size, and condition, due to encroachment and pollution from the inflow of untreated sewage, industrial effluents, and solid waste dumping (Thippaiah 2009; Ramachandra et al. 2016). This, in turn, has reduced the groundwater recharge potential and led to regular flooding in several parts of the city. An integrated resource planning and management approach is needed to make the city resilient to risks.

Objective and Strategy

WRI India's work in the water space began under the Sustainable Cities program in 2016, at the Bengaluru office. Our team developed a program based on the integrated urban water management approach to help cities better manage their water resources by identifying risks and city-specific solutions for increasing resilience. It includes the following key components:

■ Mapping and measuring urban water challenges (risk and resilience) by using WRI's tools/frameworks such as the CWAF, which is designed to model all aspects of urban hydrology.[31]

■ Identifying strategies and solutions such as water-sensitive urban design, circular economy (sludge and wastewater reuse), water quality, city

master plan guidelines and regulations, and policy and legislative interventions.

■ Increasing resilience by adopting WRI's Urban Community Risk Assessment (UCRA) framework, vulnerability and adaptation initiatives, and investments in natural infrastructure.

Actions

The CWAF was first applied and tested in Chikkaballapur (a town near Bengaluru) as a part of its Master Plan revision efforts that the WRII-RC was supporting. Water-related risks were identified, and recommendations for increasing availability, protecting water bodies, and formulating water-sensitive urban design proposals and DCRs were put forward for incorporation into the plan. At the 2017 Unlock Bengaluru[32] event, we presented and discussed various components of the program, including application of the CWAF and preliminary risk analysis for Bengaluru, sludge-to-energy (StE) potential, the UCRA framework, and governance-regulatory frameworks and issues. At the following year's event, we convened and engaged eminent water experts, social-environmental activists, and the public utility (the Bangalore Water Supply and Sewerage Board [BWSSB]). The session discussed water risks in Bengaluru, the possibility of facing a "day-zero" situation, and the city's capacity to manage in that eventuality. Over these years, our team has continued to engage with the BWSSB.

In 2016–17, our team conducted interviews and desk research to prepare a detailed case study on the water and sanitation sector and access to these services in Bengaluru, contributing to two papers in WRI's World Resources report *Towards a More Equal City* (Mitlin et al. 2019; Satterthwaite et al. 2019). These papers analyze and compare information from 15 cities in the global South and put forward recommendations to secure more inclusive and equitable access to these basic services to in turn improve the economy and environment in cities.

A technical note on the CWAF has been prepared and is under review. The team's StE work has also been presented and discussed in various forums, including a high-level meeting at the Ministry of Housing and Urban Affairs (MoHUA), GoI, in early 2018.

6. PLATFORMS FOR IDENTIFYING AND SCALING INNOVATIVE SOLUTIONS

CONTEXT AND RELEVANCE

Massive capacities for ideation and problem solving are required to address challenges in the planning and management of our urban areas. Bengaluru, being the hi-tech and start-up capital of India, also provided a good springboard for identifying promising data and tech-enabled solutions.

Over time, the WRII-RC has created and successfully leveraged several platforms to engage and bring together a wide range of stakeholders from government, the private sector, and civil society to dialogue and spur action around particular issues in cities. These platforms have also served to forge complementary partnerships and foster innovation. Taking a leaf out of and building upon our pan-India platforms such as Connect Karo, Bus Karo, and the Rickshaw Rising Challenge held earlier, in 2015, the WRII-RC along with members from the Center for Public Problem Solving (CPPS) helped devise and facilitate India's first-ever Neighborhood Improvement Partnership Challenge, NIPC, in Bengaluru.

NIPC

Based on the lessons and experiences of the HSR-NIP exercise and recognizing the gaps[33] in the public problem-solving ecosystem, the NIPC was conceived as a platform and model to involve and support citizens in addressing civic issues alongside public officials. A challenge format was adopted to help replicate and scale up neighborhood improvement projects across the city. Launched in May 2015, the Challenge was steered through a collaborative partnership between many organizations.[34]

Our team, along with members from CPPS, helped structure and run the NIPC for over six months, providing technical guidance and handholding for applicants throughout the process. The WRII-RC also helped develop an appraisal framework, creating solution types and curating for scale and impact. We

helped assess and shortlist 32 of the 86 proposals received from resident welfare associations, community-based organizations, and NGOs across the city, and in December 2015, an eminent jury panel selected 12 awardees, who received a share of the total $0.15 million CSR grant to implement their projects (Dash 2015). The WRII-RC and CPPS continued to provide technical assistance and work with the 12 winners in implementing and monitoring progress until project completion. This provided a fillip to community-led NIPs across diverse sectors.

The NIPC experience offered valuable lessons with respect to thinking more strategically when choosing partners and actors, to ensure that intent, capacities, and commitment match up to what is needed for realizing successful outcomes. For instance, it was observed that stakeholders having a professional and business interest in the project were deeply invested and had the wherewithal to sustain the work/engagement over a longer period. This experience helped us conceive the next Challenge—STAMP—and craft a robust proposal and complementary partnerships to drive it.

STAMP

Opportunity, Objective, and Strategy

In 2016, the city was looking for solutions to improve last mile connectivity and mode integration with the metro rail system, a key gap that had the potential to substantially influence travel mode choice and metro ridership. Start-ups had begun to approach the WRII-RC (thanks to our history and our reputation for offering innovation programs) with solutions, wanting to engage with government agencies but unsure about how to proceed. Around the same time, Toyota Mobility Foundation, looking for solutions to ease the daily commute of their employees at Toyota (headquartered in Bengaluru), engaged with the WRII-RC, and as a result the idea of STAMP was born. With the objective of incentivizing use, extending reach, and increasing ridership of the metro system, STAMP adopted a

Challenge format to foster innovative, data/tech-enabled market solutions for improving access to and achieving seamless integration with the metro, and also helped BMRCL appreciate the value addition that start-ups could bring. The program was launched in December 2016, and over the next year, identified the most promising solutions, which were taken through an accelerator program, incubated, pilot tested, and evaluated, before scaling up (Figure 14). This also builds upon our UDA work of improving safe access to mass transit and constitutes an integral component of TOD.

Outcomes: Impact and Influence

- Through STAMP Bengaluru, the WRII-RC has been successful in elevating the critical issues around last mile connectivity to mass transit and MMI, in the city and across the country. It has helped develop a strong ecosystem and platform for fostering innovation in integrated mobility and set a precedent for government agencies willing to explore new models for public service delivery. The project has demonstrated an approach where quick-win solutions can be piloted and customized without being limited by restrictive tendering processes.

- To help them scale, several entrepreneurs were given valuable mentorship and exposure to financing and government agencies. The initiative also gave a boost to other start-ups, and the city has since seen a rise in the number of new mobility services being piloted and introduced, encouraging a shift to shared and public mass transport modes.

- The project provided valuable insights to entrepreneurs, transit agencies, and the urban mobility ecosystem in general on the potential of data analytics for operations planning/monitoring and tech-enabled innovative solutions. The BMRCL incorporated learnings on station access and design to improve physical integration with other transport modes, circulation, and passenger information aspects within metro stations in its Phase 2 network plans.

- The STAMP Bengaluru experience, described in a project report, was leveraged to conduct the STAMP Challenge in five other Indian cities: Hyderabad, Kochi, Mumbai, Ahmedabad, and New Delhi (WRII-RC 2017e, 2018c).

More recently, the WRII-RC has been engaging in urban development initiatives that have expanded scopes and are more cross-sectoral in nature. We have successfully explored diverse formats for engagement such as high-level conventions and coalition-building events—for example, Unlock Bengaluru—as well as platforms such as CityFix Labs, which engage a diverse set of stakeholders and give us insights into private sector thinking and business models, which have strong implications for sustainability in the city and how we plan and design projects. We have also leveraged our data-driven approach and deep sectoral insights to inform not just policy, but also monitoring and evaluation metrics and suitable delivery mechanisms. A few of these initiatives are outlined below.

DEVELOPERS DIALOGUE: REIMAGINING TOWNSHIPS THROUGH A SUSTAINABILITY APPROACH

During 2012–14, the WRII-RC partnered with real estate developers in Bengaluru and undertook a pilot exercise to demonstrate how their project plans could promote safe access and sustainable mobility. As part of this study, our team conducted household surveys and mobility and design audits in several gated enclaves/townships across the city. The findings, along with other relevant case studies and recommendations, were described in two publications (Rajagopalan et al. 2015; Sudhakaran et al. 2017) and shared with a diverse set of stakeholders through workshops in Bengaluru and other Indian cities. In partnership with the National Real Estate Development Council, suggestions for enabling the required national government policies were also developed.

Based on this initial work, the WRII-RC created a platform for engagement with real estate developers/builders. The objective was to sensitize and influence them to adopt sustainable mobility principles in the design of their projects, promote active lifestyles as also the use of nonmotorized and public transport, and incorporate RE and water efficiency features to the extent possible.

In March 2018, the WRII-RC convened a workshop with key stakeholders in Bengaluru's real estate development

Figure 14 | **Station Access and Mobility Program (STAMP) Challenge 2017**

STAMP
BLR

CHALLENGE PARTNERS: c.ie | WRI INDIA | namma metro BMRCL | urbanventure labs | unitus seed fund | TMF GROUP | B.PAC Let's Be Better

THE STAMP APPROACH

DATA & EVIDENCE BASED

01 IDENTIFY
gaps and opportunities that impact accessibility to metro stations through primary/secondary studies and surveys of metro passengers and potential passengers currently not using the metro

CONTEXTUAL & COLLABORATIVE

02 ENABLE
entrepreneurs and transit agencies to understand the local context and ideate through area-based workshops with communities, grounded in the WRI safe access approach

TECH-ENABLED & INNOVATIVE

03 CATALYZE
innovation with the STAMP Challenge platform, to identify and incubate (customize, refine) the most promising solutions

DEMONSTRATE & EVALUATE

04 IMPLEMENT
winning ideas through pilot projects to test and demonstrate potential impact and public-private partnership for transport services

THE STAMP PROCESS

Conducted studies and workshops at **3 METRO STATIONS, 3 ENTREPRENEUR ROUNDTABLES**

80+ APPLICATIONS

24 SELECT TEAMS
pitch to Interim Jury

13 SHORTLISTED TEAMS
for Accelerator Program — an intensive five-day bootcamp

5 WINNERS
receive the STAMP grant at a Public Pitch Day.
BOUNCE: Scooter rentals
TAPROUTE: Auto booking app
QUICKRIDE: Carpooling app
CONSTAPARK: Parking app
CIFOS: Station Accessibility Index

3 OF 5 WINNERS
launch pilot operations at a major metro station for 3 months. CiFoS conducts accessibility audit.

OPERATIONS IMPACT
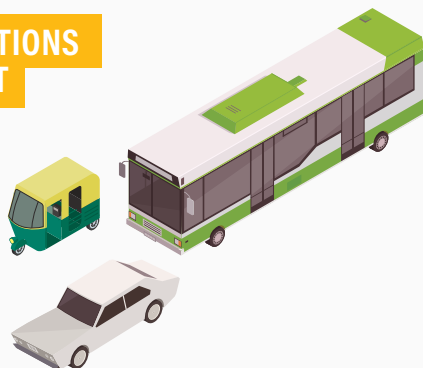
PILOT

Effective reach of metro network at terminal station extended by **8-10 KM**

Average mode shift induced from personal vehicles to shared and public mass transport was **35%**

Passenger trips served:
17,490 trips

Travel time saved:
3,766 hours

Money leveraged:
$0.1 million

POST-PILOT

Bounce wins tender to **SCALE SERVICES TO 37 (OF 41) METRO STATIONS AND MAJOR BUS TERMINALS**

In 2019,

End-mile trips served:
9 million

Travel hours saved:
3.42 million

ENGAGEMENT AND INFLUENCE

STAKEHOLDER ENGAGEMENT

Through STAMP Challenge Workshops, Events (Panels/Roundtables) — **479 STAKEHOLDERS DIRECTLY ENGAGED** — from government; transit agencies; entrepreneurs; domain experts; leading industry, innovation, and financing organizations; corporates; political and civic leaders; citizens; media

Engaged large corporates like RMZ Corp and Sasken Technologies on **MANAGING EMPLOYEE TRANSPORTATION USING THE NEW MOBILITY, TRANSIT-BASED SERVICES**
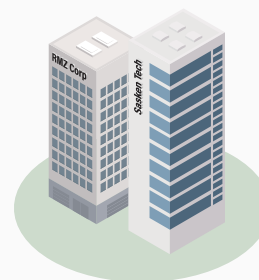
DEVELOPED 4 TRAFFIC POLICE TRAINING MODULES and engaged the Bangalore Traffic Police

BRAND ENHANCEMENT

Extensive communications and outreach to a wide audience:

Micro-website with over **8,000** views, **350** downloads
3 videos
3 radio/TV events
22 print media articles/mentions
180 social media posts
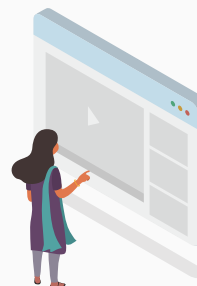
Sources: WRI authors.

sector. The "Developers Dialogue" on reimagining and building sustainable townships expanded its focus to incorporate the energy, water, and wastewater sectors, in addition to urban design and mobility. Learnings from our earlier projects and engagement with developers were shared, a repository of good practices from around the country was crowdsourced, and sectoral roadmaps for sustainable township design were developed with domain experts through interviews and focus group discussions.

In the 2018 Unlock Bengaluru edition, the roadmaps were shared with a larger audience to seek feedback. These will be used as a capacity-building tool for promoting sustainability and influencing low-carbon developments in the city.

THE CITYFIX LABS INDIA: ACCELERATING INNOVATION IN WATER, WASTE, AND ENERGY

The WRII-RC developed and launched the first TheCityFix Labs initiative in October 2018 to transfer the concept and learnings from the successful STAMP Challenge in Bengaluru to other sectors. It served as a platform to coordinate investors and the state for public good, by helping to interconnect the innovation ecosystem (WRII-RC 2018d).[35] The program conducted year-long policy dialogues and kick-off and accelerator workshops in Bengaluru and other Indian cities, engaging with government stakeholders, industry experts, entrepreneurs, and investors/financiers. The pan-India Lab identified 10 promising private sector solutions by start-ups for resource management and efficiency in three sectors—water, waste, and energy—that contribute to building and scaling sustainable built environments. Of these, four are Bengaluru-based enterprises, with Hasiru Dala winning the award for the most innovative waste management solution.

Through our facilitative efforts, three companies pilot tested their solutions with various public and private entities in Bengaluru. WeGot has completed a pilot incorporating its water metering and management dashboard into VMware's Internet of Things (IoT) platform. 75F has completed a pilot to manage HVAC, air quality, and energy management requirements across a WeWork facility. BIAL is close to engaging WeGot, 75F, and Fluid Robotics to pilot their water and building energy management solutions and conduct an assessment for one of their underground water pipelines, respectively. The CityFix Labs not only helped institute pilots but also leveraged cumulative funding to the tune of $26 million for four of the cohort companies (Figure 15).

UNLOCK BENGALURU

Since 2016, the WRII-RC has hosted Unlock Bengaluru, a dialogue on sustainable development designed to support coalition building and partnerships for our work in the city. The annual convention brings together our partners from government, private sector, civil society, and other stakeholders in the city, and enables us to share our work and learnings in Bengaluru and other global cities. We take this opportunity to seek feedback on concepts to address equity, avoid unsustainable lock-ins, initiate transformative change, and discuss imperatives for the city to consider. This platform has served to build awareness and consensus, rally support, further our engagements and networks, and strengthen our reputation in the city. At the inaugural event, the *International Journal of Sustainable Urbanization, Planning and Progress* released a special edition titled "Unlocking Urbanization: Lessons from India." Five of the seven papers were authored by WRII-RC staff and described our work and state of practice addressing key sectors and issues in Bengaluru (Sitharam 2017).

7. SCALING BEYOND BENGALURU IN KARNATAKA

Our presence and deep engagement in Bengaluru with the city and state government also provided opportunities to engage in other cities and towns in Karnataka by offering strategic advice on plans/policies and guidance with demonstration projects.

ENABLING TOD IN HUBLI-DHARWAD

Under the MoU with the DULT, the WRII-RC worked closely with their team, the transit agency, and local government authorities in Hubli-Dharwad[36] toward adopting TOD principles to guide urban expansion and development along the BRT corridor between the twin cities. Our team conducted a broad, regional study and selected the Navanagar BRTS node for the TOD and accessibility demonstration project. An assessment of existing conditions, future growth scenarios, and imperatives for the Navanagar area was carried out. A final report submitted to the DULT outlined key TOD principles for shaping Hubli-Dharwad as a "Connected City," proposals for Navanagar, and a range of measures to be taken at the city and state levels to enable TOD in the region (EMBARQ India 2014b). Thereafter, the WRII-RC continued to support two major initiatives: we guided the revision of the Comprehensive Development Plan for Hubli-Dharwad as empaneled technical advisors and served as project management consultants for the safe access and public space improvement project at Navanagar, which was approved and allocated funds in the 2017–18 budget.

"The project will serve as a reference for the creation of better streets and public spaces in other parts of the city, state and country."
– Mr. Noor Mansoor, Commissioner, HDMC

PLANNING FOR ORGANIZED DEVELOPMENT OF CHIKKABALLAPUR

Following the 2015 meeting with the city's top officials, the WRII-RC UD team was approached by the MLA of Chikkaballapur for expert guidance with the revision of the Master Plan for Chikkaballapur 2031. Due to its proximity to Bengaluru, the town experiences significant development pressures, fueled by speculative investments. Our team reviewed the Draft Plan and conducted a study to assess existing conditions and key considerations for the development of Chikkaballapur as an effective satellite town of Bengaluru offering a good quality of life. In early 2017, our inputs and recommendations around five important aspects were presented to the concerned authorities for incorporation into the revised master plan. These included strategic spatial planning and projects, structuring road networks for improved mobility–accessibility, environmental preservation, integrated water management considerations, and implementation and financing modalities.

NAVA KARNATAKA VISION PLAN 2025

In 2017, the GoK set up a Steering Committee under the chairmanship of the chief minister to oversee the creation of the Nava Karnataka Vision Plan 2025. It intended to lay out a progressive and inclusive development agenda and governance strategy, with an implementation roadmap for the state over the next seven years. The WRII-RC, in partnership with the Center for Study of Science, Technology and Policy (CSTEP), supported the GoK in framing the chapters on the energy, urban development, and transport sectors (CSTEP and WRI India 2018). Comprehensively addressing the needs of the entire state, with a special focus on alleviating the challenges in Bengaluru (which housed over 36 percent of the state's total urban population), was critical. As part of this exercise, the team conducted workshops and held several discussions with technical experts, civil society organizations, government officials, and the anchor agency to identify key transformative and implementable strategies. The final plan document was released by the chief minister in March 2018.
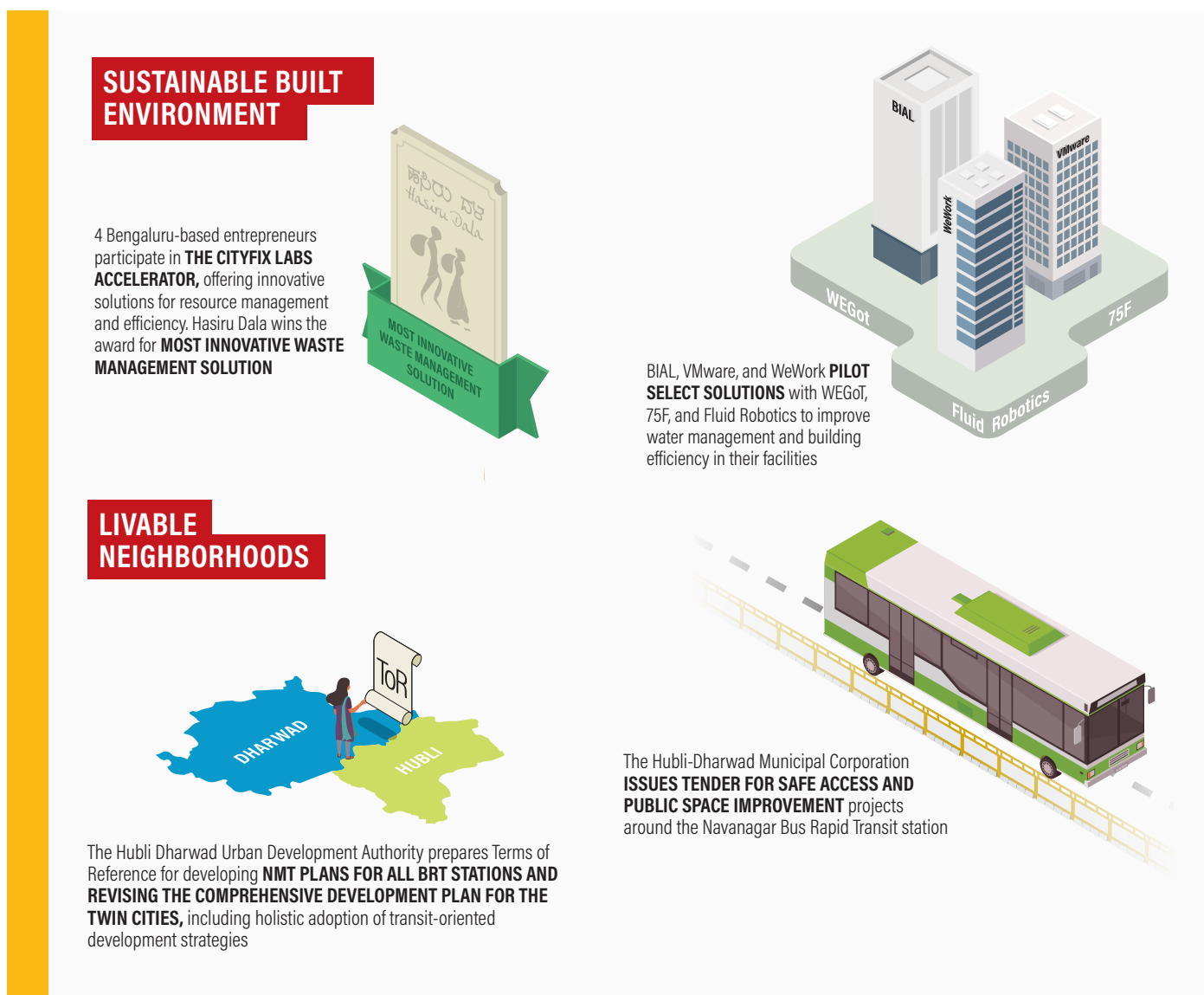
KARNATAKA'S STATE ACTION PLAN FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

As part of a national-level initiative coordinated by the GoI's NITI Aayog, in 2018, the Planning, Programme Monitoring and Statistics Department, GoK, initiated an exercise to develop a State Action Plan for incorporating Sustainable Development Goals (SDGs) in the state's planning and budgetary processes. WRII-RC staff (across different programs and teams)[39] were empaneled to participate as members on 7 (out of 17) SDG Goal Committees[40] constituted for the purpose. Our staff attended several Goal Committee meetings, providing inputs and recommendations for the preparation of action plans for each of the 7 SDGs. The plans outline medium- and long-term goals, targets, indicators, and actions needed (policies, laws, schemes, budgets, etc.) to effectively implement all the related activities and achieve the SDGs by 2030 (KEA 2020).

Figure 15 depicts the outcomes of some of our cross-sectoral initiatives in Bengaluru and in other towns/cities in the state.

Figure 15 | **Cross-Sectoral and beyond Bengaluru: Cumulative Impact 2015–2019**

SUSTAINABLE BUILT ENVIRONMENT

4 Bengaluru-based entrepreneurs participate in **THE CITYFIX LABS ACCELERATOR,** offering innovative solutions for resource management and efficiency. Hasiru Dala wins the award for **MOST INNOVATIVE WASTE MANAGEMENT SOLUTION**

MOST INNOVATIVE WASTE MANAGEMENT SOLUTION

BIAL, VMware, and WeWork **PILOT SELECT SOLUTIONS** with WEGoT, 75F, and Fluid Robotics to improve water management and building efficiency in their facilities

LIVABLE NEIGHBORHOODS

The Hubli Dharwad Urban Development Authority prepares Terms of Reference for developing **NMT PLANS FOR ALL BRT STATIONS AND REVISING THE COMPREHENSIVE DEVELOPMENT PLAN FOR THE TWIN CITIES,** including holistic adoption of transit-oriented development strategies

The Hubli-Dharwad Municipal Corporation **ISSUES TENDER FOR SAFE ACCESS AND PUBLIC SPACE IMPROVEMENT** projects around the Navanagar Bus Rapid Transit station

PLANS AND POLICY ADVICE

SPATIAL AND IMPLEMENTATION FRAMEWORKS

ENVIRONMENTAL PRESERVATION

INTEGRATED WATER MANAGEMENT

The Chikkaballapur Urban Development Authority prepares Terms of Reference for **REVISION OF ITS DRAFT MASTER PLAN 2031 INCORPORATING RECOMMENDATIONS** for environmental preservation, integrated water management, spatial and implementation frameworks

7 SDGs

The Government of Karnataka **INCORPORATES RECOMMENDATIONS ON PREPARATION OF STATE ACTION PLANS** for 7 Sustainable Development Goals

Nava Karnataka Vision Plan 2025

The Government of Karnataka **INCORPORATES RECOMMENDATIONS FOR URBAN DEVELOPMENT, TRANSPORT AND ENERGY SECTORS**, as part of the Nava Karnataka Vision Plan 2025 for the state

When implemented, these plan and policy revisions would potentially impact and improve the quality of life for over 1.5 million residents of Hubli-Dharwad and Chikkaballapur town, saving over 30 lives annually.

Sources: WRI authors.

8. CONCLUSIONS AND LEARNING

WRII-RC'S ROLE IN ECOSYSTEM STRENGTHENING AND SYSTEMIC CHANGE

Utilizing Our "Theory of Change"

Over the past decade in Bengaluru, the WRII-RC has played a crucial role in the city, bringing data, domain knowledge, and technical expertise (both local and global) to create awareness, build the capacities of various stakeholders, and inform decisions (on policies, plans, budgets) and practice (OTG projects). Given the lack of useful data for decision-making, inadequate technical capacity, bureaucratic silos, and frequent staffing changes within government agencies, our contribution has been highly valued by our partners and helps plug a significant gap.

Recognizing that "turning big ideas into action" and scaling up requires an array of supporting activities, our programmatic work has been reinforced and expanded through our core knowledge sharing, communications/outreach, training, and capacity-building functions (see Figure 16).

Figure 16 | **Key Influence Indicators: Cumulative Influence 2011–2019**

50+
KNOWLEDGE PRODUCTS

20+ Working Papers / Technical Notes

20+ Reports

15+ Tools/Toolkits

10+ Case Studies

5+ Guidebooks/Manuals

65+
CAPACITY BUILDING WORKSHOPS AND TRAINING WEBINARS

1700+ participants / persons trained

In addition, several stakeholder engagement, knowledge sharing, and capacity building sessions have been conducted at our annual events

Connect Karo (since 2013)

Unlock Bengaluru (since 2016)

15+
PLATFORMS AND COMMUNICATION/ OUTREACH CAMPAIGNS

NIPC
STAMP
Better Bus
The CityFix Labs
Developer Dialogues
KEGN
GPMDG
VR
Bus Karo
Connect Karo
Unlock Bengaluru
BIG Bus
Bus and Road Safety
Bus Day
ORR BRT/BPL
BMTC Facebook & Twitter accounts

20+
PLANS/POLICIES INFLUENCED

BMTC Open Data Policy, Bus Safety Policy and Guidelines, Taxation Policy, Fare Restructuring Reforms

Draft Revised Master Plan for Bengaluru 2031, Draft TOD Policy, Draft Comprehensive Mobility Plan, Draft Parking Policy

Karnataka Vision Plan 2025, State Action Plan for Sustainable Development Goals, Karnataka Electricity Sector Plan, Karnataka Electricity Regulatory Commission Order

Revision of Master Plans for BIAAPA, Chikkaballapur, Hubli-Dharwad, Davangere Smart City Plan and KTCP Act

150+
STAKEHOLDERS CLOSELY ENGAGED

Politicians/Elected Representatives

Government Agencies/Departments

Influential Individuals

Academic / Research / Technical Institutes

Private Sector (Tech-Entrepreneurs, Corporates, Tech-Parks/Associations, Builders/Developers)

Civil Society (NGOs, CSOs, COBs, RWAs, AAs)

Media

Funding Organizations / Venture Capitalists

10+
SCALE-UP TO OTHER INDIAN CITIES

Chennai, Mumbai, Delhi, Indore, Bhopal, Jaipur, Surat, Rajkot, Hyderabad, Kochi, Pune, Mysore

Notes: See list of abbreviations on page 69.
Sources: WRI authors.

For over a decade, the WRII-RC has been helping the city's public stakeholders at two main levels:

1. **Metropolitan scale:** This has entailed engaging with long-term initiatives, primarily related to governance, visioning, and planning for the metropolitan area.

2. **Local scale:** This involves support on short-term/interim plans and projects that have allowed us to construct proofs of concepts and provide strategic advice on operational issues.

Our engagement with city and state government authorities in Bengaluru has also enabled us to work in other towns/cities in Karnataka, as well as on state-level initiatives.

Our unique value proposition lies in pinpointing and defining the problem, bringing solutions, and testing them before scaling. Through donor support, we are able to provide technical assistance at the early stages of project preparation, leveraging our network of local and international domain experts, involving and sensitizing media to reach a broader group of influencers, supporting coordination across a multiplicity of actors and agencies, and systematically identifying and eliminating barriers along the way.

What Has Worked Well?

Expanding our work within each sector, across sectors and scales, employing data, tools, and platforms

- **Evolving strategy, approach, and work areas: connecting the dots**
  Over the years, as we transitioned from EMBARQ India to the WRII-RC, our scope of work also evolved. We initially began with a focus on BRT and bus systems, safe access, and TOD, but gradually expanded to include—based on contextual situations, opportunities, and the pressing issues faced by the city—metro rail and MMI, managing urban expansion in the city region, and bringing efficiencies in the spaces of first clean energy and subsequently water management. Working across many areas of urban expertise, we offer an integrated approach to sectoral and cross-sectoral challenges. We try to connect our work across projects, identifying linkages and synergies that may otherwise be missed by government agencies/departments operating in

silos. Being flexible and aligning our work to what was needed, we were able to address other important or systemic issues and thereby leverage our core competencies.

- **Talent and thought leadership**
  Over the years, the WRII-RC has been able to attract and retain talent and consistently improve staff capacities in the Bengaluru office.[41] This includes persons with broad domain expertise as well as specialized expertise (in research, data analytics, technical planning–design, and project execution) and senior thought leaders, apart from support functions such as (internal/external) communications, capacity building, and institutional operations. Since 2014—starting with the KTCPA revision work in Bengaluru—the Sustainable Cities program has strengthened and expanded its data science and geospatial data analytics capacities, supporting the WRII-RC's work across workstreams and regions. WRI India's Energy program and Urban Water program (under Sustainable Cities) were also initiated in the Bengaluru office. Staff talent and capacity in Bengaluru has also enabled the WRII-RC to pitch for and pilot several initiatives in the city.

- **Use of data**
  The WRII-RC focused on creating data-driven narratives to build a case and inform discourses and decision-making. Our data- and evidence-based approach has also enabled us to stay independent and objective, which has led to credibility across the board. For instance, we have used robust data analysis to plan city bus operations and to develop proposals for BBMP restructuring and the Karnataka Vision Plan 2025.

- **Scaling through knowledge products, capacity-building tools, and platforms**
  The WRII-RC has developed seminal studies and publications around our core work areas such as transport, accessibility, governance reforms, and planning frameworks. In addition, platforms and initiatives such as Bus Karo, STAMP, NIPC, Safe Access Manual and Toolkit, TOD Financing and Capacity Building Modules, CWAF, and UCRA help impart knowledge and capacity at the institutional level. The WRI India website is also extensively used as a resource platform and a repository of best practices and Web-based learning, all of which contribute to demonstrating thought leadership and connecting with a wider audience.

The deep engagement approach

- **OTG pilot projects**
  Proof-of-concept projects have played an important role in developing methodologies, demonstrating the "how-to" and setting precedents. Over time, our high-quality research has enabled us to successfully deliver OTG projects that have demonstrated impacts and our value proposition, helping us strengthen working relationships with individuals and organizations. Our long-standing relationships with the BMTC, DULT, and more recently the BMR-CL bear testimony to this.

- **Having a physical presence and a deep dive city approach**
  Having an office based in Bengaluru has allowed us to achieve the following:

  1. Stay closely engaged with our numerous partners, follow up, and consistently push for implementation/outcomes.

  2. Build and leverage our connections and networks to work synergistically and find entry into other sectors when decision-makers move to new positions. The working relationships we have built with the leadership of the BMTC, BMRCL, DULT, and BDA over the years have stood us in good stead.

  3. Quickly respond to and leverage opportunities that present themselves. We have been able to capitalize on high-level meetings with the city's top politicians and bureaucrats on important decisions, even at short notice.

  4. By holding events such as Unlock Bengaluru where we engage with the larger stakeholder community, we participate in the broader imagination of the city.

A deep dive approach allows us to build ground-up knowledge, develop a deeper understanding, and identify the root cause of many issues. The learning we gather not only allows us to scale to other cities and states but also enables us to contribute to policies at the national level. For instance, our work on SAP-DCRs and safe access has informed other engagements on TOD across India, as well as the National TOD Policy. The BBMP Restructuring modules related to strategic planning and scales of plans laid the foundation for other engagements on strategic and economic planning for Hyderabad and Delhi-NCR, and the formulation of LAP-TPS for 25 Smart Cities under MoHUA. The HSR-NIP and NIPC pilots laid the foundation for other Challenge programs at the national level, including TheCityFix Labs and the Nurturing Neighborhoods Challenge. STAMP piloted in Bengaluru and, now into its sixth edition, has helped mainstream the issue of last mile connectivity and MMI at the national level. Similarly, our work on increasing the uptake of RE and EE among various consumer categories, which was initiated in Bengaluru and Karnataka, has been scaled to other cities and states.

Stakeholder engagement: cultivating relationships and partnerships

- **Leveraging relationships to bring about ecosystem change**
  Over the past decade, as the WRII-RC's work in Bengaluru has grown, we have also expanded the range and number of stakeholders, actors, and individuals we have engaged with and have built close working relationships with many of them. Through our presence, sustained work, and engagement, which demonstrates a deep knowledge of the local context, and the objective, data-led approach we use, we have been able to build credibility, trust, and reputation in Bengaluru. We are invited to participate in conversations and initiatives, and a growing network of individuals and organizations consistently reach out to seek our opinions on critical decisions.

- **Improve capacities of various stakeholders**
  The WRII-RC has helped various stakeholders move from an intuitive to a more science-based and nuanced understanding of subjects. We have helped improve the capacities of stakeholders and have disseminated information and knowledge based on our work through our channels: media, journals, presentations in events, and so on. We have been successful in informing discourses, particularly among thought leaders and influencers.

Innovative formats

- **Citizen engagement**
  Gathering public opinion, feedback, and buy-in are as critical as the inputs themselves. Citizen engagement has far-reaching consequences and can yield long-term benefits through cumulative positive change.

The WRII-RC has engaged with the city's ecosystem in different ways, such as through campaigns or projects that aimed to change citizens' perceptions, mindsets, and behavior (Cycle Day, VR, etc.).

■ **Building robust initiatives based on complementary partnerships**
Although the WRII-RC has built internal capacities over the years, several of our initiatives have involved stakeholders and partners. The WRII-RC applied domain knowledge and expertise to issues, and collaborators contributed implementation expertise or a network of investors and funders. For example, in the challenges, we engaged with tech entrepreneurs and start-ups whose work bridges the gap between markets, finance, and customers.

LEARNING FROM AND ADDRESSING CHALLENGES TO ENABLING OUTCOMES

Political Economy and Governance Complexities

Despite a huge push, particularly from civil society, major project decisions (such as the implementation of metro versus BRT along particular corridors) continue to be taken without good data and evidence, as there is little ability to visualize issues at the metropolitan scale and use robust information (such as cost-benefit analyses) to make decisions. Moreover, the lack of clarity on governance structures and disagreement about where and with whom powers should reside continue to hamper decision-making. In addition to this, working toward systemic changes that typically require long gestation periods needs patience and alignment of interests of all stakeholders. Finally, the implementation of the envisaged outcomes sometimes becomes challenging due to external factors or interests within the political economy.

The challenges we have encountered, such as those of governance and finance, have led us to address broader or deeper systemic issues. This has not only helped us scale up our work but has also institutionalized processes (e.g., through the BBMP Restructuring engagement), enabling sustainable outcomes. The learnings along the way have helped us grow institutionally and programmatically, allowing us to exert greater influence.

Institutional and Programmatic Learnings

■ **The WRII-RC's credibility and positioning to influence city budget conversations**
Through our work in Bengaluru and other Indian cities, we have learned that in addition to influencing policies, plans, and projects on the ground, it is essential to influence city budgets and secure allocations to enable implementation and outcomes. This is especially crucial given the importance of economic and political factors—rather than policies and plans, which often remain on paper—on decision-making in Indian cities. This also extends to engaging with draft election manifestos and citizen charters to influence political and program priorities before they are set.

■ **Bringing data- and science-based understanding to the discourse has helped various stakeholders move from an intuitive to a nuanced understanding of subjects**
Having established ourselves as a credible voice of reason thanks to our evidence-based approach, our opinions are sought frequently. Key influencers (including business and civil society leaders and community groups) have the power to influence decisions and sway systems in the city. In general, alongside interaction with the bureaucracy, it is necessary to bring stakeholders onboard early and engage with them throughout the process to secure buy-in and enable implementation. This is, however, a slower, longer process that requires ongoing and long-term resource investment.

■ **Political engagement is critical in influencing decisions**
In addition to engaging with influencers, it is necessary to better understand and directly engage with the political ecosystem to be able to work strategically within political priorities, funding, and budgetary cycles. This has required us to develop our capacities for engagement across the political spectrum, where we go with well-prepared ideas and package information in a way that can be easily consumed to help politicians build campaigns that can get public buy-in.

■ **Engaging with agencies that have the mandate and the means**
Our work with nodal or lead implementing agencies having the authority, funding, and capacity to implement (e.g., BMTC and BMRCL) has been more fruit-

ful compared to our work with the DULT and DTCP, which has been much delayed, as these agencies are not empowered enough to get projects implemented. Although we can engage with local bodies that have only planning and/or coordination mandates, in order to influence a project in its early stages, direct engagement with implementing agencies is essential for success. Toward this end, in some cases, an MoU or formal arrangement with the agencies is crucial to continue longer-term engagement beyond leadership changes, sustain the association, and push through to realize the envisaged outcomes.

- **Staying broad versus going deep**
  As we expand the scope of our work, there is a need to understand key levers to be able to determine where we should work broadly and where we should go deep. We need to strategically pick issues to focus on and see through to implementation. Typically, ecosystem changes require staying engaged, going deep, and pushing the agenda over longer periods of time. Going deep in an area/sector entails understanding the gaps, addressing the issues, institutionalizing good practices and processes, and bringing in positive systemic shifts leading to larger transformative changes. Similarly, there are other areas where our role will be limited to contributing data, knowledge, or technical capacity. Discerning the level of engagement—based on our contextual understanding and theory of change—is crucial to transformation and scaling.

- **Planning for the "last leg"**
  As we have done more recently with many projects, conducting a robust stakeholder mapping at the outset not only helps identify power-interest groups and build in relevant gender and social equity perspectives, but also helps plan more systematically for other components that facilitate implementation, such as media or political engagements, communications and capacity-building needs, and addressing finance or governance challenges. Factoring these aspects into project proposals allows us to stay engaged over longer periods, to see projects through to implementation.

- **More systematic support with other functions**
  Although we have played the role of knowledge/technical partner well, it is only half the battle. The other half of the battle involves systematic support for other cross-cutting functions such as knowledge products, communications and outreach, capacity building, and lobbying with power-interest groups. Carefully designed communication campaigns connecting the pain points of a variety of stakeholders are needed to influence discourses and outcomes, make media and other key stakeholders part of the conversation, and through them widen political and public engagement. There is also a greater need to frame the conversations around benefits more strategically, building a case for not just social and environmental aspects but also economic concerns.

- **Communicating with and educating our donors about priorities and funding cycles**
  The multi-year grants that we received for work in Bengaluru, first from the Caterpillar Foundation and then the flexible funding from Ross Philanthropies, have been crucial in building our work, continuing our engagements, and quickly leveraging and capitalizing on the opportunities that came our way. To bring about transformative change, we need to find ways to deepen our engagement and start planning for 5–10-year cycles as opposed to 1–2-year ones, as most initiatives have lengthy gestational periods owing to scope, complexity, and coordination challenges. Conveying the need for longer, tapered funding cycles will require us to influence donor strategies by communicating our past work and outcomes effectively beyond set templates, designing events and knowledge/communication products targeted at educating donors about important issues, and mobilizing funding for these efforts.

GOING FORWARD IN DEEP DIVE CITIES

The WRII-RC's vision for Bengaluru is that of a thriving, livable, resilient, and inclusive city built on sustainable development principles. We intend to pursue these goals through our work under four broad, interconnected areas: metropolitan planning, integrated transport and safe access, energy transitions and resource management, and climate resilience. Based on our work and learnings up to now, the endeavor would be to engage in strategic, cross-sectoral initiatives with an increased focus on inclusion and equity. This would allow us to interface with multiple government agencies and political representatives, collaborate with various nongovernment

stakeholders/organizations, and forge complementary partnerships to address political economy and governance challenges and improve policy outcomes.

Although Bengaluru is a work in progress and does not present a definitive recipe for success, certain enabling conditions were considered and emulated for our work in other deep dive cities. We understand that different states and different sizes/types of cities in India need different pathways and solutions. Hence, based on the lessons we learned, we recommend the following actions for other deep dive cities in India:

- **Choose entry points wisely**
  Although we strive for systemic or transformative change across the city, sometimes the entry points may have a narrow scope or may be project/sector based. This need not be a limiting factor, as deep diving into a project/sector can help build knowledge and expertise, enabling us to expand our understanding of the city, the complexity of the challenges, and the means of tackling them. Integrated solutions within and across sectors will follow over time.

- **Raise and allocate unrestricted flexible funding**
  Given the urgency of climate change issues, it is important for us to use flexible funds strategically to respond to emerging opportunities. Although much of our funding is restricted to a project/sector and is time bound, allocating flexible funds for deep dives is crucial to build credibility, trust, and a sense of partnership with cities/city agencies. Being able to respond to political windows of opportunity, take

risks, and innovate while maintaining a long-term vision requires us to be agile in securing flexible/core funding and in communicating these needs to our donors.

- **Leverage internal and external champions**
  We should recognize and leverage staff strengths in local and global offices and establish "city leads" who can identify external partners, build relationships across agencies, serve as a single point of contact, and quickly identify and act on opportunities. As the scope of our work in deep dive cities expands, we need to establish internal lines of communication and collaboration across teams to enable efficiency and avoid fragmentation. This also helps build internal capacity across sectors and develop integrated solutions and pilots on the ground. Institutionalizing solutions and sustainable development approaches allows projects to scale, replicate, and leverage additional financing.

- **Be proactive in engaging politically**
  Although many of our engagements have been with the bureaucracy, building a relationship of trust with actors and stakeholders of all types, especially in line with current political imperatives, will allow us to embed ourselves in the system quickly. Seeking opportunities to influence political manifestos before elections can help ensure our staying power and give us a say when decisions are taken on important socioeconomic and environmental issues and policies. Collaborating with political actors and maintaining public relations are key enabling conditions for action and impact.

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APPENDIX B.
PROJECTS ACROSS WORKSTREAMS AND SCALES

	INTEGRATED TRANSPORT		URBAN DEVELOPMENT		URBAN EFFICIENCY	
	Bus + Bus Rapid Transit	**Metro + Safe Access**	**Local / Neighborhood**	**Metropolitan**	**Energy**	**Water**
LOCAL		• Metro Last-Mile Connectivity + Multimodal Integration – Pilot Study • Safe Routes to School Pilots • Sustainable Urban Mobility Accord + Pilots • Nurturing Neighborhoods Challenge Pilots	• Indiranagar Station Accessibility Plan and Development Control Regulations (SAP-DCR) • Townships Sustainable Mobility Design - Audits + Study • Hosur-Sarjapur Road Neighborhood Improvement Plan • Hubli-Dharwad Navanagar Node - Safe Access and Public Space Design		• Collab Solar Project • Bangalore International Airport - Solar Project • VidyutRakshaka (VR) - Phase 1	
METRO	• Big10 Performance Analysis • Fuel Emission Standards + Efficiency • BIG Bus Network - Pilot + Scale-up • Outer Ring Road Bus Rapid Transit Proposal • Fleet Augmentation - New Buses Procurement • Bus Operations + Women's Safety • Bus and Road Safety • Bus Day + Social Media Campaigns • Motor Vehicle Tax Exemption For State Transport Undertakings • Fare Restructuring • Smartcard System • Intelligent Transportation + Passenger Information Systems • Data Analytics Tool • Open Data Policy + Data Monetization • Metro Feeder Bus Services • Traffic Transit Management Centers - Design Development • Better Bus Challenge + Pilot • Fleet Electrification - Transition Roadmap • Bus-Metro Complementarity Analysis	• Station Access and Mobility Program (STAMP) Challenge • STAMP Challenge - Pilots + Scale-up • Safer Streets and Mobility Projects • India Cycles4Change Challenge Pilots	• SAP-DCR Scale-up • Neighborhood Improvement Partnership Challenge	• Bruhat Bengaluru Mahanagara Palike Restructuring - Way Forward Report + Implementation Modules • Strategic Projects - Whitefield + Ring Roads Bangalore International Airport Area Master Plan Revision	• VR Scale-up and VR Lite • VR for Aggregators	
	Unlock Bengaluru Conference; Developer Dialogues; Social Cost Accounting for Urban Services in Bengaluru; Data Portal and Greenhouse Gas Inventory for Bengaluru; Bengaluru Revised Master Plan 2031 Inputs; Inputs for Integrated Policy-Regulatory Framework for Transit-Oriented Development (TOD) in Bengaluru; Assessing Potential Benefits of Bangalore Metro and TOD					
REGIONAL	• Bus+Road Safety – Scale-up • Vision Plan for Bangalore Metropolitan Transport Corporation			• Hubli-Dharwad Master Plan Revision Inputs • Karnataka Town and Country Planning Act Revision Inputs • Chikkaballapur Master Plan Revision Inputs	• Integrated Resources Planning - Renewable Energy + Efficiency • Residential Rooftop Solar • Electricity Net-metering Program	• CWAF Pilot Application in Bengaluru, Chikkaballapur
STATE	*Karnataka Electricity Governance Network + Publications; Inputs to Karnataka Electricity Regulatory Commission Orders; Nava Karnataka Vision Plan 2025; Karnataka State Action Plan for Sustainable Development Goals*					
BEYOND	• Bus Karo Guidebooks • Public Bus Transport in Bengaluru - Case Study • Transport Accessibility Analysis		• Townships – Sustainable Mobility Design Practices Guidebook • Safe Access Manual + Toolkit • Neighborhood Improvement Planning Manual	• Alternative Mechanisms to Acquire, Plan and Service Land • Urban Villages Study	• Green Power Market Development Group India - Resources • Residential Rooftop Solar - Challenges	• City Water Assessment Framework (CWAF) - Technical Note • World Resources Report - Water And Sanitation Papers - Bengaluru Case Study • Sludge-to-Energy Potential
	Special Journal Edition - Unlocking Urbanization: Lessons from India; TheCityFix Labs Challenge + Pilots					

● ON-THE-GROUND (OTG) PROJECT   ● PLAN/POLICY INFLUENCE   ● KNOWLEDGE SHARING AND CAPACITY BUILDING

The challenges identified and faced through our initial years of engagement with the Bangalore Metropolitan Transport Corporation (BMTC) on the BIG Bus project led us to work on other related facets of the system. Since 2015, the WRII-RC has supported the BMTC in the various modernization efforts and systemic upgrades undertaken by the agency.

Financial Sustainability

Financial sustainability is key to the health of the transport corporation and its ability to continually expand and improve its services to keep pace with growing demands.

BUS FLEET AUGMENTATION

The BMTC has struggled to continually renew and grow its fleet size to match the requirements and demand.[42] In 2015, we helped the BMTC prepare a report requesting financial support for an additional 1,000 buses. The same year, our team presented an analysis of the BMTC's needs at a high-level meeting of ministers and senior bureaucrats from various government departments. This helped create awareness in political circles about the need for funding bus transport and won the chief minister's support for augmenting the BMTC's fleet. Following this, the Government of Karnataka (GoK) gave in-principle approval for 3,000 new buses in its 2016–17 budget, which was unprecedented in the state's history. We provided technical assistance to the BMTC in drafting a compelling, data-driven narrative for the funding proposal, which was submitted to the state government in early 2017. The GoK has since sanctioned an estimated $77 million for the procurement of 1,500 buses. The remaining 1,500 buses are to be leased under a PPP model, a move that was allowed for the first time.

TAX EXEMPTIONS

A paradox of the Indian taxation system is that it taxes public bus transport operators—who provide an essential service and function on social welfare principles—as commercial entities. What this does in effect is to create a perverse subsidy for private vehicle ownership. Taxes and other charges contribute to higher fares and leave many operators with a deficit and therefore no surplus capital to invest in service improvements, hardly an incentive for commuters to move to, or continue using, public buses (WRI India n.d.).

In 2016, the WRII-RC studied the taxation structure of 10 public bus operators across India, including the BMTC, and the extent to which it affected their financial sustainability. We also put forward alternate fiscal policy options and recommendations. Our research found that the BMTC

had the highest direct taxes and tax-to-revenue ratio (13.7 percent) of any city-level operator, and tax demands had grown at a much higher rate than in neighboring states. Despite serving over 90 percent of public transport trips in the city, the BMTC did not receive either the tax exemptions granted to the metro rail or the level of exemptions/subsidies received by its counterparts in other states and were, in fact, taxed more highly than private vehicles.

Based on this, the BMTC sought our support in building a strong case and drafting a proposal to the state government, seeking relief from direct taxes, which was a long-standing demand on their part. In response, the GoK exempted the BMTC from paying $18 million in motor vehicle tax for 2016–17 (which constitutes the bulk of direct taxes). It was suggested that this waiver be extended for the next five years, as was done for two other state transport undertakings (STUs) (Lalitha S. 2017; Menezes 2017b). Further, the BMTC was exempted $15 million for 2017–18, $14.9 million for 2018–19, and $9.87 million for 2019–20. This policy shift has made Karnataka one of the more liberal states in public bus taxation.

Our research also bolstered a citizen's movement demanding a more supportive financial environment for the BMTC so that it could provide better, more affordable services. This is significant as the financial losses suffered by the BMTC after clearing all its tax liabilities compel it to push for fare increases and cutting of unprofitable routes, which is bound to disadvantage commuters, especially the urban poor.

FARE RESTRUCTURING

BMTC bus fares are among the highest in the country. They follow a stage-based telescopic fare structure, making shorter trips and transfers more expensive and higher than the cost of operating motorized two-wheelers in the city. In 2016, we assisted the BMTC in a fare restructuring effort to amend irregularities in the existing system and improve ridership and revenues. Our study[43] proposed a system for structuring and revising fares. Based on our recommendation, in April 2017, the BMTC reduced and rationalized fares (in multiples of INR 5) for the first three stages. This helped lower the fare burden for shorter trips, while also reducing the problems of pilferage by staff and receiving change for commuters. Our team has also supported the BMTC with knowledge (case studies/best practices) on the adoption of smartcard-based integrated fare systems.

DATA ANALYTICS

The WRII-RC has helped the BMTC improve and institutionalize the process of gathering and managing high-quality data for performance monitoring

and operations planning. Building on past efforts, we helped the BMTC choose and adopt an integrated Intelligent Transport System (ITS),[44] which was launched in May 2016. Subsequently, our team helped the BMTC address technical issues with its ITS and develop a "Data Analytics Tool" that will help them evaluate, plan, and optimize operations using dynamic automated data instead of the static data they used in the past.

At the same time, we engaged the BMTC, civil society, and data enthusiasts in the city in several rounds of discussions on opening up BMTC data in standard format. This was intended to enable researchers and transport planners conduct studies and analyses, and help private entities such as Google, TRAFI, software developers, and tech entrepreneurs provide better information and services for both commuters and operators. Our team also supported the BMTC's efforts to explore transit data monetization. We conducted a survey to gauge the value addition from transit data and perception of travel time savings due to the apps.

Subsequently, the BMTC formed a committee to examine the issue of data sharing and prepare an Open Data Policy. Our team provided inputs and supported the development of the policy, which was officially passed by the BMTC's board in April 2017 and later approved by the state cabinet. Following some delays,[45] in February 2020, the BMTC finally announced its decision to share real-time data for noncommercial purposes (Menezes 2017a).

Safety

The WRII-RC has supported the BMTC in two specific areas to improve the safety aspects of their services.

WOMEN'S SAFETY

Following a pilot exercise in Bhopal, in 2015, the WRII-RC undertook a similar study on the safety issues faced by women using BMTC buses. The objective was to understand and incorporate these concerns into policy, institutional capacity, design of operations and infrastructure, enforcement, and grievance redressal systems. We submitted our findings and suggestions in a report to the BMTC. The same year, we convened a multi-stakeholder workshop[46] on women's safety in the public and intermediate public transport space in Bengaluru. The aim was to develop an ecosystem-level understanding of the roles, resources, and constraints of each stakeholder, identify issues, and suggest recommendations.

Subsequently, in 2016, our team helped the BMTC develop a proposal for utilizing the Government of India's Nirbhaya Fund, which led to their receiving a grant of $8.3 million. The proposal outlined several measures to make bus travel safer for women, such as awareness campaigns for commuters, gender sensitization training for staff, training for women drivers, inclusion of safety features in BMTC's smartphone app, CCTV cameras in buses and bus terminals, special women's lounges at major bus stations, and more patrol vehicles. The BMTC conducted a survey to ensure that funds were disbursed

for initiatives that passengers considered most essential, many of which have been implemented (Bhat 2017; Fathima 2018).

The WRII-RC has also facilitated hackathons to find innovative, tech-enabled solutions for improving women's safety in public transport and public spaces. The winners were given an opportunity to work closely with the BMTC and Bengaluru City Police to pilot their solutions/applications.[47]

Bus and Road Safety

Recognizing concerns around bus and road safety, in 2015 the WRII-RC conducted a study to analyze the BMTC's crash data.[48] Based on the study results, we supported the BMTC with three specific interventions to improve its data collection, driver training processes, and vehicle safety features:

- We designed a scientific crash data collection form to allow for robust, standardized, and objective collection of data, making it easier to interpret and analyze key issues.

- We developed a driver training manual and conducted two "train the trainer" workshops for over 50 trainers, inspectors, and depot managers at the BMTC, upgrading the program to deliver better insights and encourage safe driving practices. As of July 2017, 1,438 BMTC drivers had been trained using the new methodology.

- We assisted the BMTC in a pilot exercise to retrofit standard (larger) rear-view mirrors in buses plying their most crash-prone routes. A field evaluation conducted by our team found that the new mirrors considerably increased the drivers' field of vision, with over 80 percent reporting improved visibility and a better driving experience, and zero crashes since the installation. This positive result led the BMTC to issue a tender to procure standard rear- and front-view mirrors for 500 buses; more recently, it has in principle agreed to retrofit all their buses.

In addition, our team developed a bus and road safety public communication campaign for the BMTC and helped it prepare a proposal for a grant from the national Ministry of Road Transport and Highway's (MoRTH) Road Safety fund.

The number of accidents and fatalities involving BMTC buses has fallen over the past few years. This can be attributed to a combination of measures adopted by them, including those mentioned above (Gururaj 2018; *The Hindu* 2017). Although process and behavioral changes are intangible and difficult to measure in the short term, it is fair to say that our interventions and close engagement with the BMTC staff at all levels have helped prioritize the safety agenda, build their knowledge/capacity, and push resource allocation toward improving the safety of bus operations as well as of women passengers.

Based on this experience and learning, since 2017, the WRII-RC has worked toward scaling up similar efforts with four more STUs in the country and mainstreaming the bus safety agenda at the national level.[49]

Last Mile Connectivity and Multimodal Integration

To extend the reach of mass transit networks and encourage a shift, the WRII-RC has supported efforts to boost last mile connectivity and multimodal integration (MMI), recognizing it as a critical gap/issue in the city. This also builds upon our Urban Development and Accessibility work of improving safe access to mass transit and constitutes an integral component of transit-oriented development. Our transport team has also helped the BMTC design six new Traffic and Transit Management Centers[50] being built by it, by sharing with it best practices of terminal design with a focus on mode integration, circulation, and safety aspects.

FEEDER BUS SERVICES

The BMTC introduced feeder bus services for the metro network as it became progressively operational in the city. However, this was done on an ad hoc trial-and-error basis, resulting in low utilization and revenues. In 2017, our team developed a scientific feeder design framework that was data driven and based on station area surveys, which the BMTC used to rationalize their operations and plan feeder bus services around five metro stations in the city, which were later extended to other stations.

However, feeder bus services have not been financially viable, due to various reasons.[51] To overcome this challenge, the WRII-RC facilitated conversations between the BMTC and private players/start-ups to provide feeder services to the metro, major bus terminals, and the BIG Bus trunk routes, which can be a win-win for all. This led to a tie-up with Bykerr (a city-based start-up) in February 2018 to provide last mile connectivity to passengers for its airport services, as a pilot exercise. The BMTC is working on an integrated booking and payment system and plans to extend this "comprehensive commute solution" to other trunk routes after evaluating the pilot (Philip 2018). The WRII-RC is currently helping the BMTC rationalize their services along metro corridors and build in complementarities between the two mass transport systems.

Vehicle Technology and Efficiency

ELECTRIC BUSES

The WRII-RC is supporting the BMTC's efforts to transition its bus fleet from diesel to electric, to reduce emissions, fuel consumption, and operating costs in the long term. In 2018, at our annual flagship event Connect Karo, the WRII-RC hosted its 12th Bus Karo workshop on "Strategizing Electric Bus Operations in India," followed by the launch of a national-level innovation challenge platform, The Better Bus.[52] Subsequently, we worked with one of the three winners, Cell Propulsion, a Bengaluru-based company, and the BMTC to further develop and demonstrate the solution: a customized powertrain kit to retrofit diesel buses and convert them to electric buses. The adoption of this technology can potentially halve the cost of transitioning to an electric fleet, compared to purchasing new electric buses. Our team helped the BMTC pilot test the kit and evaluate its performance and potential for scale-up.

Later the same year, the WRII-RC signed an MoU with the BMTC to support them with fast-paced adoption of electric buses. Our team is currently designing a strategy and roadmap for achieving optimum bus fleet electrification, based on wide-ranging activities.[53]

Context and Opportunity

The Draft Comprehensive Traffic and Transportation Plan for Bengaluru prepared in 2007 and the city's Revised Master Plan (RMP 2015) notified the same year proposed a citywide network of bus rapid transit (BRT) corridors. Among them was a 32-km stretch along the eastern loop of the Outer Ring Road (ORR) envisaged as the "IT or Hi-tech Corridor" of the city.

In 2010, our experts were invited to speak at a national workshop on BRT organized by the Directorate of Urban Land Transport (DULT) in Bengaluru.[54] The objective was to share knowledge, global best practices, and experience related to BRT systems around the world to build awareness and consensus among stakeholders and support its implementation in various Indian cities, including Bengaluru. Wide agreement on the need and benefits of an integrated BRTS for the city and the suitability of the ORR (in terms of demand, adequate width, etc.) for implementing the pilot was a clear outcome of the workshop.

In a bid to develop the ORR as a signal-free corridor, the Bangalore Development Authority (BDA) constructed a series of grade separators and split flyovers that were specially designed to accommodate a BRTS in the future. However, despite efforts, initially by the Bangalore Metropolitan Transport Corporation (BMTC) and later by the BDA, to prepare a Detailed Project Report (DPR) for the pilot ORR BRT corridor, the project failed to take off (Sastry 2010).

In 2011, the state government's budget speech indicated funding allocation for BRT projects in three of its largest cities: Bengaluru, Hubli-Dharwad, and Mysore. The DULT was assigned the responsibility of stewarding their execution. Under the MoU, they sought EMBARQ's support as knowledge partners and technical advisors to assist them with the project planning and implementation of the pilot ORR BRT corridor.

Our established and well-known domain expertise[55] and working relationships with the DULT and BMTC enabled us to contribute to this strategic project for the city. Expected to considerably improve the quality and image of bus-based mobility in the city, it was seen as a game changer that would in turn help garner greater support for expanding the network.

Project Planning and Finance

Between 2012 and 2014, our team worked closely with the DULT and BMTC, supporting the development of detailed proposals and liaising to obtain backing and funding for the project. Our team prepared a Detailed Feasibility Report and Concept Plan for the BRT corridor, including notes on implementation and funding options. This was presented to the city agencies, whose response was favorable. We also facilitated introductions to various potential funders, including multilateral development agencies. Following this, the WRII-RC was retained to develop a full DPR[56] on a pro bono basis, which was submitted to the DULT in 2014.

During this time, our team led several site visits and presentations to different delegations. We also facilitated discussions between the GoK and the KfW Development Bank for funding the Bengaluru BRTS under the bilateral Indo-German agreement to fund sustainable transport projects in Indian cities. In early 2015, the KfW in principle approved a noncommercial (low-interest) loan of up to €200 million for the ORR BRT project.

The Bus Rapid Transit versus Metro Debate

The BRT project was, however, a hard sell for many in the government, who were concerned about the consequences of allocating dedicated road space to buses on a fast-growing and already congested traffic corridor. Meanwhile, with Phase 1 of the metro rail project nearing completion and work on Phase 2 alignments under way, the BMRCL was looking to further expand their network, and the eastern loop of the ORR was a key segment. As the rapidly developing "Hi-tech Corridor" of the city, this route served as an arterial link connecting major tech hubs and upcoming commercial and residential areas to the international airport. By 2015, the metro was being analyzed as an alternative to the BRT on that corridor, with the DULT and BMRCL asked to carry out a comparative assessment. In a high-level meeting attended by the chief minister, the Bengaluru development minister, and top officials from various government departments, our team made a presentation in favor of the BRT project. Soon, the BMRCL put forward a proposal to develop a 17-km metro line along the eastern ORR (between/connecting its Phase 2 lines), which overlapped with one-half of the proposed BRT line.

Amid much speculation on the fate of the BRT project and debate around BRT versus metro or BRT+metro on the ORR, the WRII-RC engaged in a host of communication and outreach activities to build wider consensus and support for the BRT project. We prepared presentations and media articles highlighting the salient features and benefits of the project and facilitated consultations with corporates, company associations, and citizen groups along the corridor. In September 2016, the WRII-RC along with the Bangalore Political Action Committee (B.PAC, a nonpartisan citizen group) hosted a public event to discuss the BRT versus metro options for the corridor. We invited a leading public transport expert from Latin America, who presented a strong case in favor of the BRT.[57]

We also engaged closely with eminent members of the high-profile Bengaluru Vision Group (BVG), constituted and led by the state government, to address critical infrastructure and civic issues in the city. Although initially some influential members of the BVG publicly supported the BRT project, soon there was a change in stance, with key decision-makers and powerful voices within the group backing the metro project instead (Menezes 2016). A major selling point was that the BMRCL could quickly raise the requisite funds using innovative financing techniques and execute this line as an exclusive, fast-tracked project within three years, particularly as it did not need much land acquisition. The BRT also lost out on a few technical challenges,[58] and it was decided to extend the metro along this route and integrate it with the larger network rather than introduce a new transit mode.

Upon getting the chief minister's nod, the BMRCL swiftly readied the DPR for the ORR metro line, which was submitted to the GoK in November 2016, following which the decision to drop the BRT project and instead implement the proposed metro was taken (Chaturvedi 2016). The DPR for the ORR metro line was approved by the government in March 2017 and received state cabinet clearance a year later, in February 2018. Initially slated to be completed by 2020, several setbacks have left the BMRCL still in the process of garnering funds for the project, and tenders are yet to be awarded (BMRCL 2019).

Challenges and Learning

Despite a series of positive responses and intermediate outcomes early on, the BRT as a concept and feasible option in Bengaluru remains a challenge, as it is widely believed that most arterial roads, already choked with traffic, are not wide enough to accommodate a BRT. There is also weak political will for taking bold (though justifiable) decisions such as allocating dedicated road space for bus transit, for fear of stiff opposition from private vehicle users. Another problem is inadequate capacity for monitoring and enforcement. On the other hand, there is strong backing for image-building, big-ticket projects such as the metro, which also does not take up as much road space and is therefore more acceptable despite the cost and time implications. Although the accessibility and ridership of a metro system are far below those of the city bus system, it is publicized and viewed as an urban transformation project rather than as an urban transport project.

In addition, the lack of high-quality and robust data hampered both case building and project planning. Although we attempted to bring evidence, domain knowledge, expertise, and influential voices to weigh in on the conversation, it still fell short of changing mindsets and decisions, with political considerations overwhelming technical arguments.

In such cases, developing more comprehensive analyses (impact, cost-benefit); systematic communication and outreach campaigns; wider media, public, and political engagement to garner support; and making key stakeholders part of the discourse can help influence views, public policy, and strategic project decisions.

We, however, turned the failure into an opportunity and deepened our engagement with the BMRCL to improve last mile connectivity to the metro system and MMI through the Station Access and Mobility Program (STAMP) Challenge.

Over time, the WRII-RC has conducted studies to fill knowledge gaps and guide action on specific issues; for example, around urban finance, equitable access, and climate action. These have served as important thought leadership exercises sparking other work across and outside WRI. Some of these research activities and publications, beyond those already discussed under our projects, are briefly described below.

Fuel Emission Standards and Efficiency

In 2012, the WRII-RC used the Bangalore Metropolitan Transport Corporation (BMTC) fleet data to study the relationship between the central-government-mandated fuel emission standards (BS-IV), fuel efficiency, and financial implications for bus operations. The study explored the reasons for fuel efficiency reduction, suggested possible interventions, and identified potential unintended consequences. It made a case for ensuring that emission standards improvements of public transport vehicles should not be at the expense of service quality, scale, and affordability, which would lose passengers to more emissions-intensive and polluting private modes. This was described in a paper submitted to the Transportation Research Board (Fok et al. 2014).

Case Studies: BMTC's Atal Sarige and BIG Bus Services

In 2012, our team conducted a study to assess the adequacy and effectiveness of the BMTC's Atal Sarige, a special bus service introduced in 2009 for the urban poor and slum dwellers in the city. The research methodology, findings, issues, and suggestions were described in an article published the following year (Shastry and Bhatt 2013). Building upon this study and our engagement on the BIG Bus project, in 2015, the WRII-RC prepared a case study for the Indian Institute of Human Settlements in Bengaluru. Examining the efficacy of the two BMTC initiatives (Atal Sarige and BIG Bus), it explored how public bus transport agencies could better serve the travel needs of the urban poor: do services targeting them help or are more systemic solutions needed? These teaching cases, which are included in the institute's academic and training curriculum, are also aimed at influencing policy (Mahendra and Chanchani 2015).

GPC: Transport Sector GHG inventory for Bengaluru

Climate work in the city builds upon the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). A first-of-its-kind greenhouse gas (GHG) inventory for the transport sector in Bengaluru was developed in 2014 using bottom-up methodologies. The intention was to develop a "low-carbon action plan" for the city to reduce emissions in the coming years. Officials from the Directorate of Urban Land Transport (DULT) were trained to use the GHG emission models, to be able to regularly update and track the progress of emissions. Based on the inventory, the WRII-RC created alternate development scenarios and a sector-specific low-carbon strategy using the GPC and mitigation goals. Our team also prepared a guide to measuring urban road transport emissions for use in the GPC training of cities worldwide. Unavailability of data and the absence of a nodal public agency for developing and maintaining a GHG inventory were the key challenges faced in institutionalizing the process.

NCE: Social Cost Accounting for Urban Services in Bengaluru

A critical concern for India's rapidly urbanizing future is the provision of basic urban services for all its citizens. Under the aegis of the New Climate Economy, the WRII-RC collaborated with the Indian Council for Research on International Economic Relations (ICRIER) to develop a social cost accounting methodology to estimate the market and non-market costs associated with the public, private, and self-provided delivery of urban water, sanitation, transport, and energy services. This was applied to Bengaluru, Pune, Surat, and Indore. The research went beyond the typically studied issues of access to services and the associated direct costs to focus on ignored social costs such as indirect, health, and environmental costs. The WRII-RC published a working paper in 2018 showcasing this research and the findings, which were also presented at CK 2018 (Shastry et al. 2018).

Urban Villages

Our research on the various aspects of managing urban expansion included a particular focus on "urban villages" absorbed into Bengaluru's municipal limits.[59] These areas are often excluded from planned development initiatives and lag other areas in the provision of municipal services. Over the years, as living conditions deteriorate, they tend to be declared as "slums" by the government. Through a primary case study (involving ground surveys and focus groups discussions), the WRII-RC assessed the effects of urbanization on such rural village settlements and their transformation over the years, outlining issues and possible planning strategies to better manage this transition. The findings and recommendations of this study were included in the Municipalization Strategy report submitted to the Bruhat Bengaluru Mahanagara Palike (BBMP) Restructuring Expert Committee.

Land Procuring Mechanisms for Public Purposes

The findings and recommendations of our research on land management to prevent haphazard and under-provisioned development in urban areas were included in the Land Procurement Mechanisms for Public Purposes report submitted to the BBMP Restructuring Expert Committee. This research was also extended and published as a working paper (Mathews et al. 2018). Looking beyond the conventional practice of compulsory land acquisition, this document analyzes alternative state-led mechanisms to acquire, plan, and service land, along with land value capture techniques to help pay for basic infrastructure and civic amenities. It also evaluates the legal frameworks of these mechanisms against the parameters of equity and efficiency and presents recommendations to strengthen them.

LIST OF ABBREVIATIONS

AA   Apartment Associations
BBMP   Bruhat Bengaluru Mahanagara Palike
BDA   Bangalore Development Authority
BenSCL   Bengaluru Smart City Limited
BESCOM   Bangalore Electricity Supply Company Limited
BIAAPA   Bangalore International Airport Area Planning Authority
BIAL   Bengaluru International Airport Limited
Big / BIG Bangalore Intra-city Grid
BIGRS   Bloomberg Initiative for Global Road Safety
BMA   Bengaluru Metropolitan Area
BMLTA   Bengaluru Metropolitan Land Transport Authority
BMRCL   Bangalore Metro Rail Corporation Limited
BMRDA   Bangalore Metropolitan Region Development Authority
BMTC   Bangalore Metropolitan Transport Corporation
BPL   Bus Priority Lane
BRT   Bus Rapid Transit
BS-IV   Bharat Stage Six
BTP   Bengaluru Traffic Police
BVG   Bengaluru Vision Group
BWSSB   Bangalore Water Supply and Sewerage Board
CAGR   Compound Annual Growth Rate
CBO   Community-Based Organizations
CDD   Consortium for DEWATS Dissemination Society
CIIE-IIMA Capital Incubation Insights Everything – Indian Institute of Management Ahmedabad
CPPS   Center for Public Problem Solving
CSO   Civil Society Organisations
CSR   Corporate Social Responsibility
CSTEP   Center for Study of Science, Technology and Policy
CWAF   City Water Assessment Framework
DTCP   Directorate of Town and Country Planning
DULT   Directorate of Urban Land Transport
EE   Energy Efficiency
FoV   Fields of View
GHG   Greenhouse Gas
GIS   Geographic Information System
GIZ   Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI   Government of India
GoK   Government of Karnataka
GPC   Global Protocol for Community-Scale Greenhouse Gas Emissions
GPMDG   Green Power Market Development Group
GPS   Global Positioning System
HDBRTSCL   Hubli-Dharwad BRTS Company Limited
HSR-NIP   Hosur-Sarjapur Road Neighborhood Improvement Plan
ICRIER   Indian Council for Research on International Economic Relations
IIHS   Indian Institute for Human Settlements
IISc   Indian Institute of Science
IT-BT   Dept. Department of Information Technology, Biotechnology and Science & Technology
ITS   Intelligent Transport System
JRC   Joint Research Centre
KEGN   Karnataka Electricity Governance Network
KERC   Karnataka Electricity Regulatory Commission
KGWA   Karnataka Groundwater Authority

KIIs   Key Influence Indicators
KLCDA   Karnataka Lake Conservation and Development Authority
KPIs   Key Performance Indicators
K-RIDE   Rail Infrastructure Development Company (Karnataka) Limited
KSNDMC   Karnataka State Natural Disaster Monitoring Centre
KSPCB   Karnataka State Pollution Control Board
KSRTC   Karnataka State Road Transport Corporation
KTCPA   Karnataka Town and Country Planning Act
KUIDFC   Karnataka Urban Infrastructure Development and Finance Corporation
KUWSDB   Karnataka Urban Water Supply and Drainage Board
LAP   Local Area Plans
LVC   Land Value Capture
MLA   Member of Legislative Assembly
MMI   Multimodal Integration
MoHUA   Ministry of Housing and Urban Affairs
MoRTH   Ministry of Road Transport and Highways
MoU   Memorandum of Understanding
MP   Member of Parliament
NASSCOM   National Association of Software and Service Companies
NEKRTC   North East Karnataka Road Transport Corporation
NGO   Non-Governmental Organization
NIP   Neighborhood Improvement Plan
NIPC   Neighborhood Improvement Partnership Challenge
NITI   Aayog National Institution for Transforming India
NIUA   National Institute of Urban Affairs
NMT   Non-Motorized Transport
NSRCEL-IIMB N.S. Raghavan Centre for Entrepreneurial Learning – Indian Institute of Management Bengaluru
NWKRTC   North West Karnataka Road Transport Corporation
ORR   Outer Ring Road
OTG   On-The-Ground
PPP   Public-Private Partnership
PRR   Peripheral Ring Road
PV   Photovoltaic
RE   Renewable Energy
RMP   Revised Master Plan
RWA   Resident Welfare Associations
SAP-DCRs   Station Accessibility Plan and Development Control Regulations
SDG   Sustainable Development Goals
STAMP   Station Access and Mobility Program
StE   Sludge-to-Energy
STRR   Satellite Town Ring Road
TIDE   Technology Informatics Design Endeavour
TOD   Transit Oriented Development
TPS   Town Planning Schemes
UCRA   Urban Community Risk Assessment
UDA   Urban Development and Accessibility
UDD   Urban Development Department
USGS   United States Geological Survey
VR   VidyutRakshaka
WRI   World Resources Institute
WRII-RC   WRI India Ross Center for Sustainable Cities

ENDNOTES

1. As an organization, WRI faces the multifaceted challenge of trying to shift views and practices in a continuously changing political, cultural, and economic landscape. We use a simple notion of change here while acknowledging a vibrant literature on "transformative change" both within and outside WRI (Limerick et al. 1994; Maassen and Galvin 2019), considering transformative change as broad, cross-sectoral, sustained progress toward improving the economy, environment, and health and well-being for all those living and participating in a city (Beard et al. 2016).

2. "Outcomes" occur when WRI's analysis, solutions, or partnerships result in significant change on the ground (WRI 2022).

3. The methodology used for this research is only summarized here; a detailed write-up will be published in an accompanying WRI working paper.

4. EMBARQ's global experience was honed through the implementation of BRTS and city bus transport projects in Latin American cities.

5. Launched in 2009, the program is a peer-to-peer learning network (of public/private bus operators) to help improve the quality of bus services in Indian cities. It comprises three main components: Mentoring Transit, which involves partnering with bus transport agencies and providing technical support to aid implementation of pilot projects; Talking Transit, which involves organizing workshops for knowledge sharing, technical training, and capacity building; and Learning Transit, which involves sharing best practices through documentation and dissemination.

6. EMBARQ India's first Bus Karo publication (2009) carried detailed case studies of the bus systems and operators in these two cities, equipping us with insights to help further aid these project choices.

7. The twin cities of Hubli and Dharwad are the second-largest metropolitan area in the state after Bengaluru. The HDBRTS was established in May 2012 by the GoK for implementation of BRTS project in Hubli-Dharwad.

8. These include new arterial and missing link roads, a bus rapid transit system, a high-speed rail link to the international airport, a light/monorail system, and a local commuter/suburban rail system. Despite several plans to start suburban train services (first mooted in the 1980s), Bengaluru still does not have them, making it the exception among comparable cities in the country. Following persistent public pressure, a 148-km suburban rail project has finally received government approval but continues to face hurdles and delays in implementation.

9. The number of registered motor vehicles crossed 8.5 million in 2020. Officials, however, claim that this is not a fair representation of the actual number of vehicles in the city, which would be lower, given that records of old, scrapped, sold, or de-registered vehicles are not updated regularly and accurately.

10. A holistic, sustainable transport planning approach proposed by GIZ. "Avoid" refers to avoiding or reducing the need for motorized travel and over longer distances through travel demand management measures; "Shift" refers to enabling the shift from personal vehicles to sustainable, active, and public transport modes; and "Improve" refers to improving system quality and efficiency (vehicle, fuel, and operations).

11. This means that any origin-destination pair with a certain level of demand is provided with a direct bus route between them, primarily to avoid or minimize transfers.

12. At the time, the BMTC seldom used any travel demand modeling or data-driven techniques for planning operations. Rather, they employed a demand-response or trial method to add new routes/schedules, based on judgment and local knowledge of major city trip generators, accessibility levels of various localities, and requests made by the public or local political leaders. The agency also did not conduct systematic performance monitoring. Bus driver reports (on completion of trips, fare collections, etc.) were reviewed to alter schedules, crew allocations, and so on.

13. In a direction-oriented system, bus services are structured along particular axes. This is considered more efficient as it minimizes overlapping and redundant routes. This is a well-known solution—essentially coming from mass rapid transit systems having trunk lines and feeders—that has been successfully adopted by many cities around the world for structuring their bus systems.

14. The proposal was to tailor a substantial service share (40–50 percent) to serve as the direction-oriented BIG Bus network, whereas the rest would remain as destination-oriented services, especially those with high demand. Although the bus system would always be a combination, the objective was to create a simpler, more efficient underlying structure.

15. These were found to be irregular or long wait times for connecting services, physical difficulties in making transfers, resistance to change and user education, transfer penalties, and higher fares. BMTC's telescopic stage-based fare structure, wherein one pays more for the first few stages, made shorter trips, and especially transfers, more expensive.

16. Twenty-five hundred users of both trunk and feeder services on all three corridors were surveyed.

17. These were Hosur Road, Kanakapura Road, Old Airport Road, and Old Madras Road.

18. Amounts were converted from INR (in crores) to million $ using the average exchange rates for each year from 2016 to 2019.

19. The Nurturing Neighborhoods Challenge and India Cycles4Change Challenge are initiatives of the Smart Cities Mission, Ministry of Housing and Urban Affairs, Government of India. The former, developed in collaboration with the Bernard Van Leer Foundation and WRI India,

20. Growing levels of motorization, the lack of natural barriers, and greater availability and affordability of land on the outskirts combined with lax regulation have led to the fluid outward spread of the city in all directions.

21. Our team helped integrate 100+ spatial and nonspatial datasets or GIS layers onto a single platform for the Expert Committee on BBMP Restructuring.

22. In the BESCOM area, domestic consumption increased at 7.13 percent CAGR during FY2012–16, compared to commercial and industrial consumption, which increased at 2.36 percent and 1.52 percent CAGR, respectively.

23. This information is taken from BESCOM tariff filings and the tariff order for FY 2017–18.

24. The GoK had committed to providing 3 percent (2 GW) of electricity from solar by 2021, whichwould help avoid approximately 2.8 million tons of greenhouse gas emissions and create more than 18,000 jobs. This target was handsomely exceeded as solar energy plants met about 20 percent of Karnataka's daily power requirements in 2021.

25. The EGI assessment looks at policy processes at the central level in India, and electricity regulatory processes in the Indian states of Haryana, Andhra Pradesh, and Tamil Nadu.

26. GPMDG members include Infosys, Coca-Cola, Cognizant, IBM, Wipro, Jones Lang LaSalle, Intel, The Associated Cement Companies, Vasavadatta Cement, etc.

27. The GPMDG initiative aims to guide and catalyze the market for RE uptake. It has produced a range of knowledge products, including publications, decision-making tools, and datasets, all freely shared online. These resources have helped several businesses across the country define appropriate targets and procure RE.

28. Recommendations were provided for lighting, cooling, heating, and other common area electricity usage, based on best practices for efficient use.

29. The Bangalore Water Supply and Sewerage Board (BWSSB) gets 12 percent of its water from ground water (deep wells) and the remaining 88 percent from the river Cauvery. A capital-intensive, heavy engineering solution with high embedded energy, the utility spends a major portion of its budget on electricity costs.

30. The National Compilation on Dynamic Ground Water Resources in India, 2017, noted that a third of the total groundwater assessment units were in a critical and overexploited state with the stage of extraction at 70 percent; for Bengaluru Urban, it was 143.81 percent.

31. The framework addresses key aspects of urban hydrology related to water availability and risks at the basin level; water demand, supply, and stress faced by the city; areas vulnerable to risk or disasters such as flooding, extreme heat, or land subsidence; sanitation conditions; and a range of city-specific solutions.

32. An annual convening event conducted by the WRII-RC to share our work and learnings in Bengaluru with stakeholders and build partnerships. It is discussed in more detail later.

33. Public problem-solving efforts led by the government often lack in community engagement and domain expertise, whereas the weak links of local community efforts are often the required critical capital, expertise, and legitimacy (mediation with government). Domain experts are often left disconnected from organic, incremental projects on the ground. Meanwhile, corporates with Corporate Social Responsibility (CSR) funds are looking to get involved in reliable, impactful, and socially responsible initiatives.

34. The United Technologies Corporation provided CSR funding, disbursed through a leading nonprofit organization, United Way Bangalore. CPPS and WRI India executed the Challenge as knowledge partners. The exercise also drew on the crucial support of Bangalore Political Action Committee to connect and engage with local communities and the BBMP to enable project implementation (permissions/approvals). The Practice, a public relations agency responsible for media, communications, and outreach for the project, was also part of the consortium.

35. TheCityFix Labs builds on the WRII-RC's work around the world supporting the market transition to sustainable investments by combining knowledge sharing, capacity building, and direct technical assistance to help cities better define and initiate fundable projects.

36. With a population of just under 1 million per the 2011 census, Hubli-Dharwad is the second-largest urban agglomeration in Karnataka after Bengaluru. Over the course of this project, we engaged with the Hubli Dharwad Urban Development Authority, Hubli-Dharwad Municipal Corporation, North-West Karnataka Road Transport Corporation, and the Hubli-Dharwad Bus Rapid Transit System Company Ltd., among others. Our team conducted several primary/secondary studies, public consultation workshops, stakeholder interviews, and meetings to inform our proposals and make the decision-making processes participative.

37. The road map laid out city-level strategies pertaining to incorporation of TOD in the master plan revision, institutional setup and capacities, implementation, and financing modalities, along with project–planning–policy interventions, time frames, and responsibilities of different line agencies.

38. The chapters include a detailed situational analysis and good practices, along with the proposed vision, goals and targets, strategic interventions, and an implementation roadmap for Bengaluru and Karnataka state.

39. Staff were included from WRI's Integrated Transport, Urban Development, Urban Water, Energy, Climate Resilience Practice, Landscape Restoration, and Governance teams.

40. Goal Committee members included representatives from concerned government departments, NGOs, invited domain experts, academicians/researchers, and content writers, headed by an appointed ex-bureaucrat.

41. The Sustainable Cities team in Bengaluru has grown from 5 (of total 12) in 2011, to 68 (of total 186) in 2022. Currently, WRI India's Bengaluru office has a staff strength of 108, across its four programs. More than 10 people have been with the organization over seven years, and many more over five years.

42. The 6,775 buses the BMTC had in 2013–14 were far lower than what the city required. At about 1.2 buses per 1,000 population, Bengaluru with a population of 10 million needed 12,000 buses (WB Group and PPIAF 2006).

43. This involved a survey of over 30,000 bus commuters to gauge the elasticity and sensitivity to fare changes and review the prevailing fare structure, policy, and method of fare setting and payment.

44. A first of its kind in India, the key features of this system include GPS-enabled vehicle tracking units and electronic ticketing machines in all BMTC buses; a control room and data center; a passenger information system at major bus stands; and a smartphone application for real-time bus tracking and trip planning.

45. Change in BMTC leadership and concerns with competition from private companies like Ola, Uber, and Zipgo delayed its implementation until recently.

46. Participants included city authorities and regulators, transport and law enforcement agencies, and several tech-enabled shared mobility companies, among others.

47. In October 2015, we partnered with HackerEarth Technologies Pvt. Ltd. to conduct "Urban Hack," the first-ever Smart City hackathon aimed at building technology solutions for crime prevention and public safety. Winners got a chance to pilot test, pitch to investors, and qualify for the NASSCOM 10000 Startups initiative. In March 2017, on International Women's Day, the BMTC and WRII-RC launched the #SafeMobility Hackathon to find innovative smartphone/tech solutions for women's safety in BMTC buses (WRII-RC 2015, 2017d).

48. Between 2012 and 2015, the BMTC reported a total of 306 fatal crashes and 327 fatalities (over 10 percent of the total road fatalities). Of these, 48 percent were two-wheeler users, 27 percent pedestrians, and 17 percent bus passengers—largely vulnerable road users, resulting in high-severity incidents. These road crashes translated to an average annual loss of $1.7 million for the BMTC (Chitturi and Toshniwal 2018).

49. Under the banner of India Vision Zero, the WRII-RC convened a national summit to deliberate the unique safety challenges faced by bus agencies and the need to adopt a scientific, multipronged approach for reducing bus crashes in India. We have also drafted a compendium of best practices and recommendations to improve fleet safety for consideration by MoRTH and organized workshops on the subject.

50. These centers are large bus terminals with space for depots and maintenance facilities, provisions for intermodal connectivity, offices and commercial activities (retail/restaurants, etc.), public amenities, and park-and-ride facilities.

51. The reasons include poor road networks resulting in longer loops, narrow roads hindering bus entry and movement, unsuitable bus size, difficulty in matching supply to demand, lack of bus bays at metro stations, and competition from paratransit and other shared mobility services.

52. The Better Bus challenge aims to identify and foster innovative solutions to improve the quality of public bus systems in Indian cities, specifically in the areas of operations and management, commuter experience, and new service models.

53. We are supporting the BMTC with domain research, data analysis, alternatives assessment, pilot testing and evaluation, convening, knowledge-sharing and capacity-building activities, and drafting proposals to obtain government subsidies and investment from financial institutions.

54. The high-profile event was attended by over 100 participants, including top officials from various transport and urban development departments at the city and state levels, technical experts from premier institutions, media persons, and citizens.

55. EMBARQ had global experience honed through the implementation of BRTS projects in Latin American cities.

56. The report includes a detailed assessment of the existing situation and demand, physical and operational design parameters and drawings, project costing, cost-benefit and alternatives analyses, and an institutional structure for implementation and operations.

57. Key considerations were that the BRT could adequately match and cater to demand on the corridor, a well-worked-out plan and funding for immediate implementation were available, and it could be executed at a fraction of the time and cost (less than 20 percent) required for the metro, with the government able to recover the investment within a decade.

58. For instance, insufficient BRT lane width in places, no diversion for the large number of trucks using the road, loss of several trees, future demand on the corridor, and so on.

59. When the Bengaluru city area expanded from 225 sq. km to 710 sq. km in 2007, it engulfed 110 villages (comprising over 220 village habitations), which were brought within its urban limits. Such village settlements that become part of the city are usually referred to as "urban villages."

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ABOUT WRI INDIA

World Resources Institute India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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