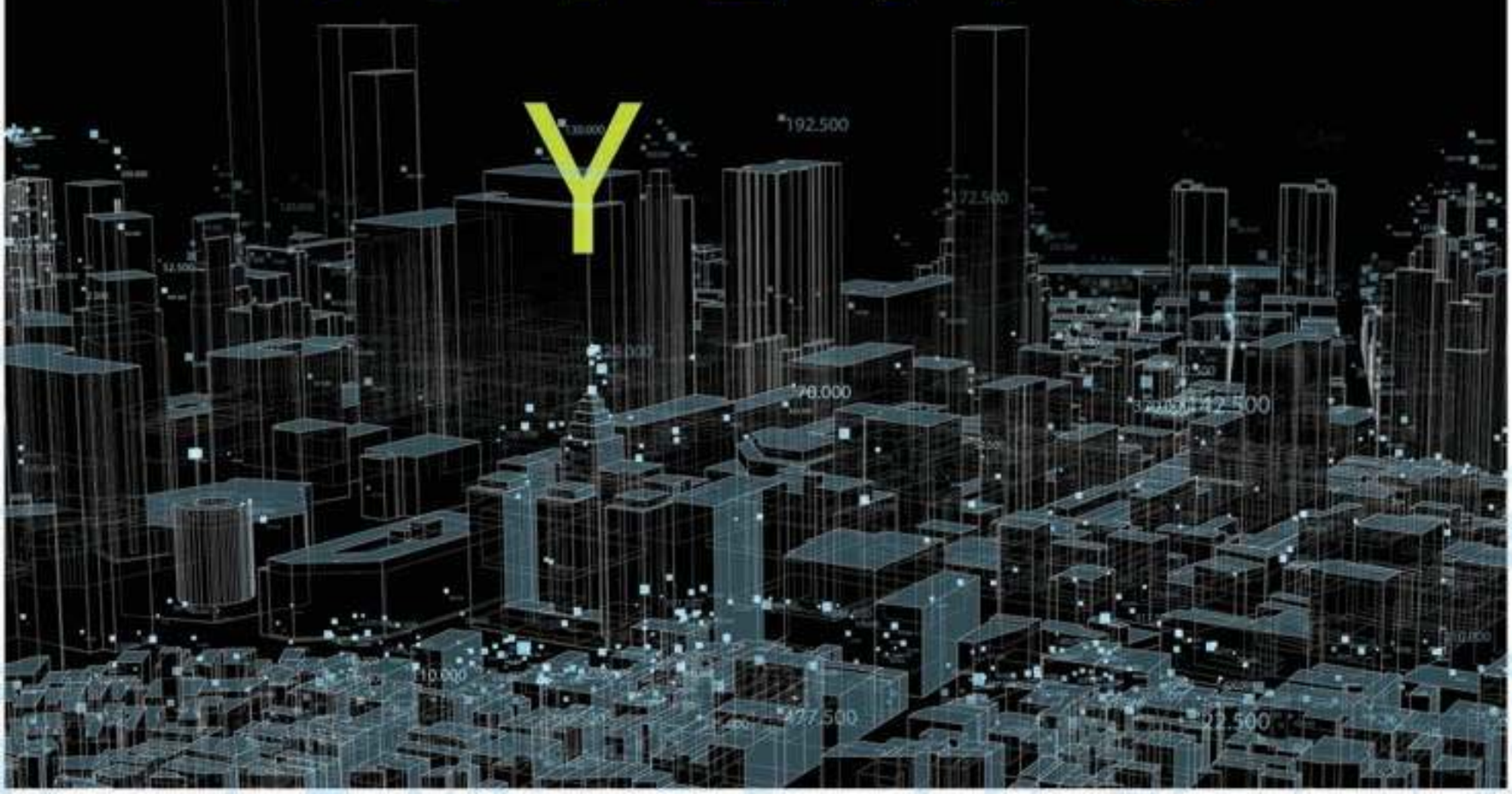
CITY ATLAS

Centre for Urban Informatics Technology and Policy at LUMS

CITY at LUMS



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Centre for Urban Informatics,
Technology and Policy

at

Lahore University of Management Sciences

CITY at LUMS

Acknowledgment

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Editor in Chief

Amna Azeem

Sub Editors

Muhammad Hamza Rafi, Muhammad Ahmed Waseem, Mina Rafael Arif

Cartography, Geospatial Analysis, AI/Deep Learning

Dr. Amir Bashir, Dr. Usman Nazir, Muhammad Talha Qudoos, Amna Azeem, Muhammad Ahmad Waseem, Sheraz Hassan, Osama Ahmed Muhammad Ibrahim, Mustafa Siddique, Fatima Naweed, Hamza Rashid Saif Ullah Shakeel, Omer Abdul Jalil, Muhammad Osama

Centre for Urban Informatics Technology & Policy

The Centre for Urban Informatics, technology and Policy (CITY) is a multidsiciplinary research centre at the Syed Babar Ali School of Science and Engineering, Lahore University of Management Sciences (LUMS), Pakistan. Established through the generous funding support of the Higher Education Commission of Pakistan under its Grand Challenge Fund, CITY at LUMS strives to use informatics, technology, data analytics, and evidence-based policy design to drive sustainable urban development in Pakistan and beyond. We operate within three key spheres. our goal is to drive change through (a) City Research, (b) City Solutions, and (c) City Academy. These interconnected areas showcase our impact on multiple levels. artnering with public- and private-sector organizations, we attempt to address urban issues by conducting comprehensive research, developing practical deployable solutions, and ultimately ensuring their longevity through capacity-building of relevant stakeholders.

CONT

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FOREWORD

MOMIN UPPAL

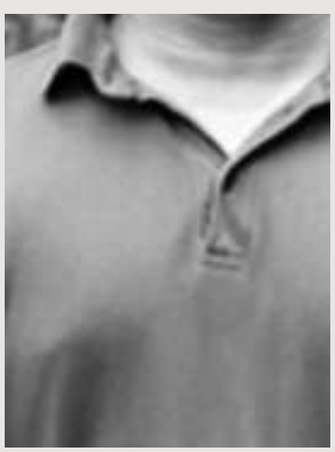
The CITY Atlas is a visual narration (comprising mostly of maps) of the past three years of exciting multidisciplinary work carried out by team CITY @ LUMS. Behind these visuals is an incredible amount of hard work that has helped put CITY on the map (pun intended). As I look back, I am not only incredibly proud of everything our team has achieved, but also extremely grateful for everything they have taught me. While CITY has made great strides in its short lifespan, a lot more needs to be done. CITY continues to learn. CITY continues to grow. CITY looks forward to exciting times ahead. CITY looks forward to making a difference.

MUHAMMAD TAHIR

CITY Atlas represents the collaborative and multidisciplinary spectrum of research and development activities carried out by CITY@LUMS team. It is the manifestation of a joint vision of our team that we all need better cities to live. In this journey, we learned this vision can only be achieved by engaging a broad range of stakeholders, identifying their needs, and producing realistic solutions – solutions that will enable future-proof and safe cities for all communities. The CITY@ LUMS journey will continue to bring together ideas from technologists, local communities, architects, planners, traffic engineers, urban economists, and many others, to identify and resolve problems and conflicts in order to create better places for everyone. Join us in this journey of making future cities better for everyone to live

ZUBAIR KHALID

This CITY Atlas provides an overview of our innovative and interdisciplinary work toward addressing issues related to mobility, growth (sprawl), and the environment and health in our cities. It showcases our efforts over the last three years to design cities that are not only sustainable but also dynamic and inclusive. Recognizing that the challenges of modern urbanization require holistic and collaborative approaches, our team, comprising experts from diverse fields, has partnered with public and private sector stakeholders and policymakers to identify pressing urban issues and develop pragmatic solutions. The maps and data presented in this Atlas capture this collaborative spirit and the advancements we have achieved together at CITY @ LUMS. As you explore this Atlas and witness the tangible results of our team's dedication and hard work, we want to thank the interdisciplinary team of engineers, urban planners, economists, and computer scientists at CITY for their invaluable expertise and creativity in making this Atlas possible. Looking ahead, we at CITY are committed to expanding our research, embracing innovative technologies, developing robust solutions and fostering stronger collaborations with our partners.



Maps are more than just representations of physical spaces; they are tools that tell stories, provide insights, and offer a deeper understanding of our environment.

We are all mesmerized by the buildings that stand in their utmost glory, yet nobody sees the boulders that bear the weight. CITY Atlas is an amalgamation of all the contributions that the CITY Team has made in the past three years, initiated and worked on resiliently to bring out such a cascade of outputs. To explore the journey the CITY Team has undertaken over the span of three years, this initiative aims to broaden the spectrum of readers like you by bringing new perspectives and equipping you with the necessary knowledge of all the maps and visuals the CITY Team has created through their hard work and endeavor. Viewing these maps will give you a unique perspective on the intricate details that go into shaping our cities. From the depth of my heart, I am grateful to the CITY leadership, Dr. Momin Uppal, Dr. Muhammad Tahir, and Dr. Zubair Khalid for their utmost support and trust in having me for this task. Additionally, my fellow editors and subeditors deserve recognition, without whom this masterpiece wouldn't exist!

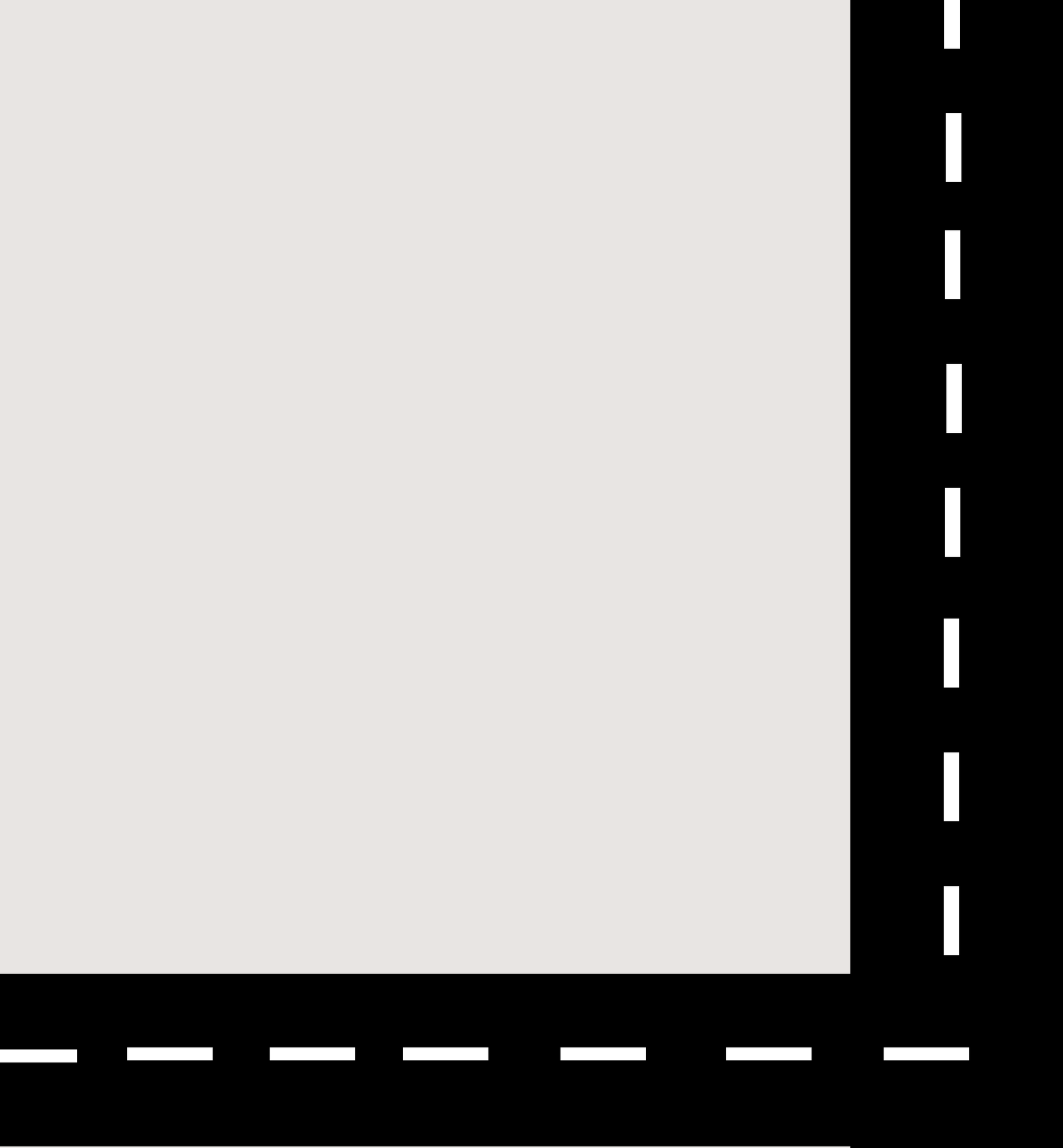
◆◆◆

Amna Azeem
Chief Editor

Empowering Urban Change: The CITY Atlas of Lahore

In our pursuit to catalyze change, merely presenting data about urban challenges often proves insufficient. At the Centre for Urban Informatics (CITY), we are steadfast in our commitment to transforming data and informatics into compelling narratives that drive meaningful action. Through the creation of this Atlas, we aim to intricately map the complexities of urban landscapes, shedding light not only on the problems but also on the values and stories that underpin them. By leveraging the power of storytelling, our Atlas endeavors to bridge the gap between data and action, inspiring individuals and communities to embrace transformative change for a better urban future. Given that Lahore has been the primary focus of our extensive research efforts at CITY, this comprehensive collection of maps and visualizations depicts various regions and aspects of the city. We believe this atlas serves as a valuable resource for understanding the urban landscape and development patterns of Lahore.

01
INTRODUCTION



WHY MAPS MATTER?

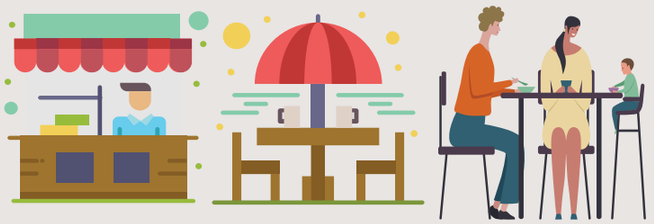
Sitting in a workshop in London at the London School of Economics, I was receiving leadership training from the Urban 95 Academy and LSE team. It was the third day of the workshop led by Savvas Verdis on Public Campaigning and Narratives, and the central focus remained on the public sphere. Throughout the workshop, the recurring question persisted: How can we successfully inspire people to take action? After years of developing solutions to various problems, we've encountered a recurring challenge: while we understand the problems and devise solutions, ensuring their impact remains elusive. What is it that can influence people to take action? Typically, presenting figures and numbers to individuals may capture their attention momentarily, but often fails to sway them. However, could numbers and figures be transformed into compelling narratives? Can they speak? Can we utilize data to craft stories that resonate with people on a deeper level—shifting from stories of self to stories of us, and ultimately stories of now? This line of thought not just inspires a fresh perspective on bridging the gap between data and action, but also underscores the crucial role of maps and visual storytelling in evoking people's values.

Amna Azeem

Dont lead with the problem, Lead with Stories

Lessons from Urban 95 Academy: Often, when we attempt to communicate, our focus gravitates towards highlighting the problem. Each individual encounters personal challenges, and when we inform them of issues like poor air quality, they may not prioritize it amid their larger concerns. Consequently, simply presenting the problem often fails to incite action. So, how do we effectively influence people? One of the key lessons gleaned from the Urban 95 academy is the importance of starting with values in communication. By acknowledging individuals' biases and addressing how the problems are actually coming their way, we can better engage them. When we discuss values and actions, an essential question arises: do our actions truly mirror our values? While we may express concern for the environment, our behavior (action), such as driving diesel cars, may contradict this. This disconnect between our values and actions is significant. By sharing personal narratives to evoke values and then transitioning into a public narrative, we can translate our values into motivations for action. This approach not only appeals to the heart but also spurs individuals into action. And this concept is at the core of mapping.

Visual narrative of a city designed for harmony with both its people and the natural world.



Vibrant Streets

Multimodal Transport Hub

A

Walkable & Pedestrian Friendly

THROUGH

A city where community well-being, health, and climate resilience are integrated into the urban fabric.

Cyclist's Haven

NAVIGATING

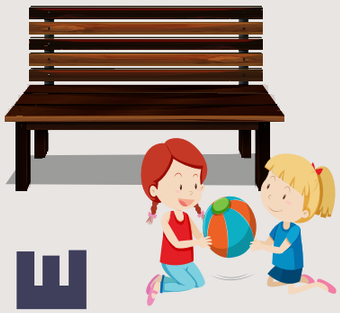
The role of cities has long been perceived primarily as engineered structures, buildings, and infrastructure. However, the essence of a city extends beyond mere physical constructs; embodying values of diversity, inclusion, public spaces, and mobility. Offering a visionary portrayal of city life immersed in diverse cultures, through this visualization, I invite the audience to dream and advocate for cities that prioritize the collective well-being of its people, fostering flourishing communities in urban life.

CITY MADE FOR PEOPLE

Child-Friendly

A city where residents thrive in an environment that actively contributes to the health of the planet.

Public Spaces



Mixed-Use Centre

Eco Friendly

Happy Community

A city designed for and by its people, offering vibrancy and diversity.

Inclusive & Diverse

CITY Journey

2020

Dr. Momin and his team secure a Rs. 210 million grant to harness technological innovations and address urban challenges.

CITY signs MOU with Punjab Safe City Authority

Amidst rapid urban growth & increased strain on infrastructure, environment, & public services, the project aims to resolve complex urban issues through technology.

CITY signs MOU with Lahore Waste Management Company

2021 Begins

The project's focus revolves around three interconnected themes within the urban system: Urban Development and Growth, Urban Mobility, & Urban Environment and Health.

CITY signs MOU with National Transport Research Centre

CITY signs MOU with Punjab Emergency Services Department (Rescue 1122)

With the surge in accessible sensing technologies, and digitalization, this project aims to embrace the technological revolution of data-driven decision-making in urban management and planning.

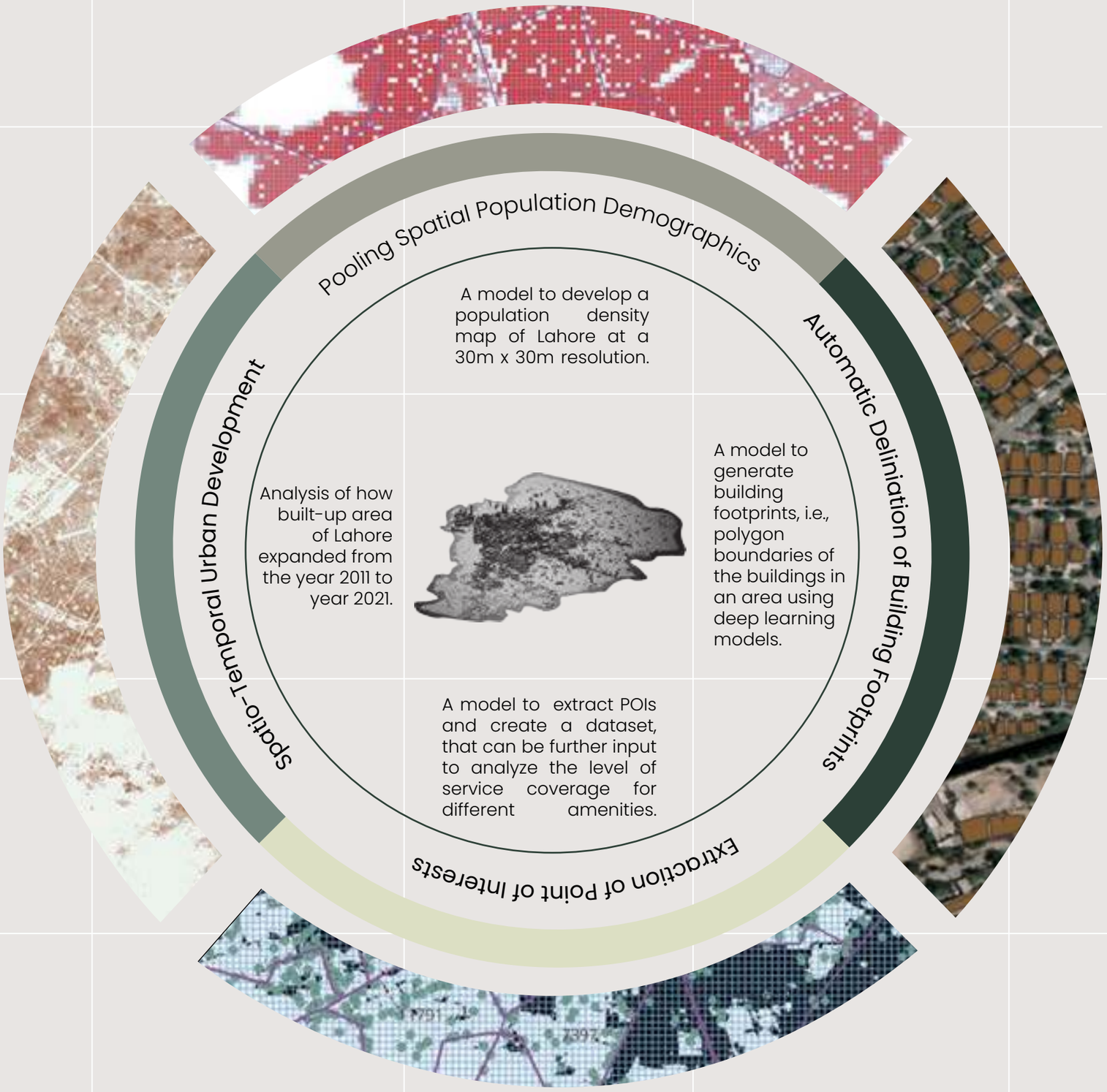
Promoting Climate Resilient, Sustainable, & Compact Urban Development

02 UNRAVELING URBAN GROWTH

Urban Development and Growth

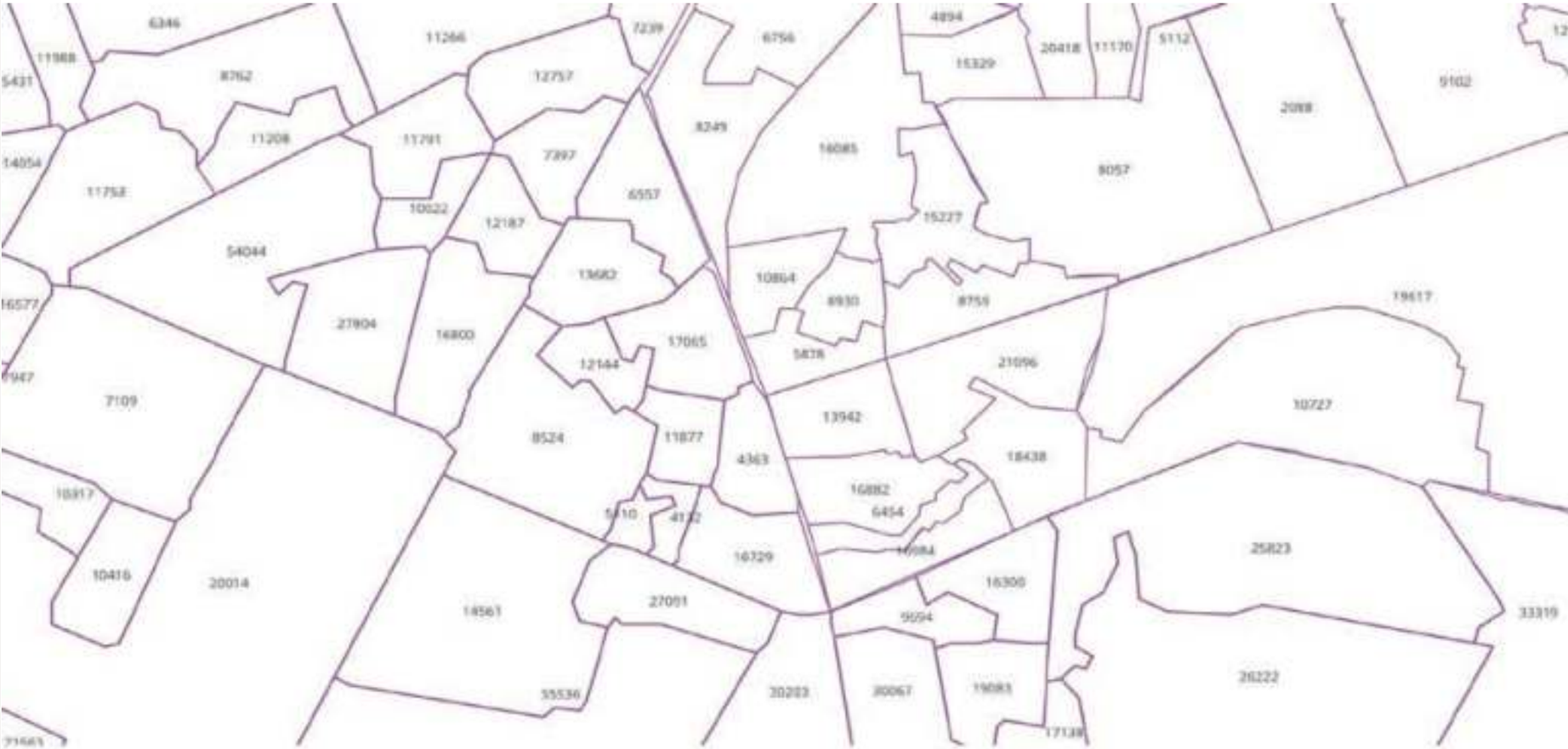
Cities have long been considered as powerful engines of economic growth and opportunities worldwide. However, in Pakistan, and particularly in Lahore this potential is often unrealized. Rapid urbanization and haphazard urban development in our cities have not just taken away from us the potential for economic development but have instead given rise to multiple issues such as environmental degradation, traffic congestion, social inequalities, public Health challenges and much more. We talk about about sustainable cities, and focus so much on the problem and even on the solutions, but when it comes to developing "effective solutions" we often fail. That is where CITY steps in. At CITY, we believe that in the pursuit of creating sustainable cities, a lot of research and analysis is required. Cities are not built overt-night. When we are working for a neighbrohood, or a city, we must ensure that we are well versed in the geographic, the spatial, the political, economic, the social contexts. Not solely understanding what the cities are about, but examining the spatial relationships between them. Usually, when any spatiotemporal urban research is performed, it requires population, building, land-use, and road network data as a baseline—data products that are not readily available in Pakistan.

Through our rigorous research efforts under the Urban Development and Growth theme, we have developed a data-driven framework utilizing satellite imagery, surveys, and crowd-sourced data collection methods to map and analyze urban growth. By developing these data-driven modeling tools, we generate useful insights ultimately leading towards developing solutions for more informed decision-making. In this chapter, we delve into the narratives crafted by four of our projects, showcasing how our research analyses and models have seamlessly transformed into captivating visual stories. Through these visual narratives, we illuminate the intricate patterns of urban development, unveil the challenges faced, and highlight the pathways towards sustainable solutions. Each visualization serves as a powerful tool, not only conveying data-driven insights but also engaging and informing stakeholders, policymakers, and the wider community about the complexities of urban growth and development.

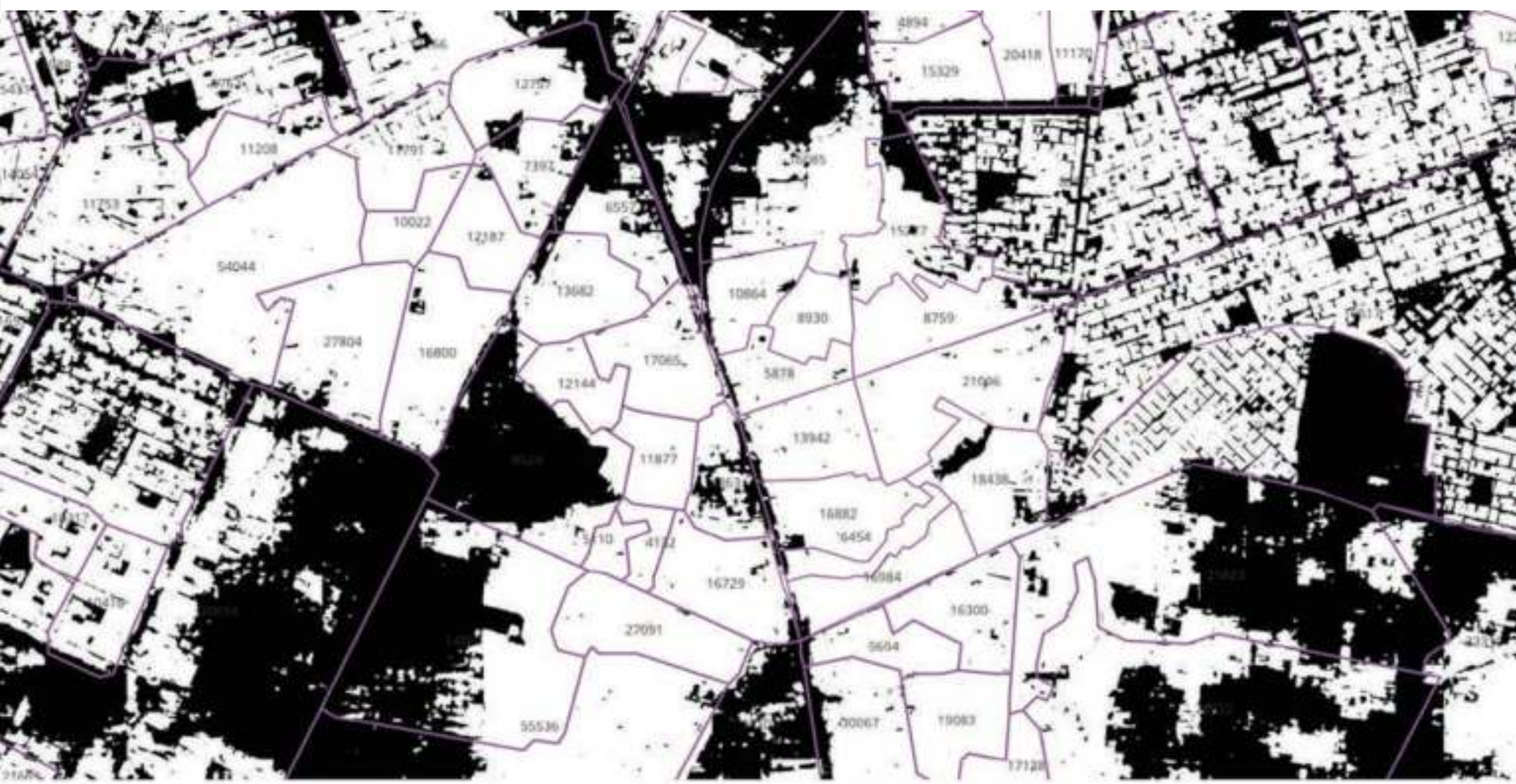

Pooling Spatial Population Demographics
A model to develop a population density map of Lahore at a 30m x 30m resolution.
Automatic Delinition of Building Footprints
A model to generate building footprints, i.e., polygon boundaries of the buildings in an area using deep learning models.
Extraction of Point of Interests
A model to extract POIs and create a dataset, that can be further input to analyze the level of service coverage for different amenities.
Spatio-Temporal Urban Development
Analysis of how built-up area of Lahore expanded from the year 2011 to year 2021.

Spatial Population Demographics

To tackle the issue of urban sprawl and associated challenges, it is important that cities are prepared for future population growth. Whether it is about forecasting population growth, developing growth boundaries, identifying areas where new development can or cannot be built, or preserving agricultural lands, farmlands and forests, we must understand the population demographics. Accurate and detailed population demographics data supports effective planning, equitable resource distribution, and sustainable development, ultimately enhancing the quality of life for urban residents and fostering economic growth. Considering the dire need for a reliable population density dataset for all cities of Pakistan, we began with Lahore and using deep learning models, remote sensing techniques and geographical information systems our novel technique aimed to estimate population counts with exceptional precision, at an impressive resolution of 30 meters by 30 meters. Our methodology involved the meticulous disaggregation of the latest census data, leveraging an enhanced constructed settlement mask created using cutting-edge deep segmentation networks. To further enhance the accuracy of our estimates, we integrated Points of Interest (POIs) to exclude non-residential areas, ensuring more reliable and granular results. While we have prepared the dataset for Lahore only, the methodology can be replicated for other cities of Pakistan. On the following page, we showcase a series of step-by-step visuals generated throughout the research process. The top image in the subsequent page illustrates the retrieval of block-level population data, while the image below demonstrates the creation of a built-up mask in black using an AI-driven deep learning model.



1- Fetch the block level population

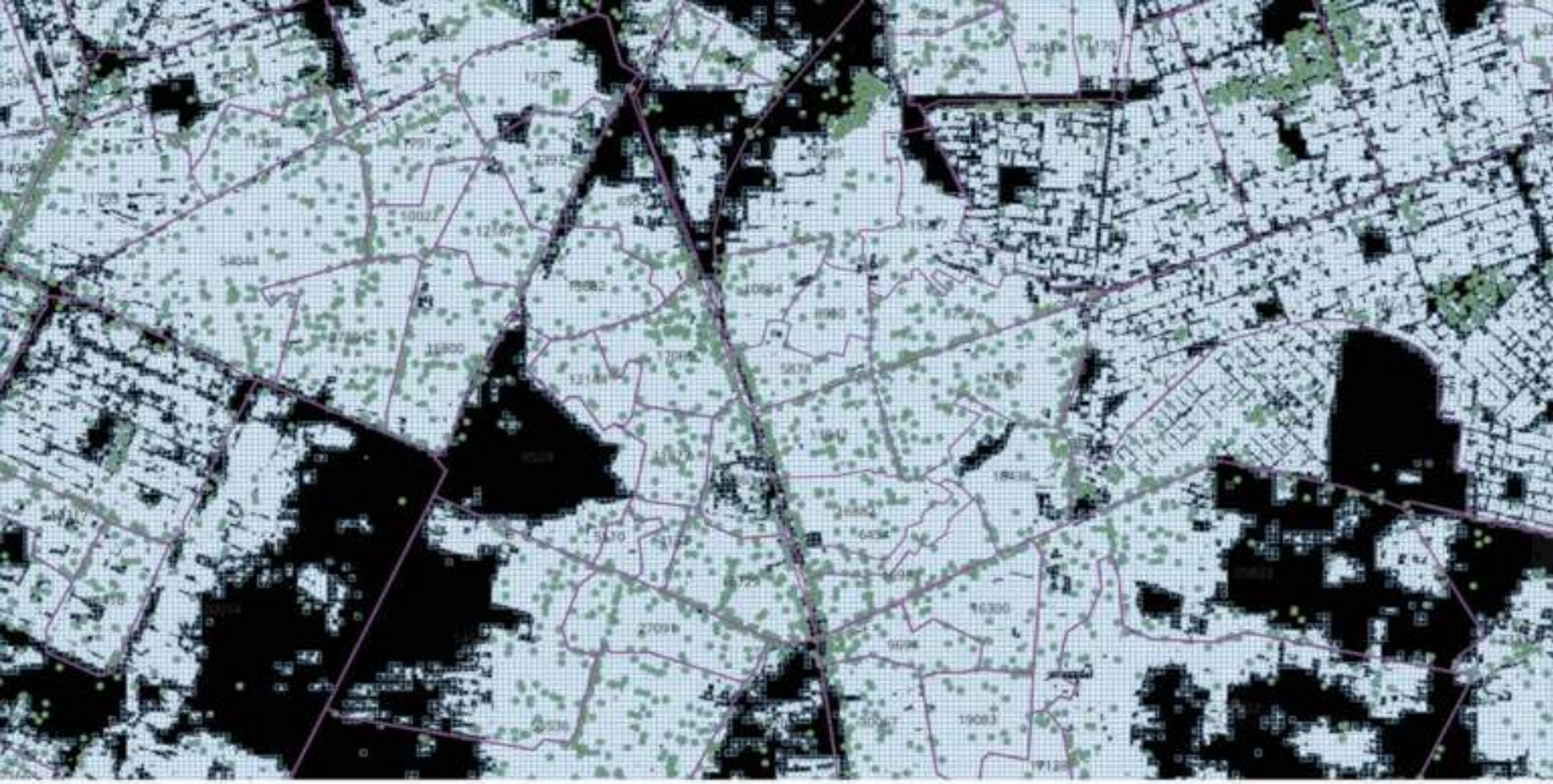


2- Predict built-up mask using AI (Deep Learning)

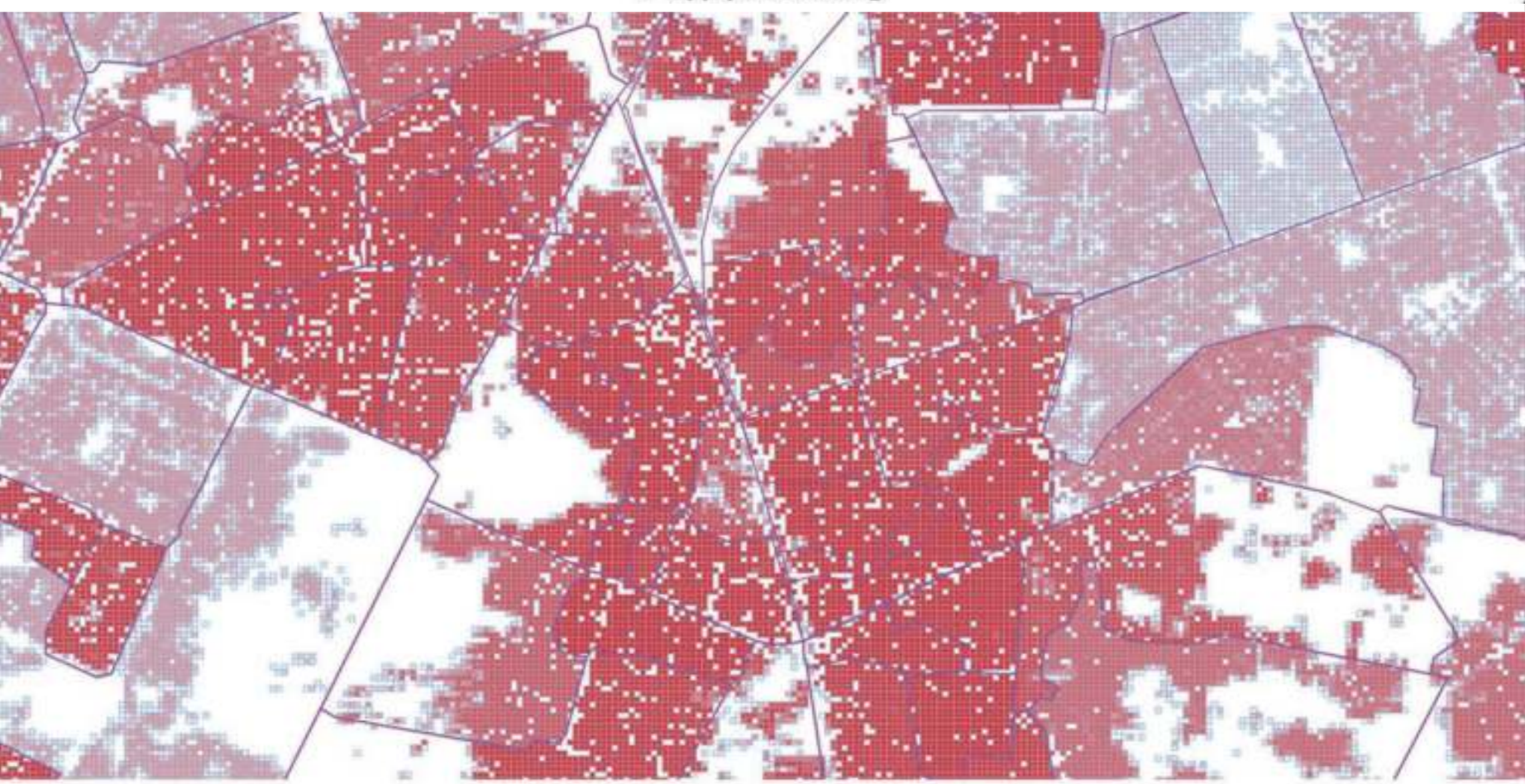
3- Extract non-residential POIs using AI

4- Create 30m x 30m tiles

For developing countries like Pakistan, the existing state-of-the-art datasets provided by WorldPop and Meta fail to realize this goal; inputs of their algorithms result in estimates which do not reflect the true picture on the ground. For example, both Meta and WorldPop have disaggregated the population based on 2010 estimates (provided by Demobase), and therefore do not accurately capture the current dynamics of 2023. Moreover, these estimates are at the Tehsil level, i.e., the 3rd administrative level out of the six available levels. Additionally, the co-variates and methodologies used by both WorldPop and Meta to disaggregate the population lack quality, leading to inaccuracies. For example, the WorldPop dataset, even the constrained one, shows high population values on visually barren lands, while Meta uniformly disaggregates the population estimates among built-up tiles for each Tehsil. We introduce a new strategy for disaggregating population at a 30-meter by 30-meter resolution, based on the latest 2017 census data at the circle (5th) administrative level and deep segmentation networks, combined with high-resolution satellite imagery. This methodology drastically improves the population estimates for the current built regions.



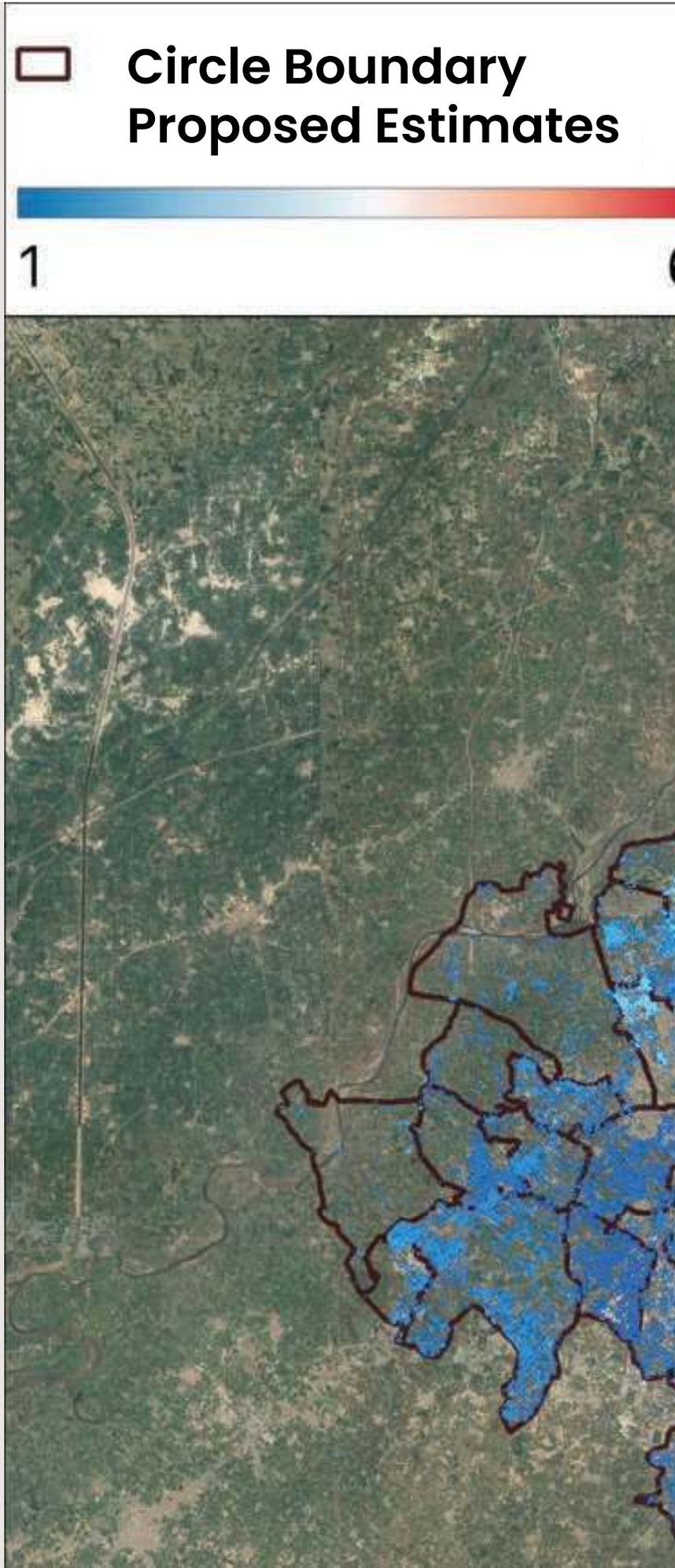
5- Apply tile filtering

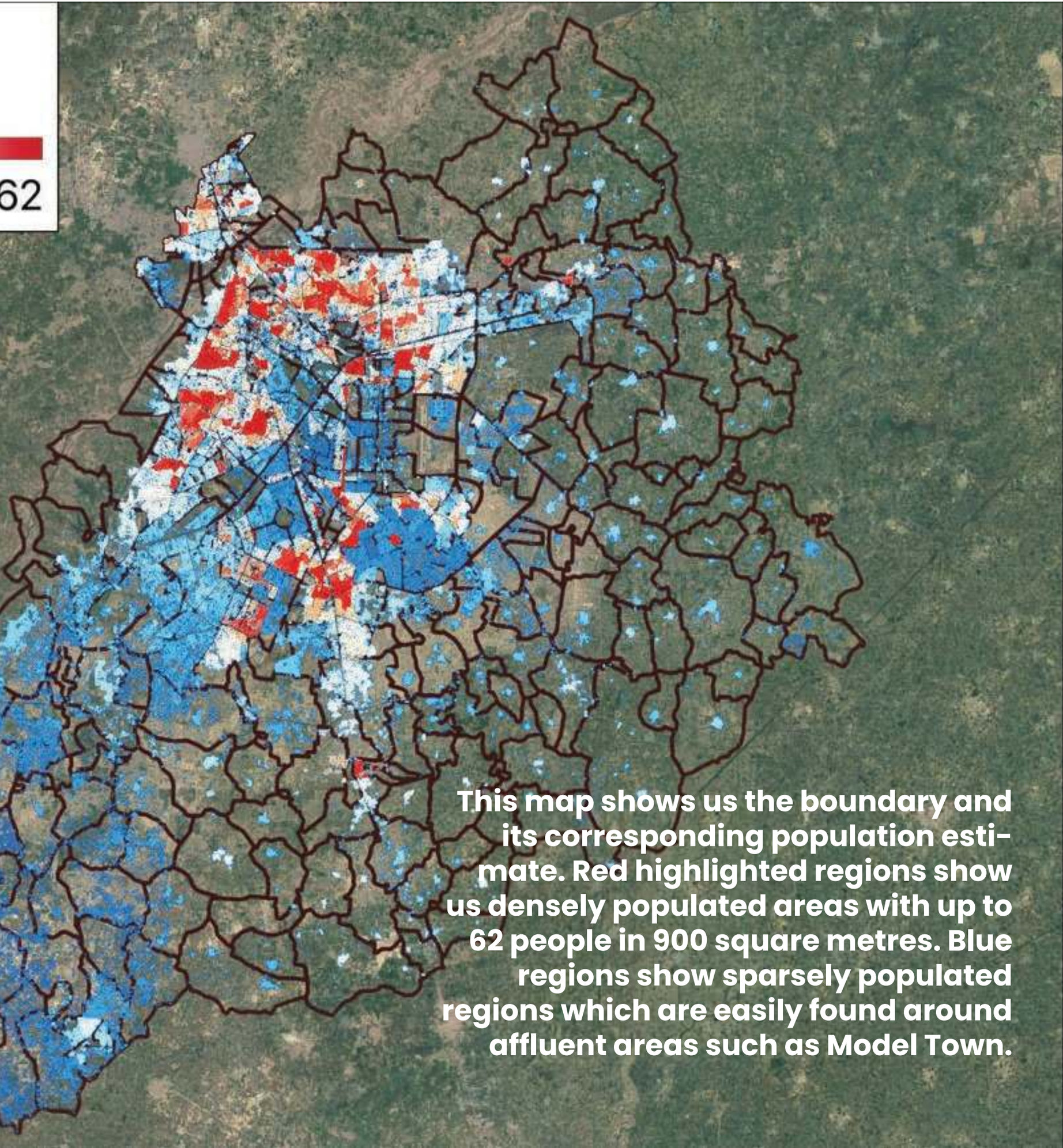


6- Disaggregate population among remaining tiles

The latest 2017 census data from Pakistan Bureau of Statistics (PBS) website was collected and digitized into GIS vector files up to the circle, i.e., the 5th administrative level. Once the high-resolution population aggregates were available, the next task was to disaggregate them into 30m x 30m tiles. For this purpose, we used built-up area prediction masks obtained through the deep semantic segmentation model based on DeepLabV3+ architecture with dilated ResNet encoder. Once these built-up masks were estimated, we divided the circle-level population among the tiles by weighing each tile by the number of built-up pixels present in that tile. In this way, we were not only able to exclude the un-built tiles/regions, but also to disaggregate more population towards the tiles with higher built-up densities. Census data and built settlement masks were fed into geographical information systems leading to a population density map.

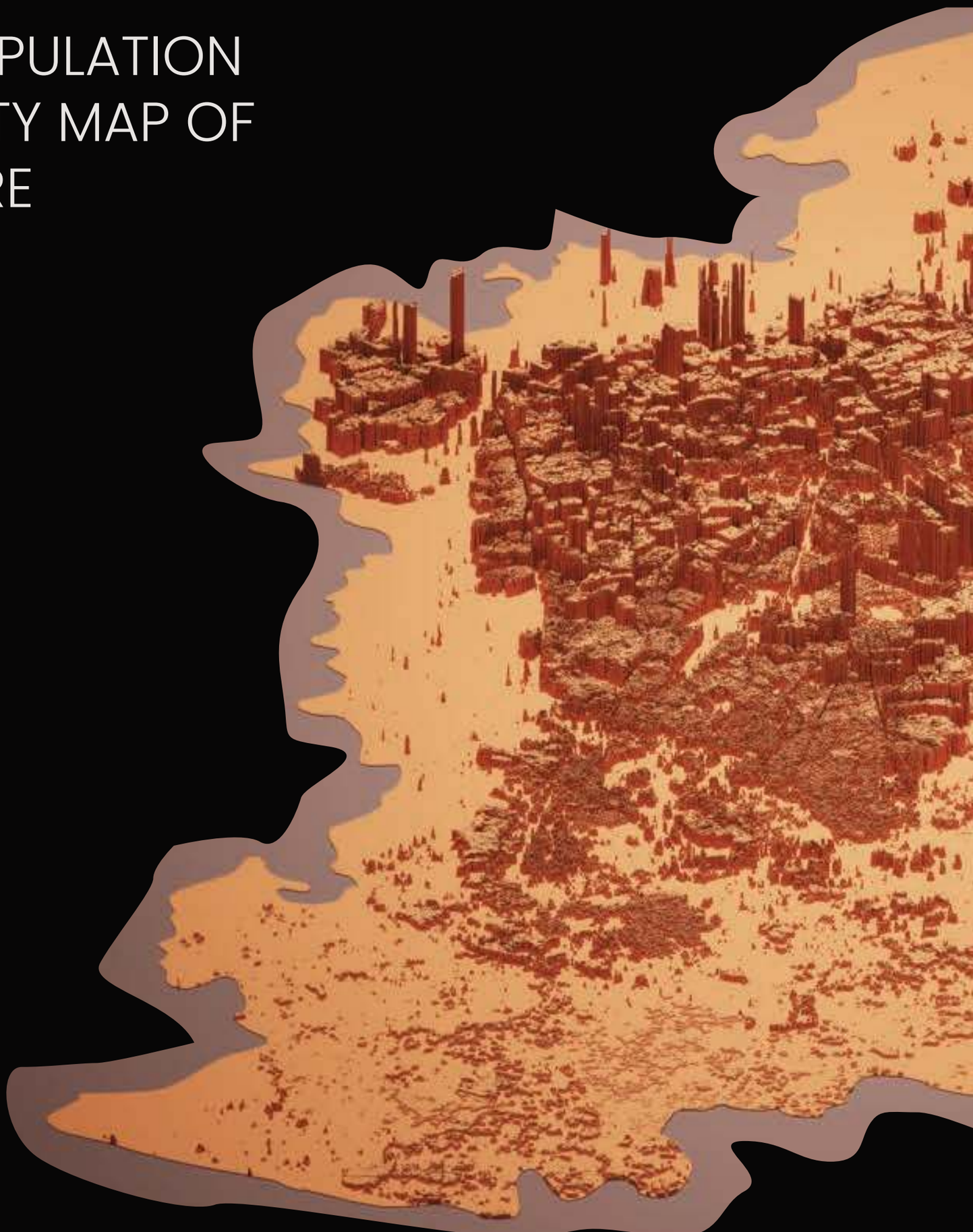
The density map clearly highlights the crowded nature of the city. Red hot spots in the areas of Walled City and other regions, where up to 62 people live in a space of just 900 meters square, demand the attention of policymakers for a restructuring of basic amenities. Affluent regions such as Model Town tend to have lower density estimates, in addition to rural outskirts. Our goal is to bridge the data gap in urban policy and research. By openly providing high resolution and accurate population estimates to the public, we strive to contribute to more informed decision-making processes and facilitate groundbreaking academic investigations. These precise population density statistics can be a valuable resource for governments, organizations, and researchers involved in development planning and policy formulations.

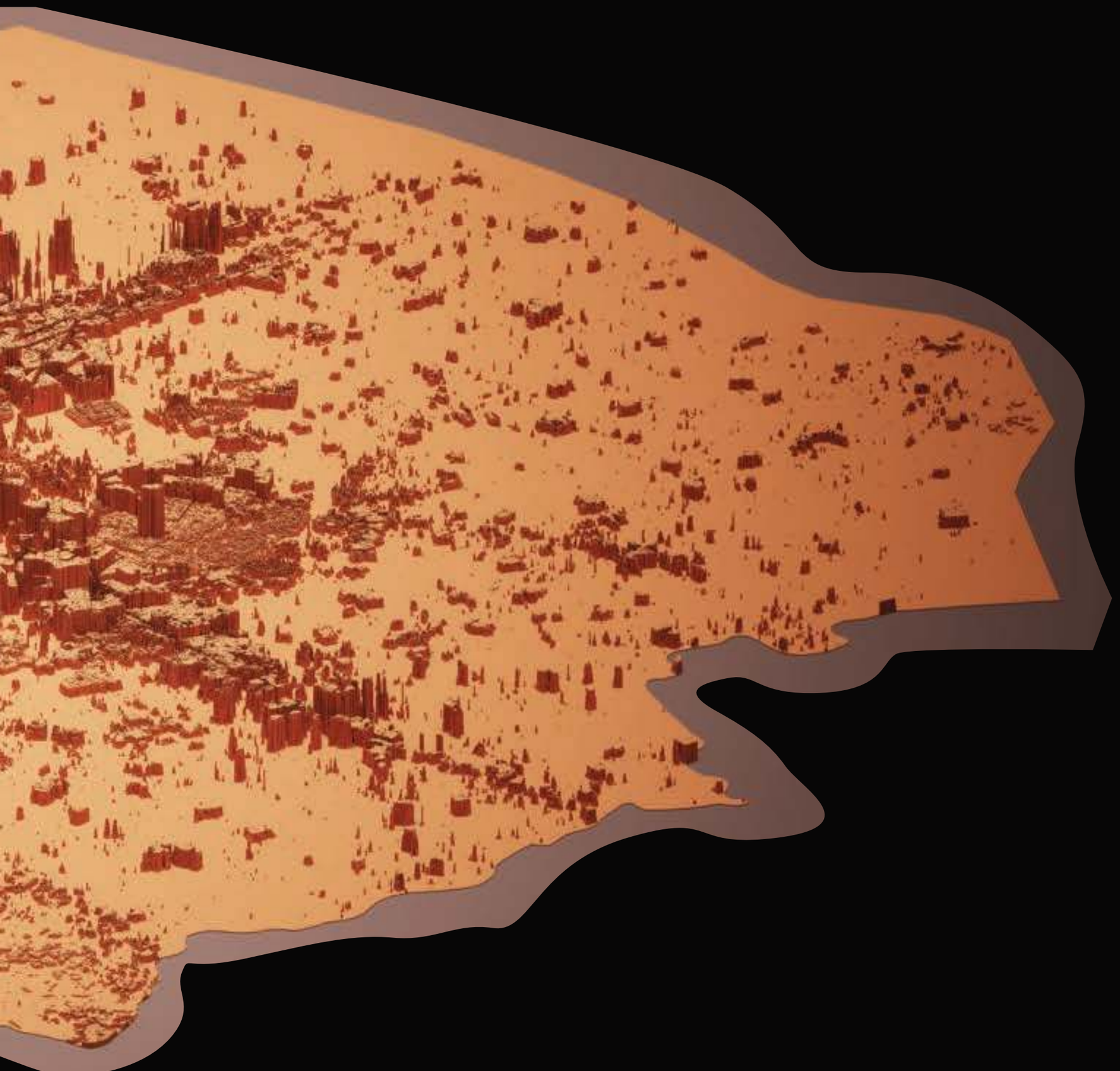




This map shows us the boundary and its corresponding population estimate. Red highlighted regions show us densely populated areas with up to 62 people in 900 square metres. Blue regions show sparsely populated regions which are easily found around affluent areas such as Model Town.

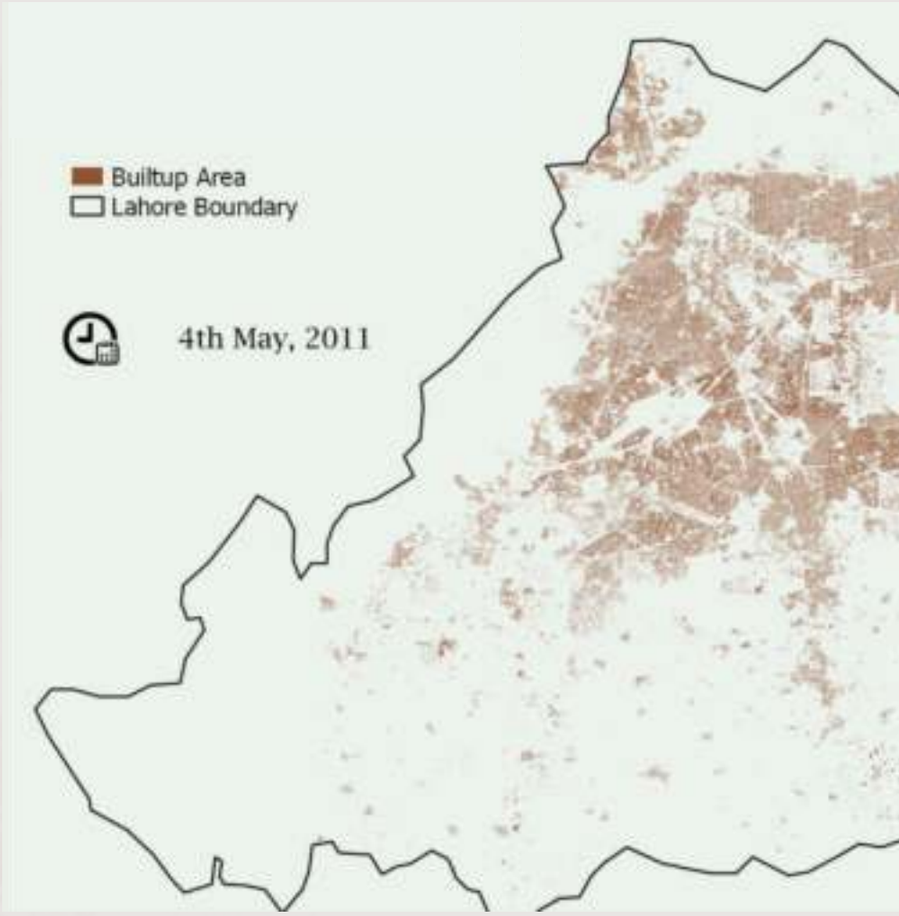
3D POPULATION DENSITY MAP OF LAHORE

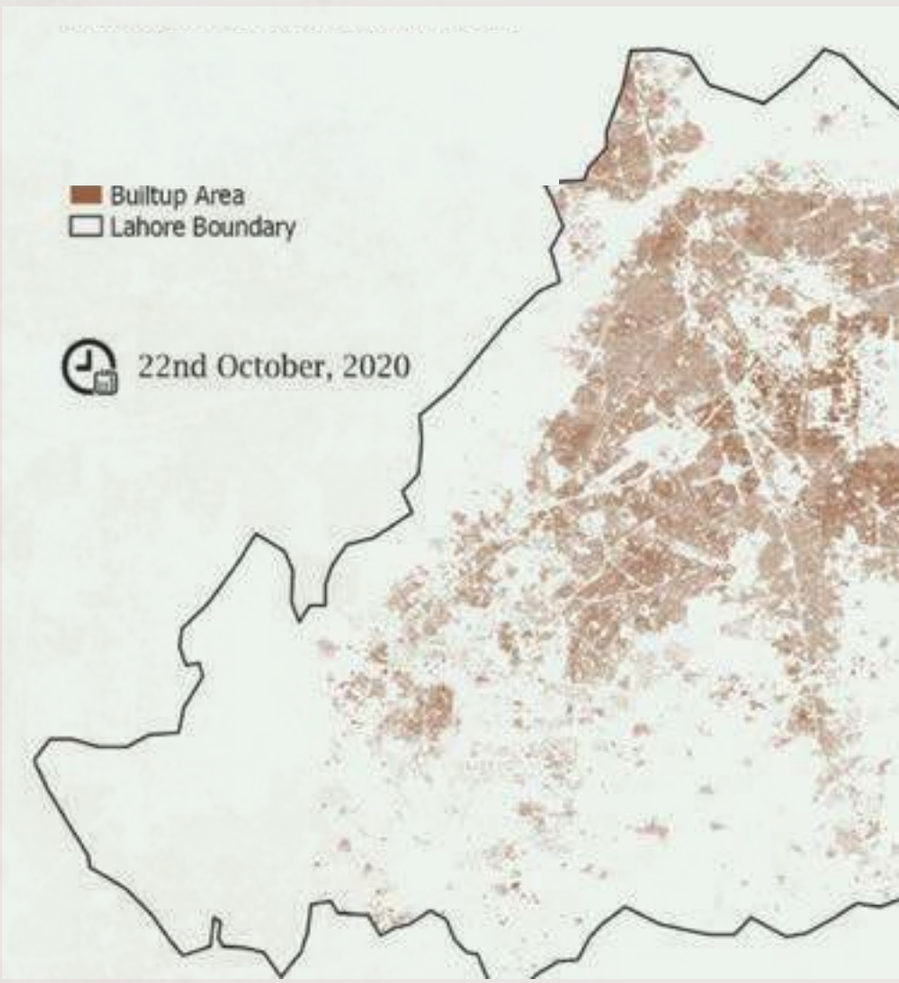


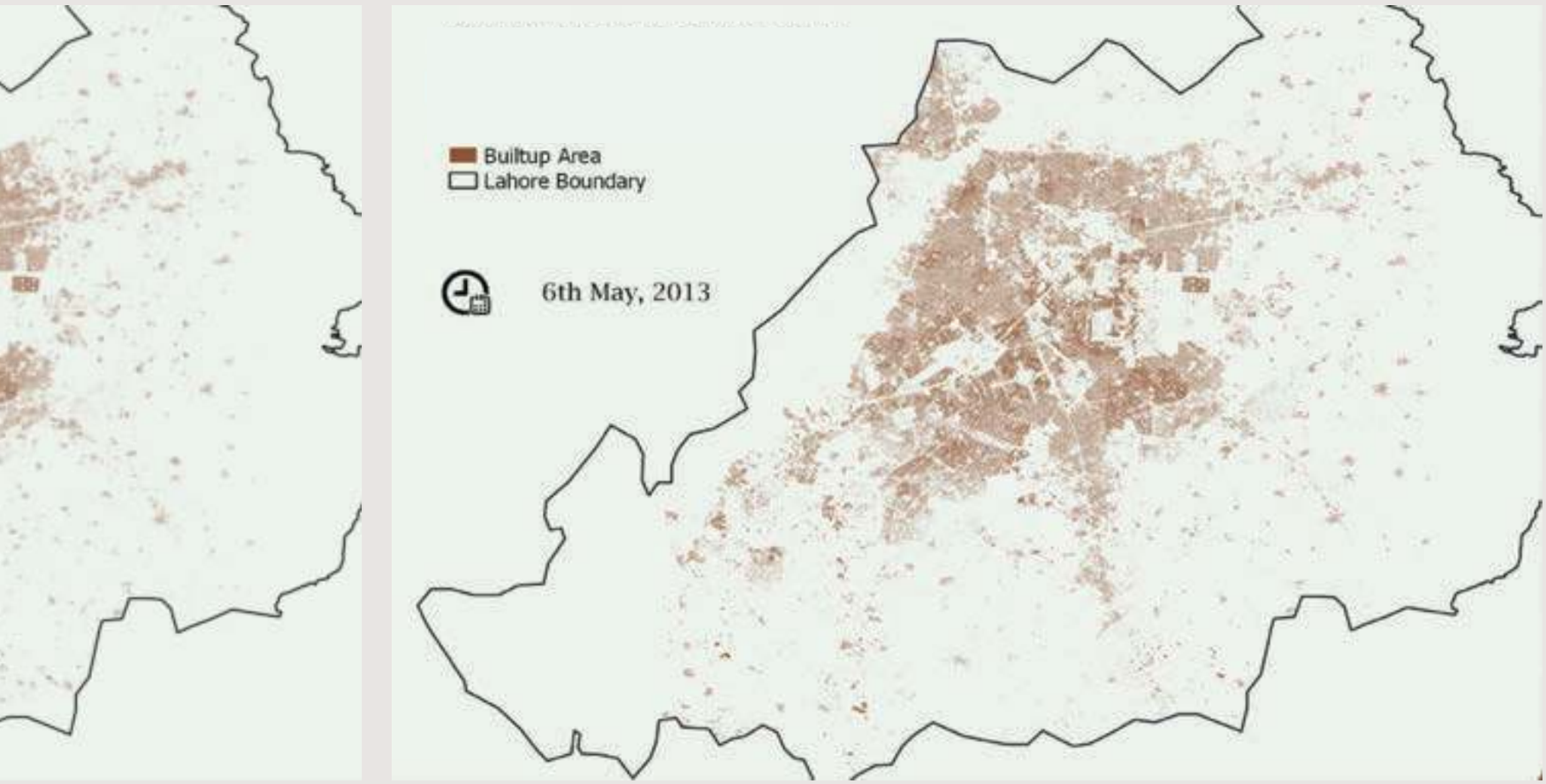


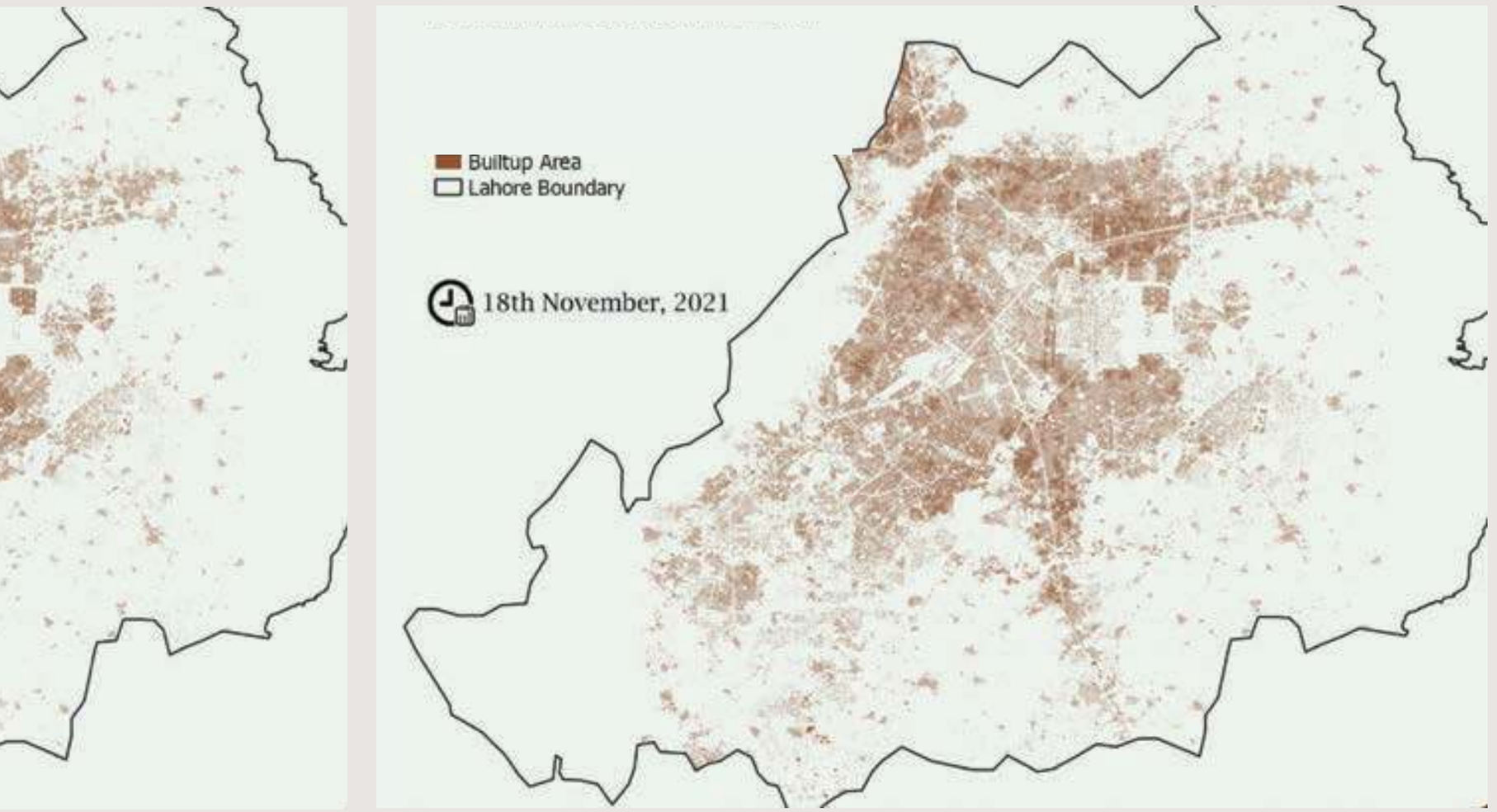
Spatio-temporal Urban Devleopment

Urban areas are not just about space, but also time, as they continuously evolve and develop in both dimensions. The spatio-temporal urban development is a dynamic process that intertwines the physical expansion of cities with the passage of time, shaping the landscapes and lives within them. With this continuous expansion, Pakistan today faces the issue of Urban sprawl, resulting in not only the loss of prime agricultural land and open spaces, but also an increased traffic congestion, environmental degradation, and many other health impacts. To understand urban sprawl more deeply, it is important to understand how much of the built-up area increased in a city over the period of time. This gives insights not into efficient resources management, but also effective land-use planning and better infrastructure development. Hence we analyzed how built-up area of Lahore expanded from the year 2011 to year 2021. The expansion is quite alarming as can be seen in the maps in brown color, and must be halted in order to mitigate cliimate change, biodiversity conservation and also for the efficient mangement of water resources.





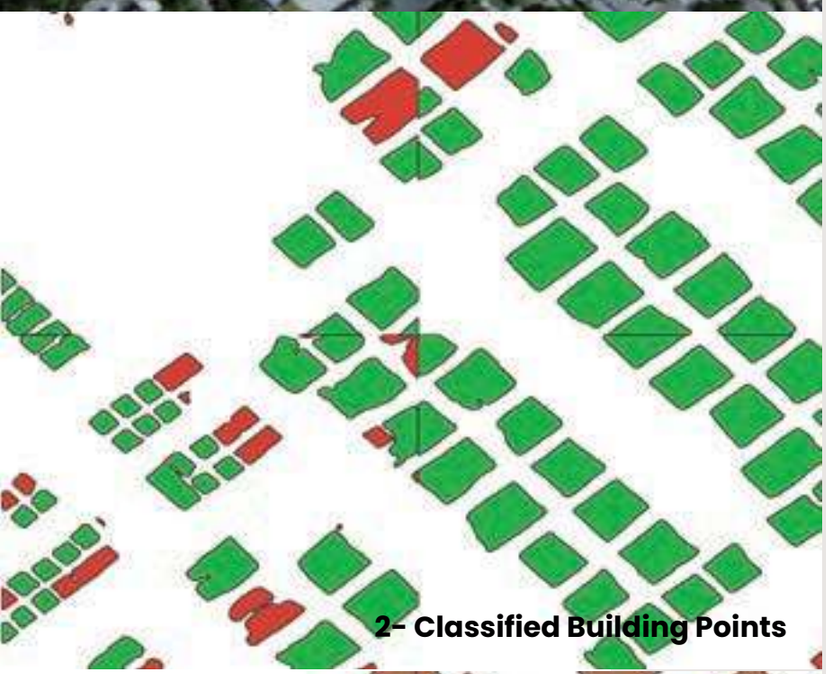

Builtup Area
Lahore Boundary
6th May, 2013


Builtup Area
Lahore Boundary
18th November, 2021

Automatically Delineating Building Footprints

CITY recognized the significant time investment urban planners make in digitizing satellite imagery into vectors for creating land-use and various other maps. To address this, CITY initiated this research on developing a tool that automates the generation and delineation of building footprints using satellite imagery. This initiative resulted in a tool that offers a plethora of advantages including enhanced efficiency, precision, cost-effectiveness, and accessibility. To begin with, Step 1 involved using digital maps and deep learning models to estimate the number of buildings in an area and identify built-up areas. We called this "building detection and counting". Step 2 focused on creating the boundaries of buildings directly from satellite images using deep learning models, termed as "footprint extraction". The outputs we aimed for included a map showing where buildings are located, and a list of coordinates for different areas marked as built or unbuilt. Additionally, during the footprint extraction process, we aimed to create a single file containing the shapes of each building in the area. These outputs are useful for data-driven urban planning and decision-making.

1- Built-up Area Mask



2- Classified Building Points

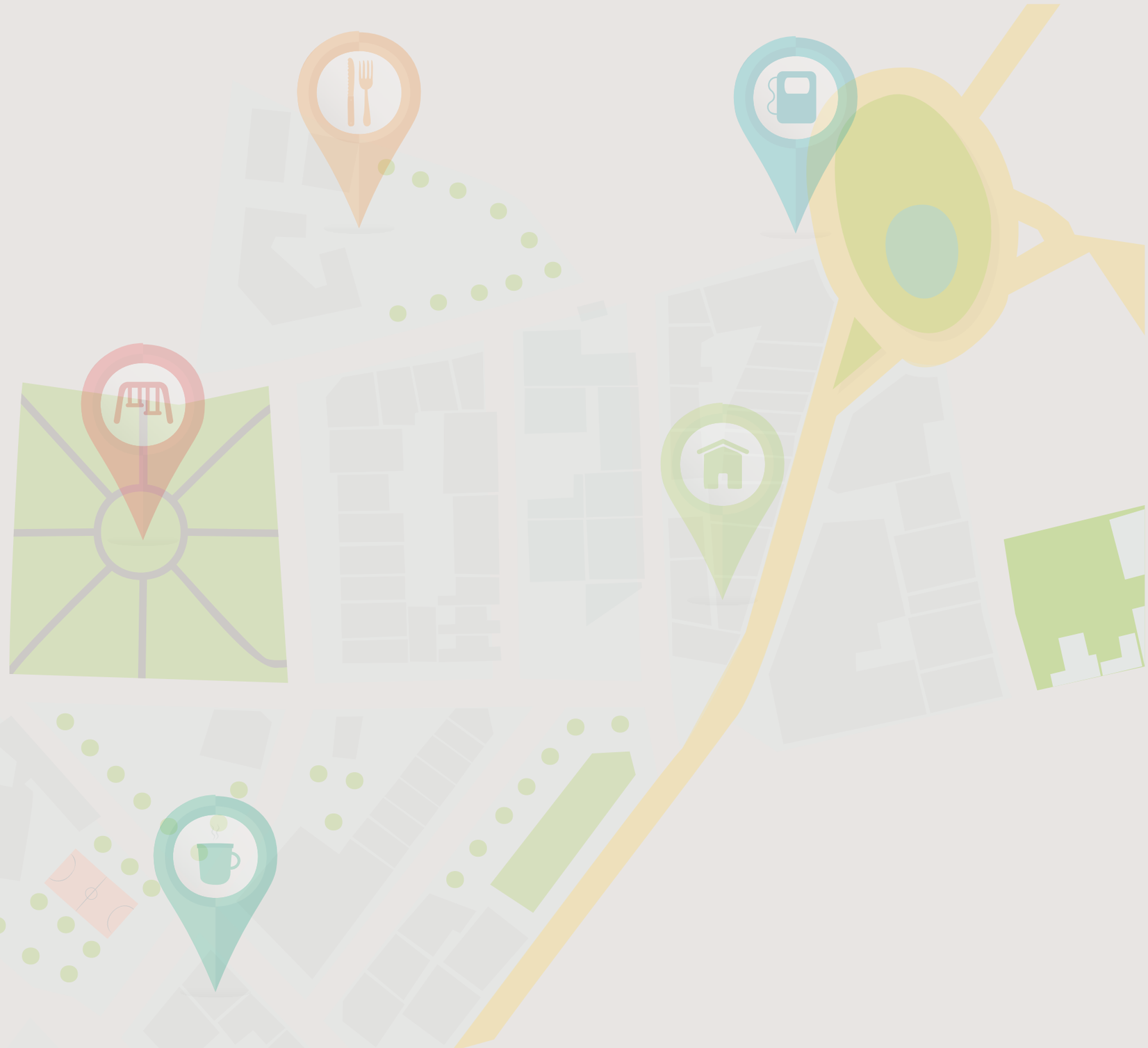
3-Building Footprint Polygons

The step-by-step process of how buildings were automatically detected in DHA Lahore; each map shows the progress made in identifying building footprints using automated method.

The built-up area mask could be used as a covariate in many applications, for example, population disaggregation, air quality prediction at grid level, and damage assessment at a granular level of an area.

Classified building points (geocoordinates) can be used in many applications, for example measuring and optimizing distances between municipal service points and housing points etc.

Building footprints polygons can be used for generating and updating society maps or for tax valuation purposes, which can save a lot of manual effort.

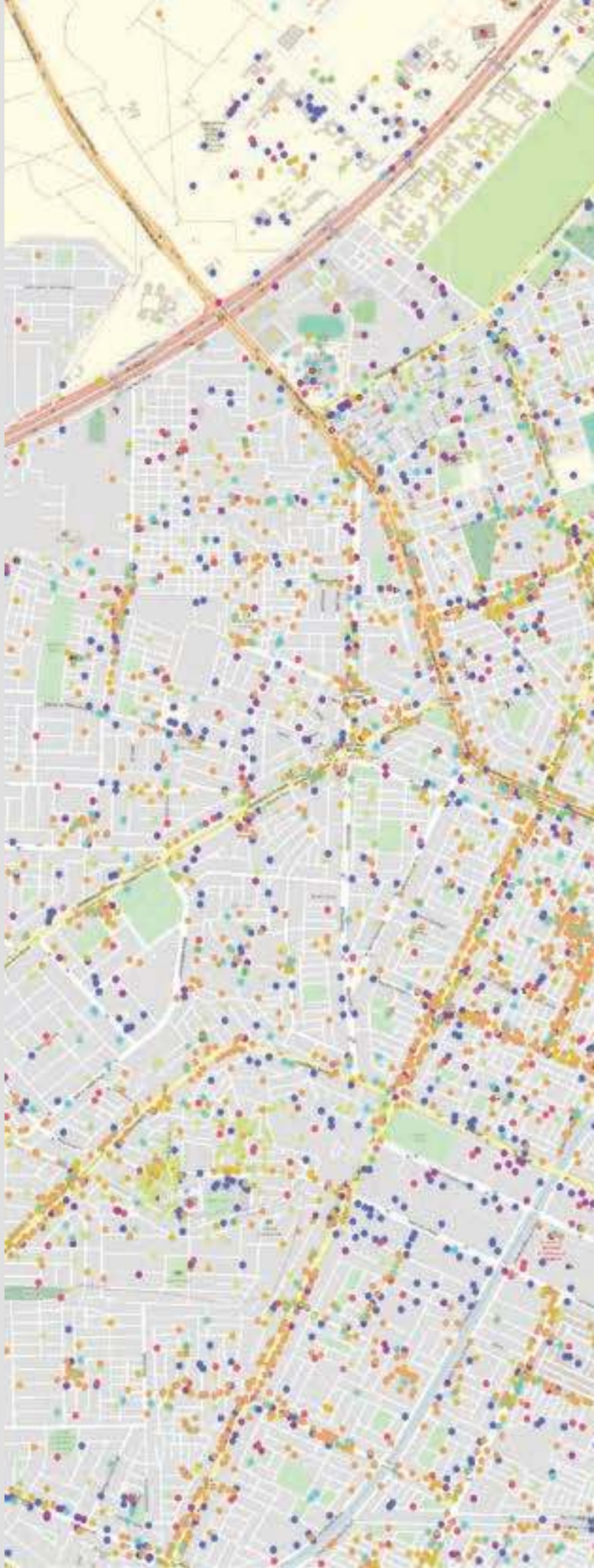


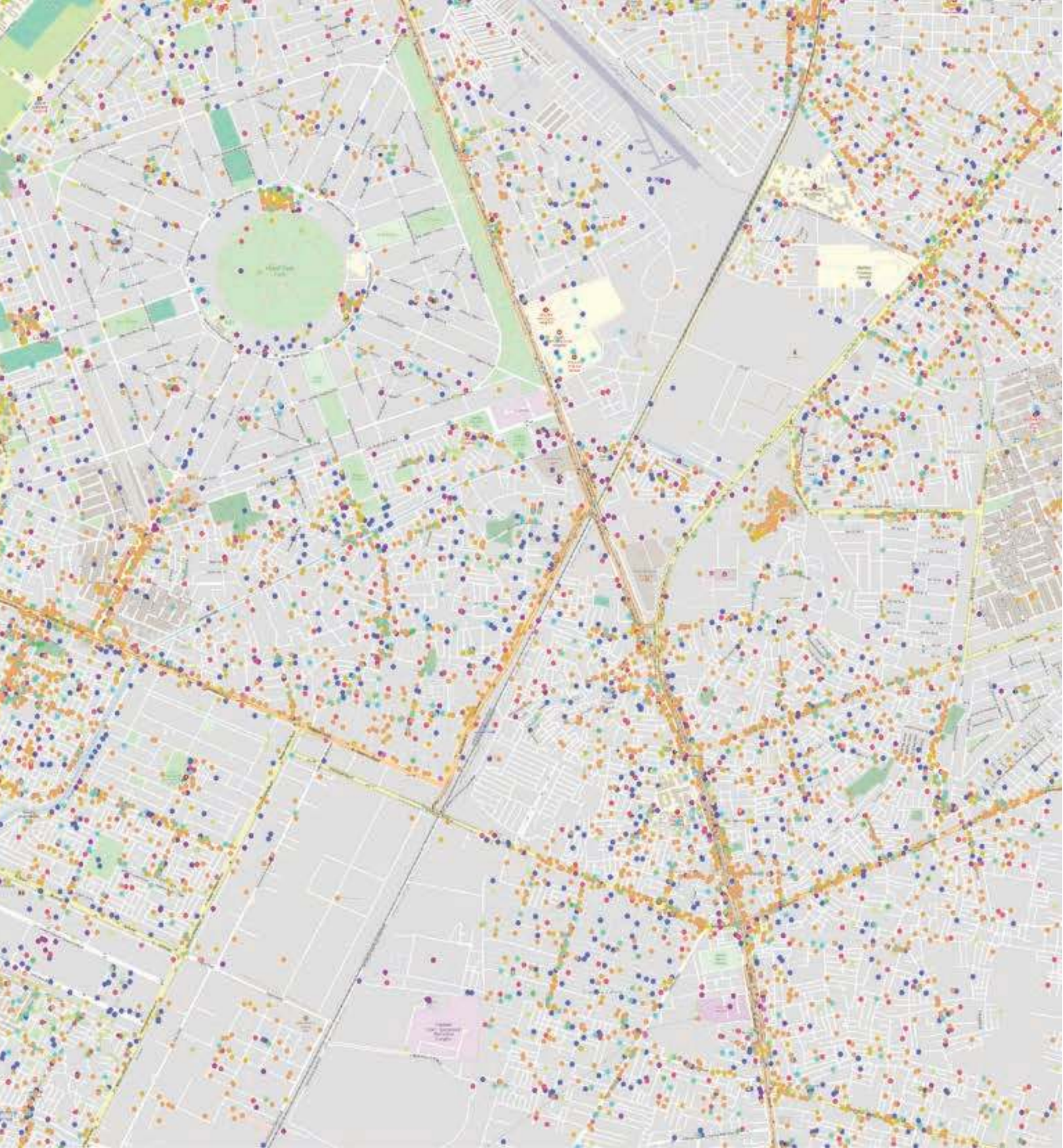
Extracting Points of Interest (POI)

Points of interest (POIs) are specific locations or features within a city that are considered important for various reasons, including social, economic, cultural, environmental, and functional aspects of urban life. Accessing datasets for Points of Interest (POIs) is a challenge in a country like Pakistan. Recognizing the critical importance of this data, researchers usually encounter numerous hurdles while attempting to extract it through conventional methods. After attempting various approaches, CITY used AI to devise an innovative solution. Our AI-driven method allows us to accurately identify and compile crucial POI data from crowd-sourced platforms. We have made the dataset for Lahore publicly available, and have also prepared the dataset for two other districts of Punjab and provided it on-demand to a local urban planning company. This initiative has far-reaching implications, providing vital information that can benefit diverse sectors.

Considering the demand and usefulness of this dataset, we have extracted following Points of Interests for Lahore:

- Banks
- Caffe
- Education
- Food Points
- Govt. Offices
- Health Points
- Hotels
- Mosques
- Petrol Pumps
- Pharmacies
- Police Stations
- Post Offices
- Qabirstan and Tombs
- Shops
- Super Markets





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CITY Signs MOU with Careem

Marking a significant step forward in urban mobility solutions, through strategic partnerships and collaborative efforts, CITY and Careem work together to investigate sustainable transportation solutions.

CITY continue

CITY Signs MOU with M & P Logistics

22

CITY Signs MOU with Trans Karachi

s to Grow

Committed to addressing the growing challenges of female mobility, congestion, accessibility, and sustainability in the urban transportation system.

Solving Mobility Challenges of our Cities through Technology

03 NAVIGATING THE CITY

Urban Mobility

Urban mobility, an umbrella theme, is a complex subject that impacts every aspect of our lives. CITY at LUMS is focused on using technology to improve and enhance urban mobility in the cities of Pakistan. Traffic congestion is a major concern in the cities of Pakistan, which leads to economic losses, increased fuel consumption, and time delays and air pollution. According to a recent TEPA survey, the increasing traffic difficulties in Lahore are due to a lack of public transportation, unlawful parking, encroachments, and commercializing roadways without a detailed traffic impact study. To understand these pressing issues, CITY initiated its research threads under the urban mobility theme primarily to find answers to questions like: How can congestion be evaluated? Where are the most congested bottlenecks in Lahore and at what times of the day? How do different government decisions such as school closures or lockdowns impact traffic congestion? What could be the sustainable mobility options for the residents? Under this research theme, CITY has successfully developed cutting-edge AI tools for analyzing vehicle flows from traffic video feeds. While these solutions could be deployed on Punjab Safe Cities Authority (PSCA)'s infrastructure in Lahore, this project is also in the process of prototyping its own traffic analytics product that could be deployed at strategic locations in any city. The aim is to utilize this infrastructure, along with publicly available data (e.g., from crowd-sourced platforms such as Google) to replace historically cost-intensive manual surveys. Through these methodologies, we aim to facilitate effective evidence-based mobility planning through technology, AI, and data analytics.

Developing Smart Systems for Traffic Management

Extracting the Road Network

Predicting Ride-Hailing Demand-Supply

Streamlining Last-mile Logistics and Deliveries

Capitalizing Public Transport Investment through Transit Oriented Development

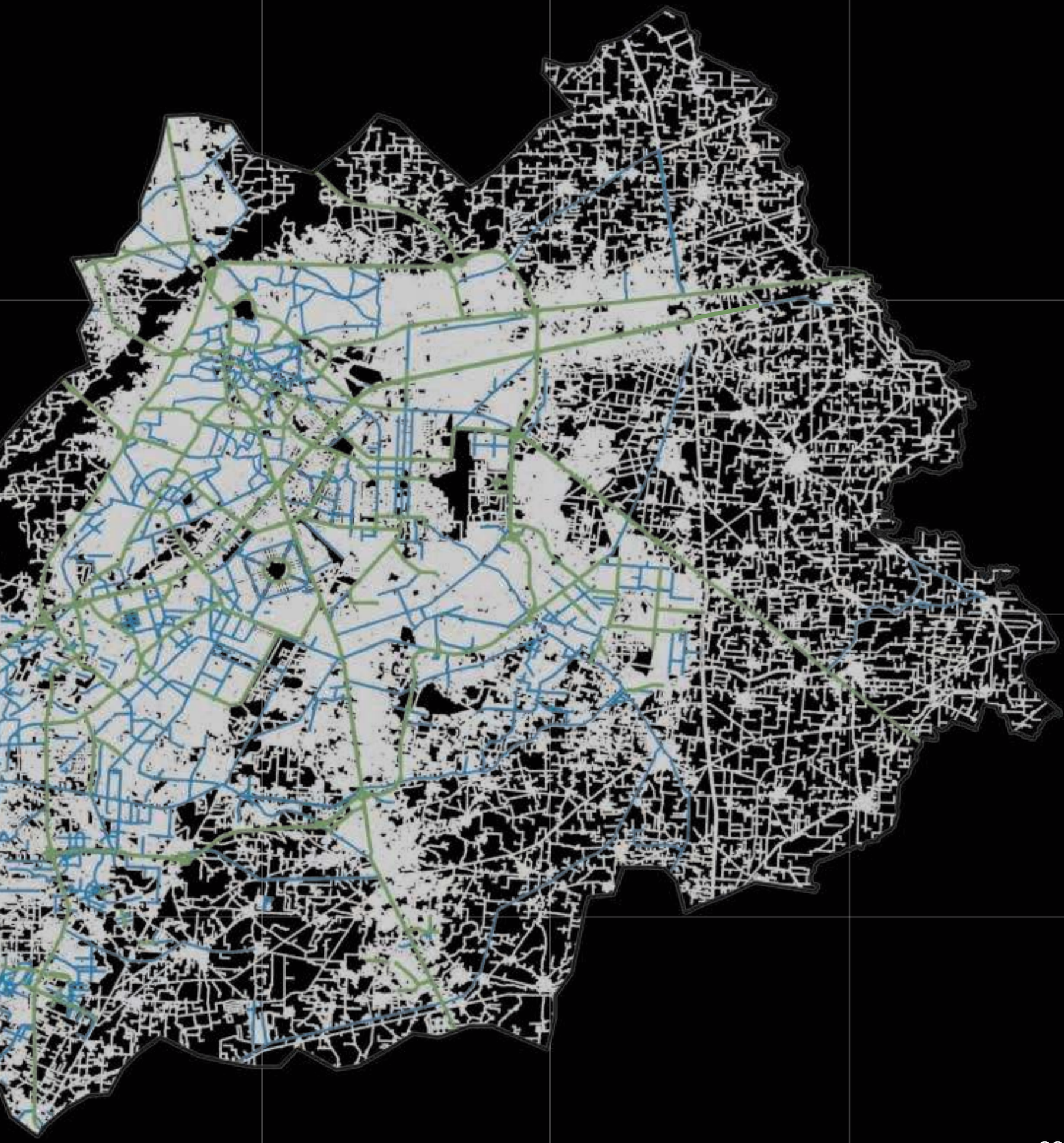
Detecting Parking Slots using Computer Vision

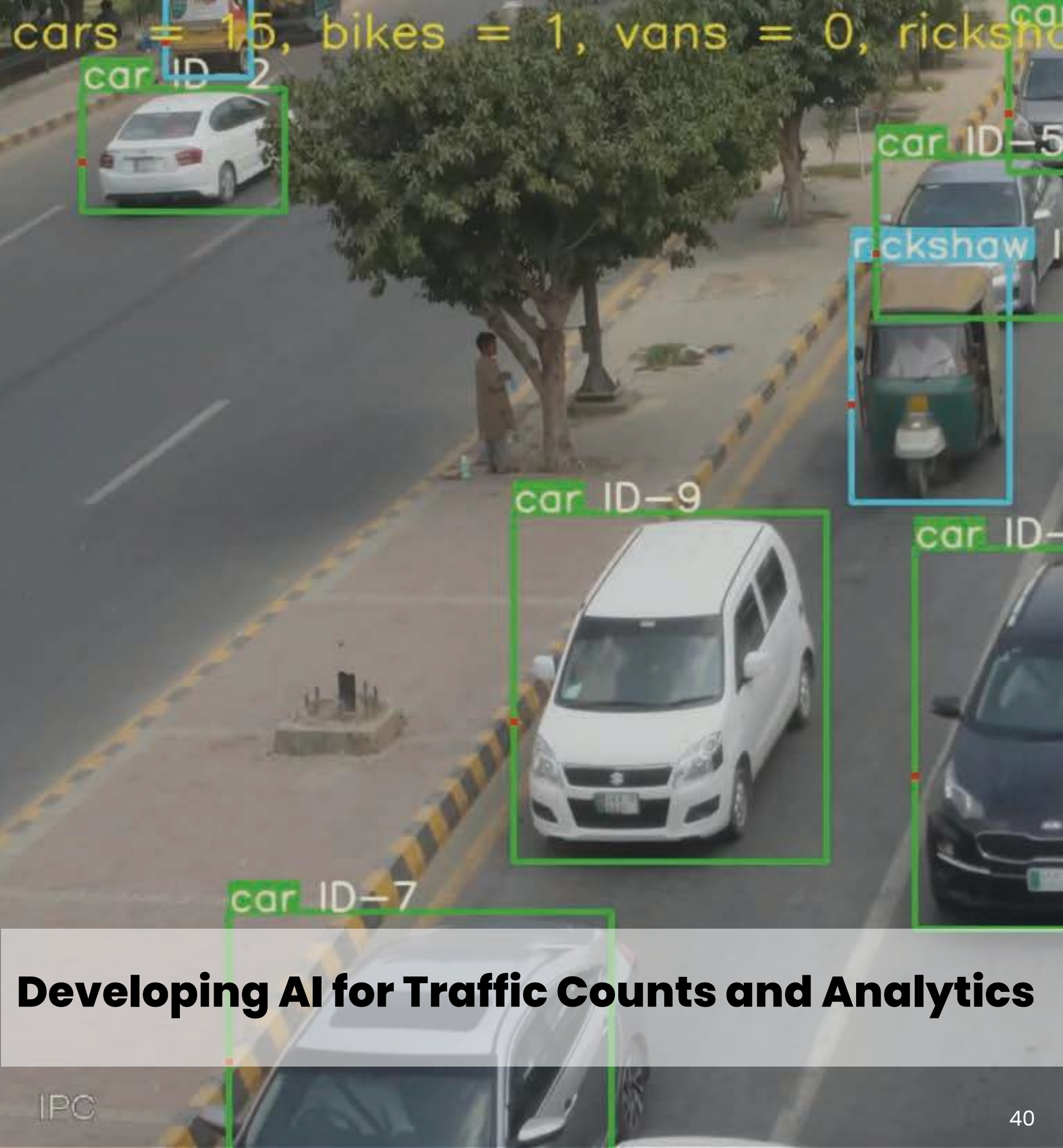
Developing AI for Traffic Counts and Analytics

Urraan: Gendered Tech and Urban Mobility

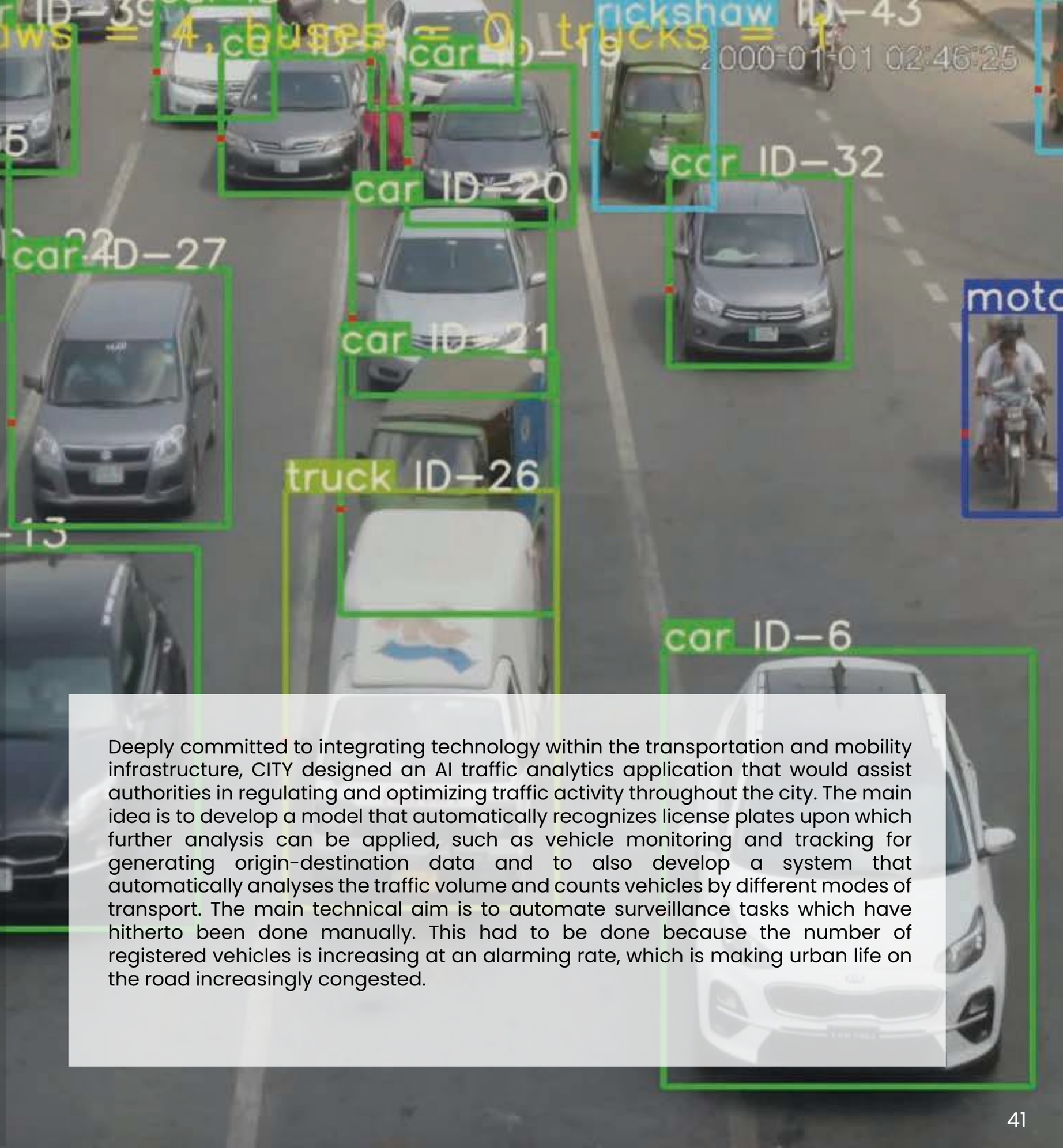
Road Network Extraction

This research thread was initiated to extract the road network in a geospatial format for Lahore so it can be an input for other studies. A road network is a collection of nodes and edges, much like any other graph. Nodes (or vertices) and edges (or links) respectively represent the intersections and roads. A curved road may have additional nodes (not representing junctions) that help in the tracing of road segment shapes in contrast to a straight road, which only has two nodes at the beginning and end. Each node in this graph has a latitude and a longitude to indicate its location on the earth's surface, unlike other graphs. The main intended output of this research thread was to develop set of nodes and edges translated into a detailed georeferenced road network.





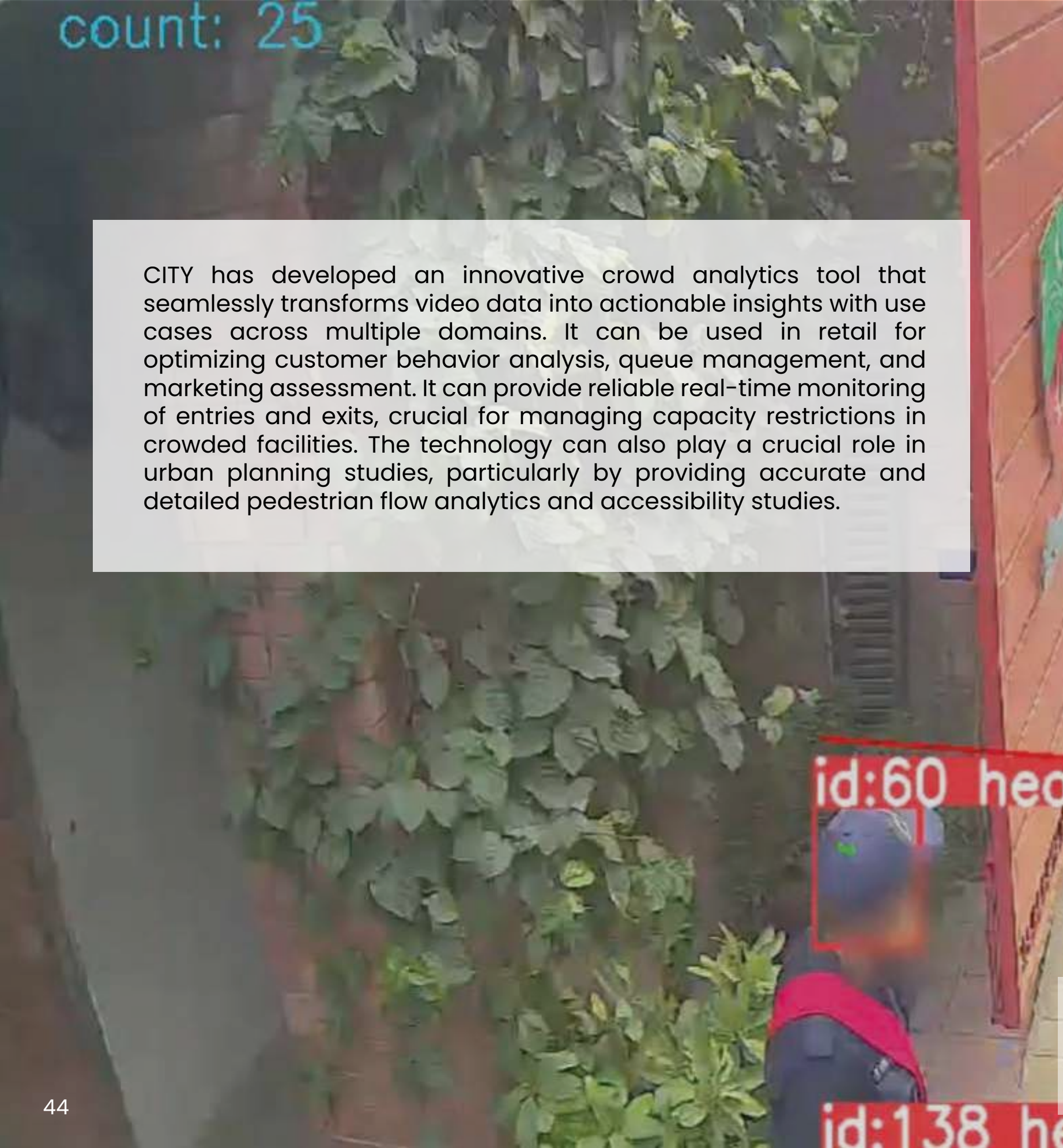
Developing AI for Traffic Counts and Analytics



Deeply committed to integrating technology within the transportation and mobility infrastructure, CITY designed an AI traffic analytics application that would assist authorities in regulating and optimizing traffic activity throughout the city. The main idea is to develop a model that automatically recognizes license plates upon which further analysis can be applied, such as vehicle monitoring and tracking for generating origin-destination data and to also develop a system that automatically analyses the traffic volume and counts vehicles by different modes of transport. The main technical aim is to automate surveillance tasks which have hitherto been done manually. This had to be done because the number of registered vehicles is increasing at an alarming rate, which is making urban life on the road increasingly congested.

Detecting Parking Slots using Computer Vision

CITY developed a model that identifies vancant and occupied parking spots using computer vision. This parking management system is a set of tools, technologies, and processes designed to optimize the utilization of parking spaces and provide a better parking experience for drivers. It can help optimize the use of parking spaces by providing real-time information about available parking spots, reducing the amount of time drivers spend searching for a parking space, and improving the overall efficiency of the parking facility. Furthermore, by implementing a parking management system, parking facility owners and operators can increase revenue by charging for parking, implementing dynamic pricing based on demand, and reducing the number of free or unauthorized parkers. This can improve the security of a parking facility by providing access control, surveillance, and monitoring capabilities. Moreover, by reducing the time drivers spend searching for a parking space, it can also help reduce traffic congestion and associated air pollution. Overall, this parking management system can provide valuable data and analytics about parking patterns, utilization rates, and customer behavior, which can be used to optimize operations, improve revenue, and inform future planning and development.

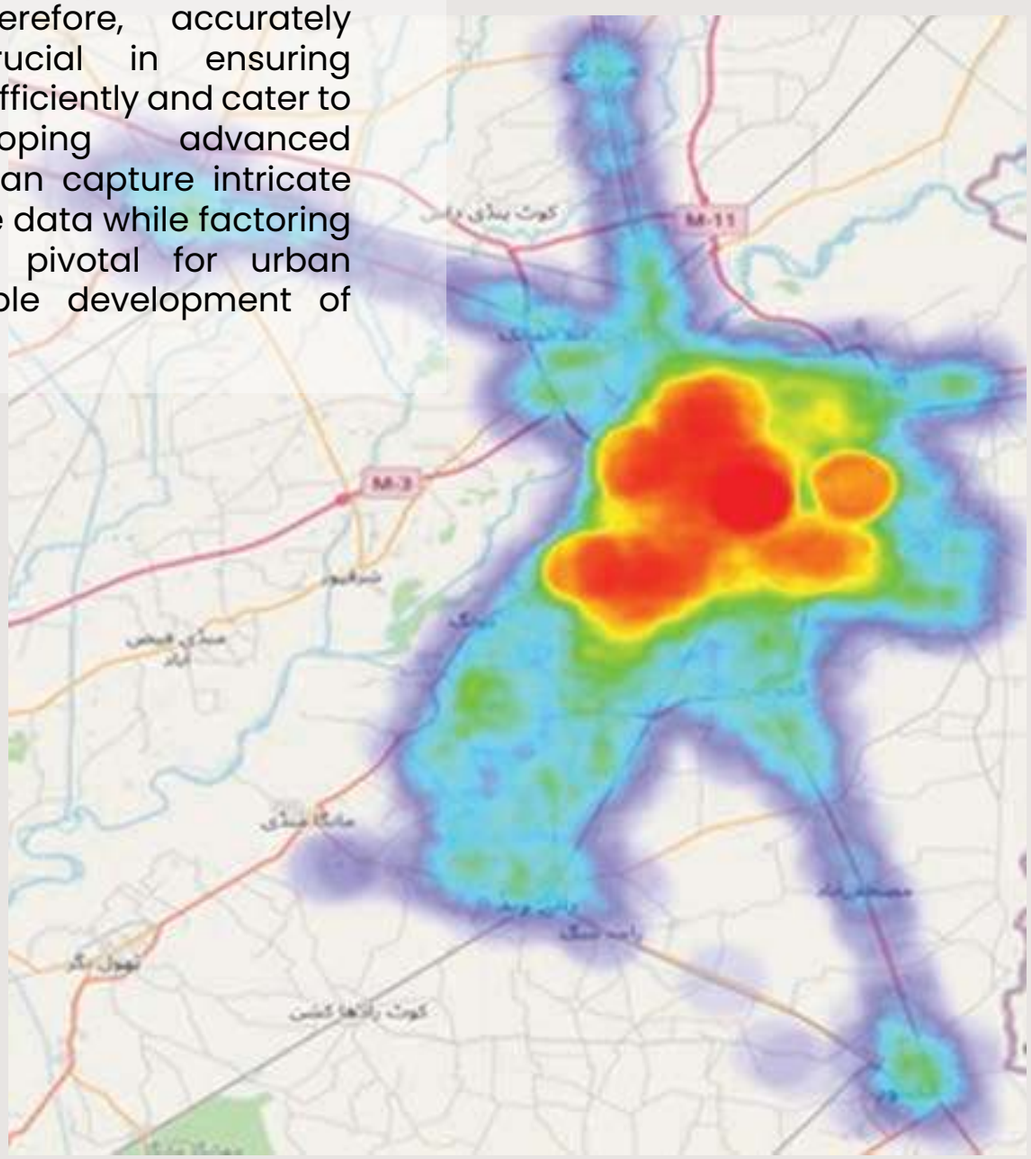


CITY has developed an innovative crowd analytics tool that seamlessly transforms video data into actionable insights with use cases across multiple domains. It can be used in retail for optimizing customer behavior analysis, queue management, and marketing assessment. It can provide reliable real-time monitoring of entries and exits, crucial for managing capacity restrictions in crowded facilities. The technology can also play a crucial role in urban planning studies, particularly by providing accurate and detailed pedestrian flow analytics and accessibility studies.

Crowd Analytics

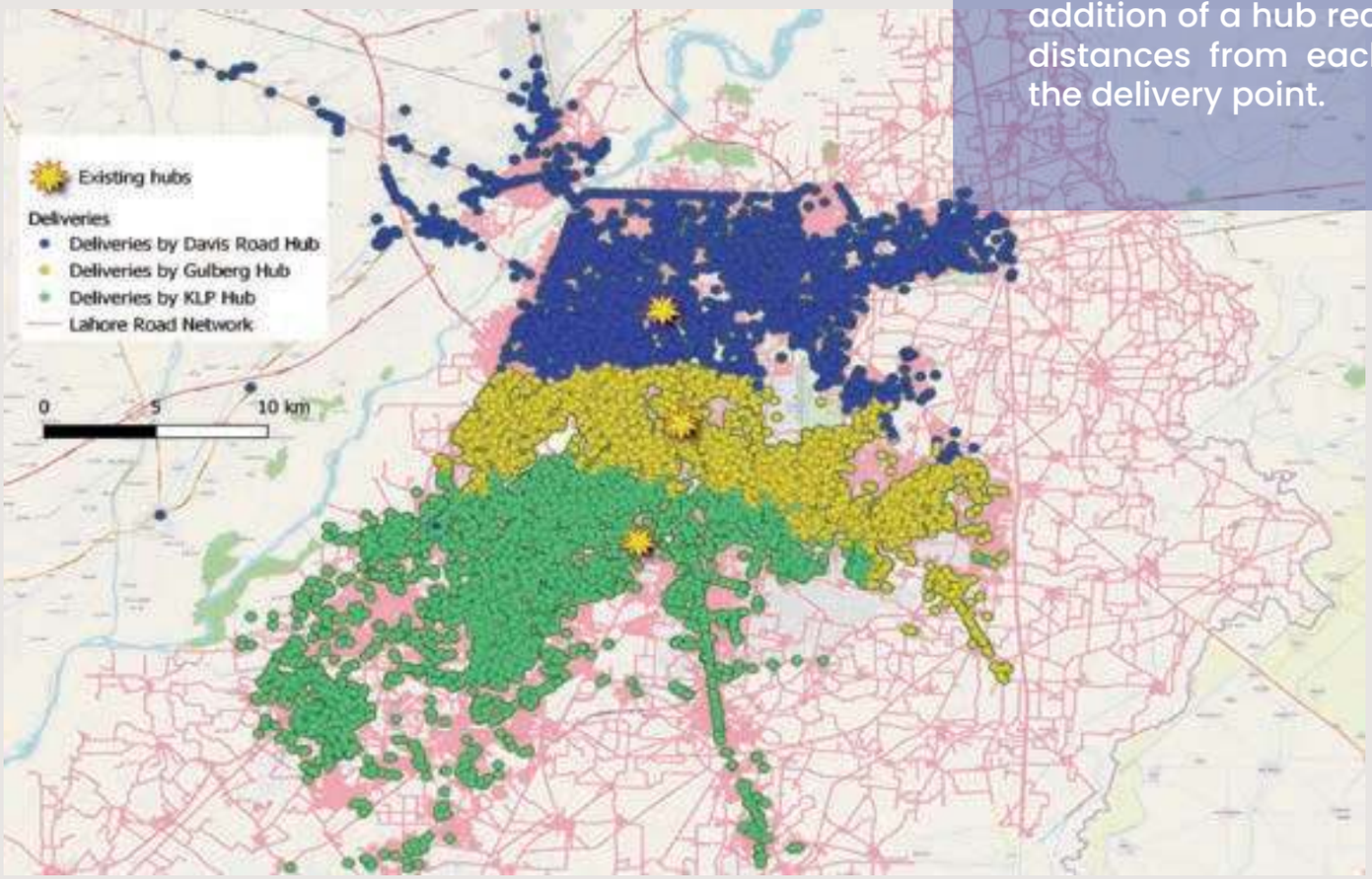
Predicting Ride-Hailing Demand-Supply

Done in partnership with careem, this research thread aims at developing a model that predicts rolling taxi demand for one day by time and geographic area based on different impacting variables. Efficient management of ride-hailing services has significant benefits for citizens and the economy, including improving citizens' quality of life, boosting economic productivity, and reducing environmental impact. Therefore, accurately predicting demand is crucial in ensuring ride-hailing services operate efficiently and cater to citizens' needs. Developing advanced deep learning models that can capture intricate spatiotemporal patterns in the data while factoring in dynamic externalities is pivotal for urban management and sustainable development of cities.



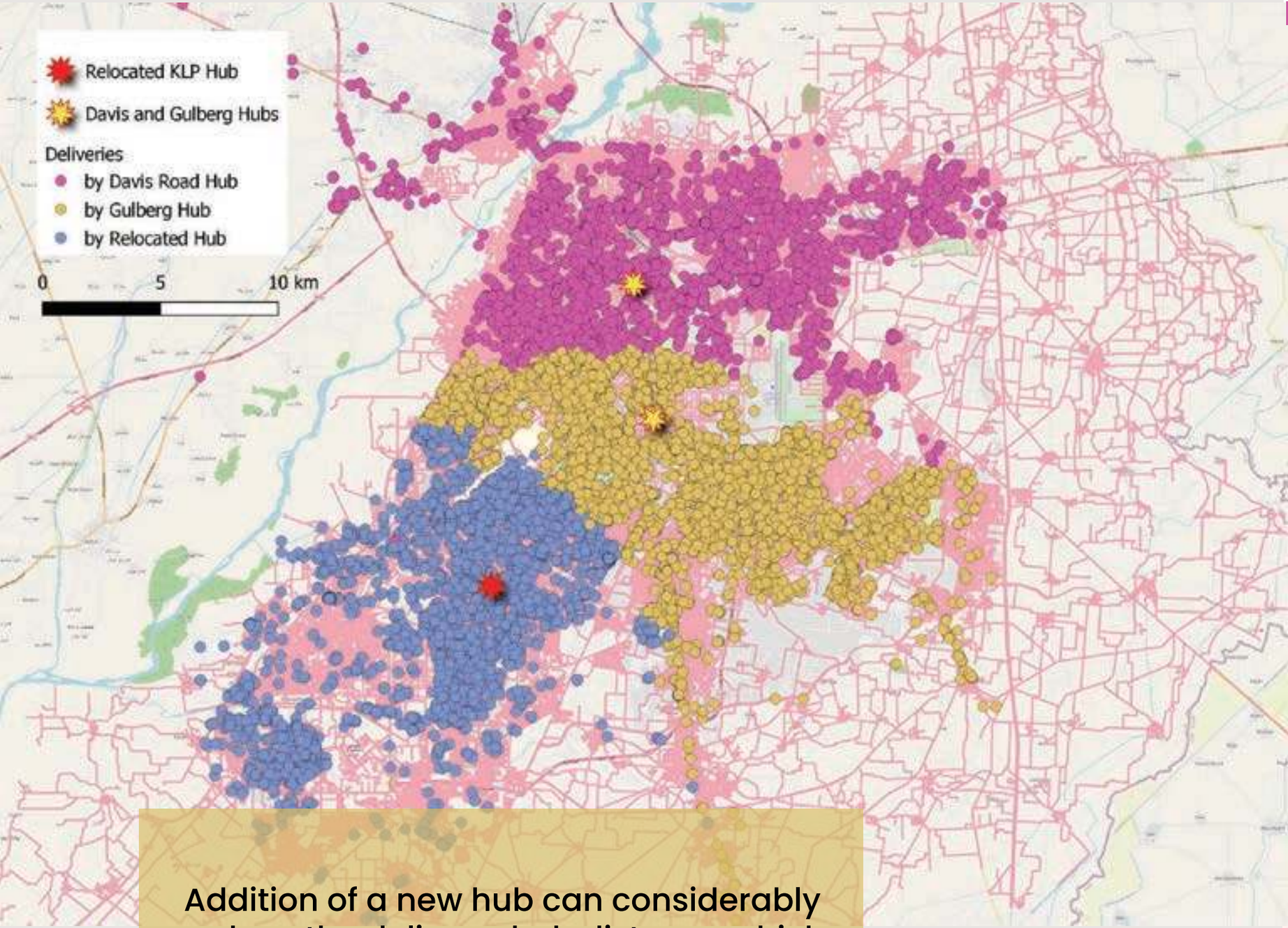
Demand Variation of Careem in Lahore

Locations of existing hubs and areas for which they handle the deliveries. Next, we show how relocation of KLP hub or addition of a hub reduces the distances from each hub to the delivery point.



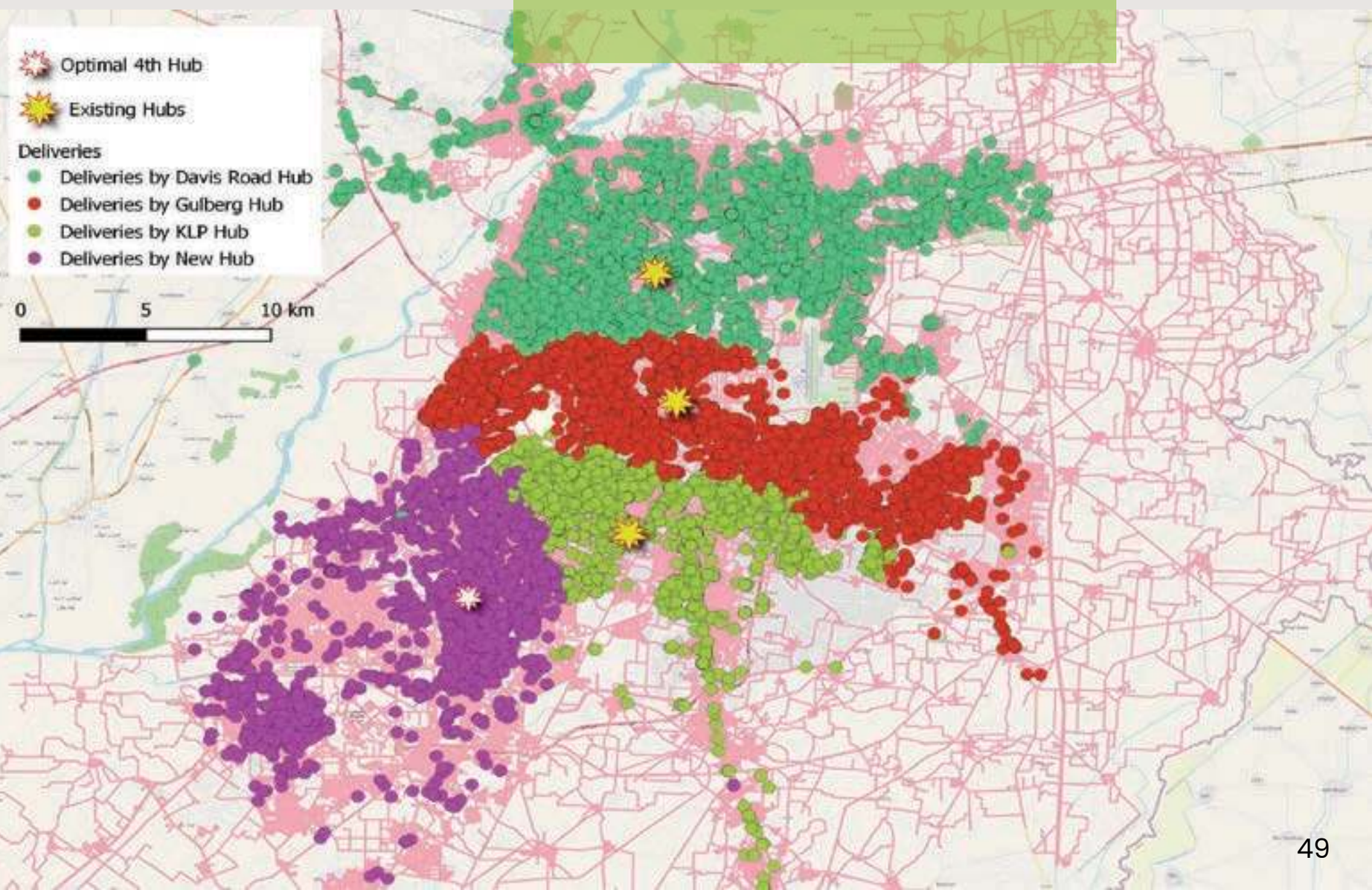
Over the past few years, there has been considerable growth in the e-commerce industry, which has highlighted a few gaps concerning last-mile logistics. These gaps can be categorized as unstructured addresses, or optimizing distribution hub locations. In order to address these problems, the main aim of the research was to achieve stream-lined and efficient data-driven solutions which would lower last mile delivery distances and costs. The maps show how our data-driven approach improves the last-mile logistics for Lahore.

Streamlining Last-mile Logistics and Deliveries



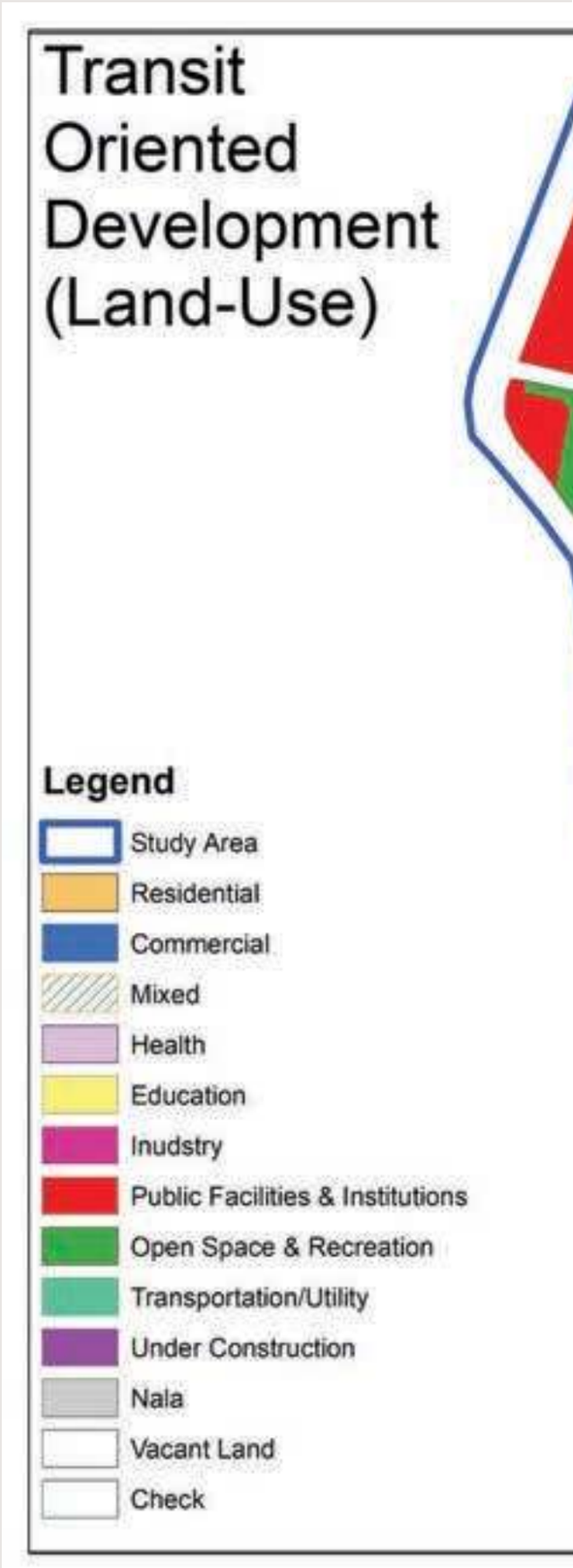
Addition of a new hub can considerably reduce the delivery-hub distance which would make handling the last-mile logistics considerably convenient for services and the drivers.

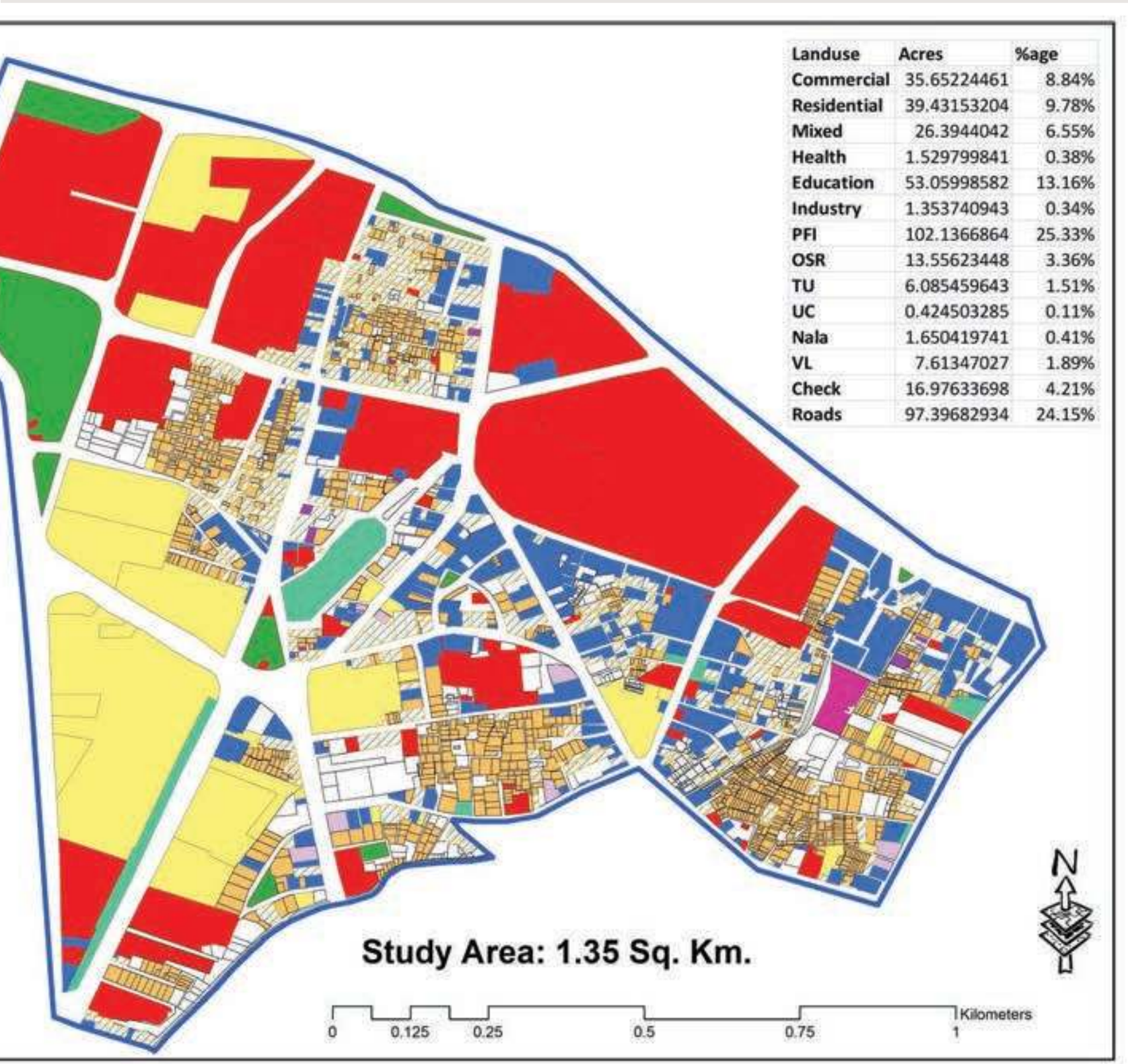
Map demonstrating an even distribution of deliveries handled by the relocated KLP Hub and the Gulberg hub.

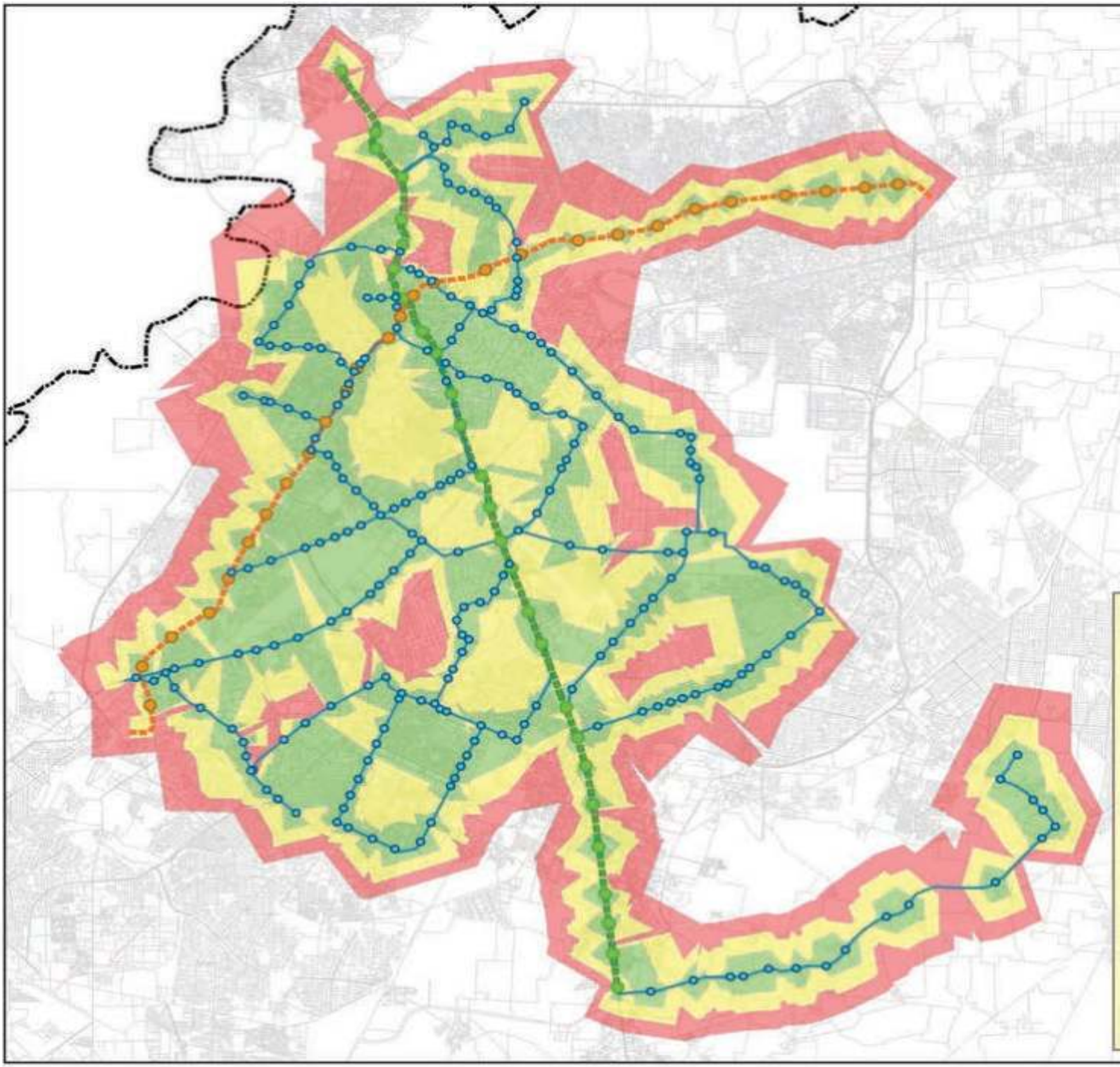


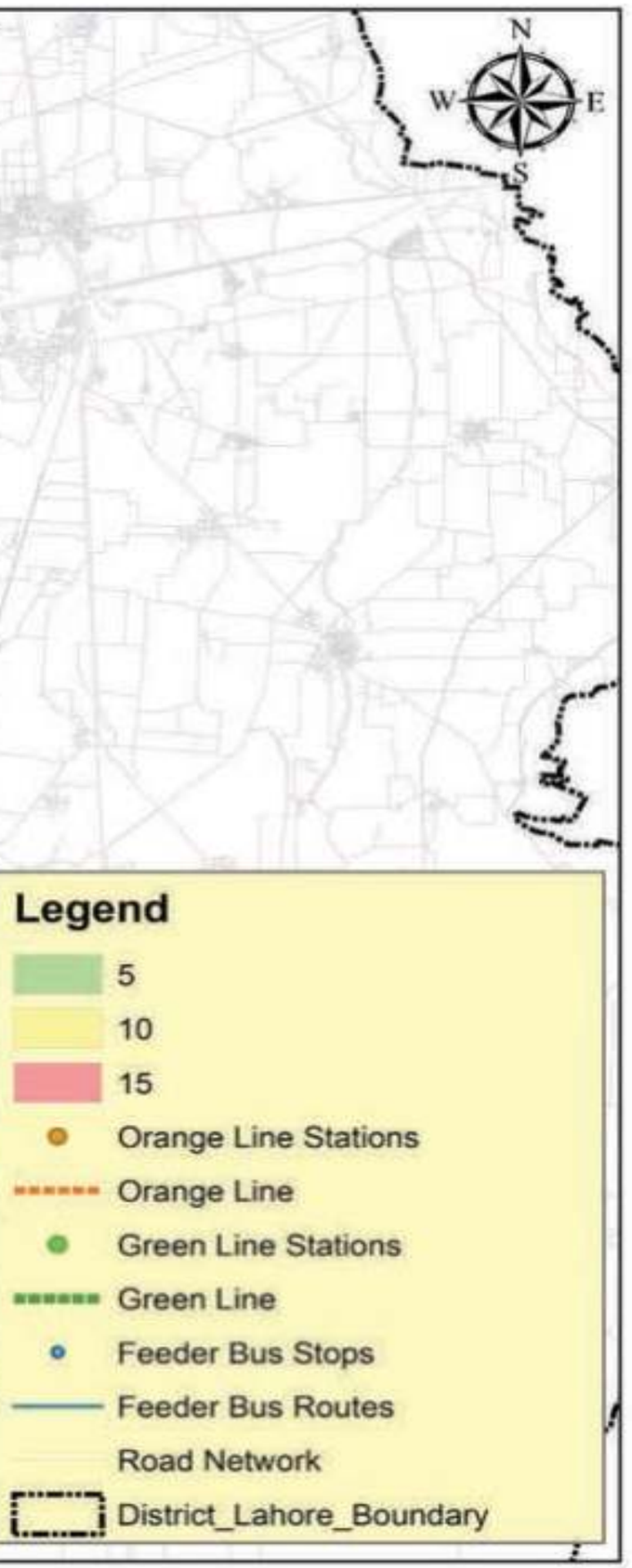
Capitalizing Public Transport Investment through Transit-Oriented Development

This research focuses on leveraging the interaction between land-use and transport, the process of coordinated urban development, to encourage sustainable transport modes such as walking, bicycling, and public transport. Experience has shown that urban development patterns and transport should complement each other to ensure sustainable. development. The goal of interaction between urban development and transport is to build a balance between the demand of the two. Pakistani cities are facing several mobility related issues from traffic congestion to toxic air quality, high road accidents, and an exponentially increasing number of motor vehicles. Lahore, being the second largest city of Pakistan, is no exception to these mobility problems. Public transit in Lahore, the city with the first Bus Rapid Transit (BRT) and metro train system of Pakistan, does not serve the majority of the population or cover a wide service area. While there are feeder routes of Speedo bus service, the majority of the public in Lahore does not have easy access to public transit primarily due to the lack of first and last mile connectivity. The map represents the study area of Jain-Mandir in Lahorewith its land-uses.




Landuse | Acres | %age
Commercial | 35.65224461 | 8.84%
Residential | 39.43153204 | 9.78%
Mixed | 26.3944042 | 6.55%
Health | 1.529799841 | 0.38%
Education | 53.05998582 | 13.16%
Industry | 1.353740943 | 0.34%
PFI | 102.1366864 | 25.33%
OSR | 13.55623448 | 3.36%
TU | 6.085459643 | 1.51%
UC | 0.424503285 | 0.11%
Nala | 1.650419741 | 0.41%
VL | 7.61347027 | 1.89%
Check | 16.97633698 | 4.21%
Roads | 97.39682934 | 24.15%
N
Study Area: 1.35 Sq. Km.
0
0.125
0.25
0.5
0.75
1
Kilometers





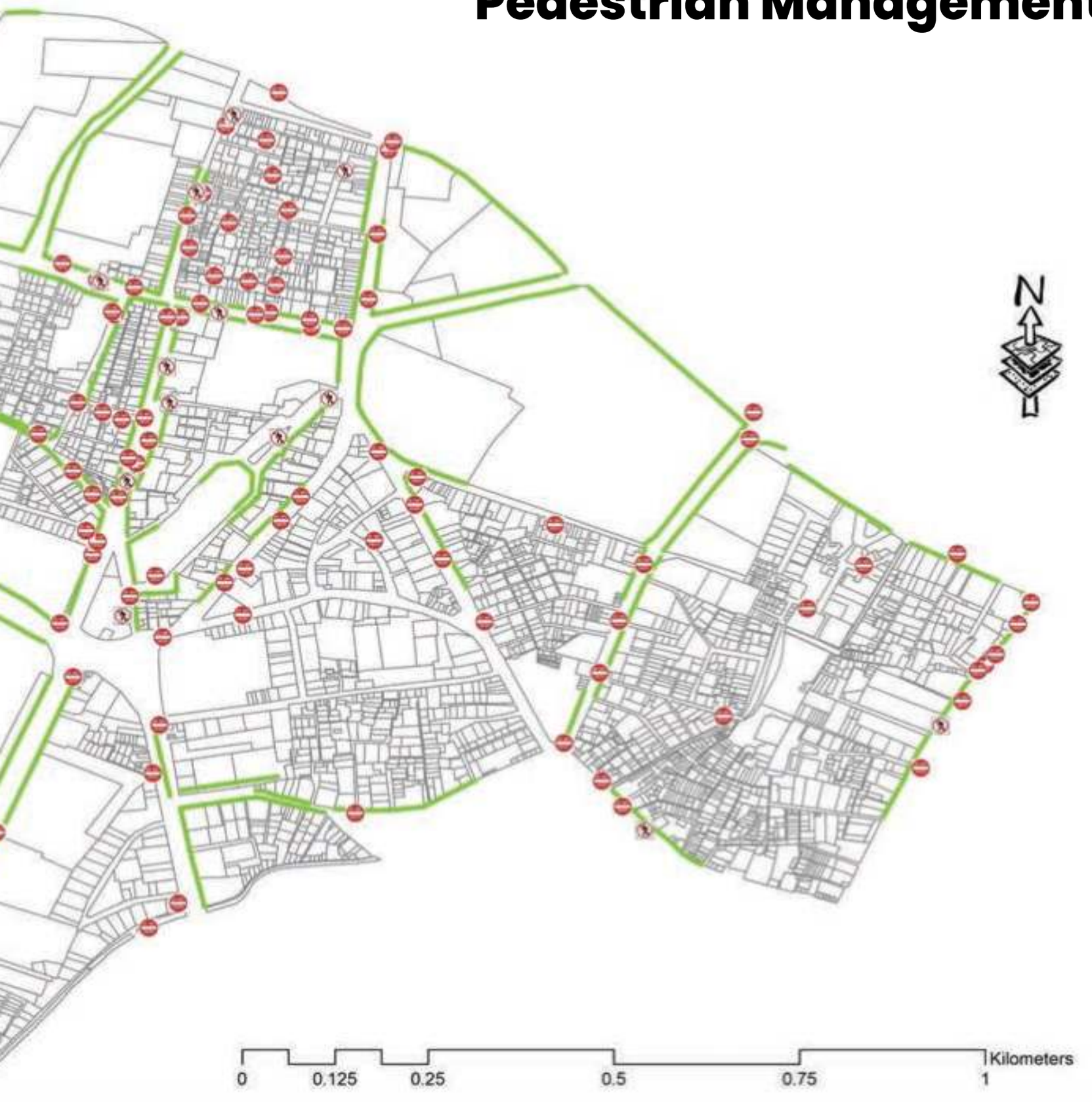
Public transit services act as a counterforce to reduce urban sprawl through dense urban development in recent years, transit-oriented development (TOD) has achieved increasing significance. Transit-oriented development seeks to create useful, mixed-use, pedestrian-friendly urban districts with transportation, accommodation, parks, schools, and other social and economic improvements that will benefit a variety of stakeholders. The intended outputs of this research thread were to Identify the transit nodes that have the utmost potential for TOD and to design a development framework that will be feasible to encourage compact development around transit nodes. Quantification of the number of housing units and jobs could be created by redesigning a transit node.

The adjacent map visualizes the population coverage of Lahore's public transport system. As per an in-house study conducted by Team CITY, only 15% of Lahore's population lives within 5 minutes of walking distance from the public transportation network. The population coverage increases to 30% and 40%, within 10 minutes and 15 minutes of walking, respectively.

Area Coverage: 5, 10 and 15 minutes from Public Transport Station

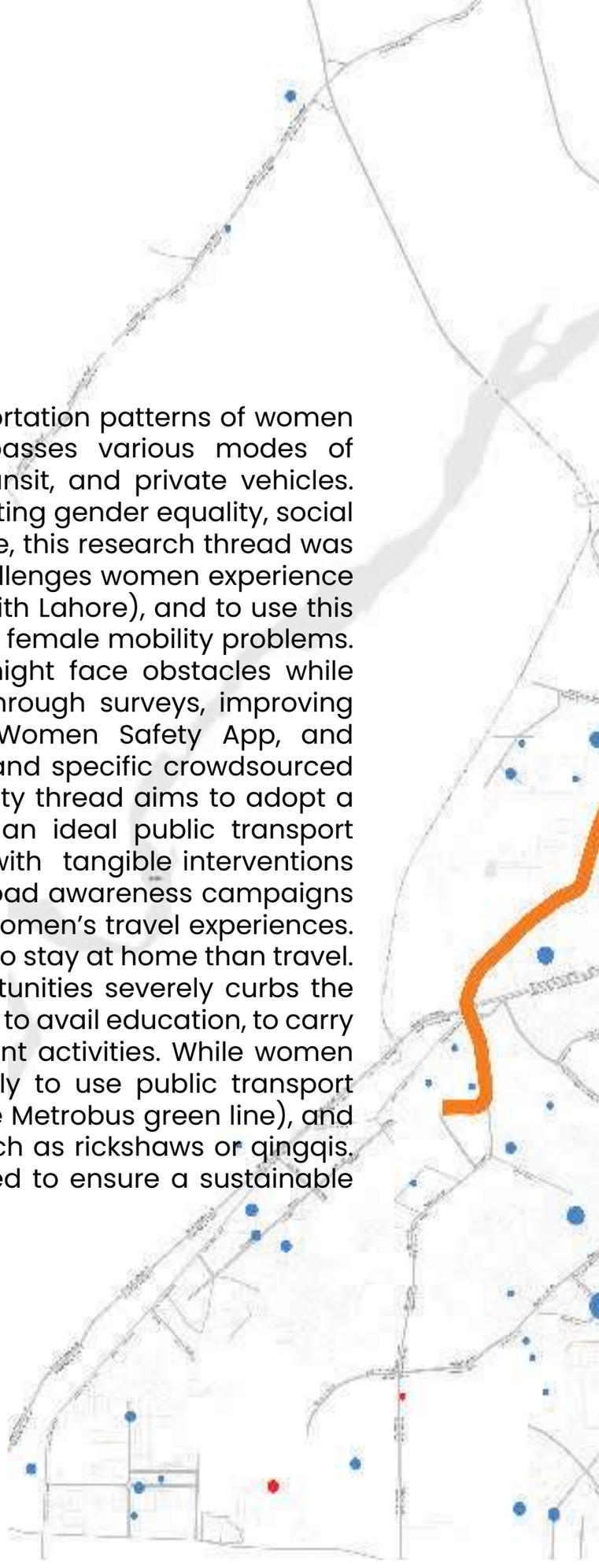
The public transit system and consequent land use in Lahore so far is a classic example of a transit adjacent development, and not Transit-Oriented Development (TOD). The former primarily focuses on primarily provision of mass transit facilities only whereas in the latter case, decisions about the provision of public transportation and land use on accessible space are made simultaneously. Therefore, for Lahore, planning for accessibility, quality, and capacity of public transit along with optimal utilization is imperative and the need of the hour. We tackled these two mass transit routes (i.e., Metrobus and Orange Line Train) to identify the transit nodes that have utmost potential for TOD. The map represents pedestrian movement in the study area.

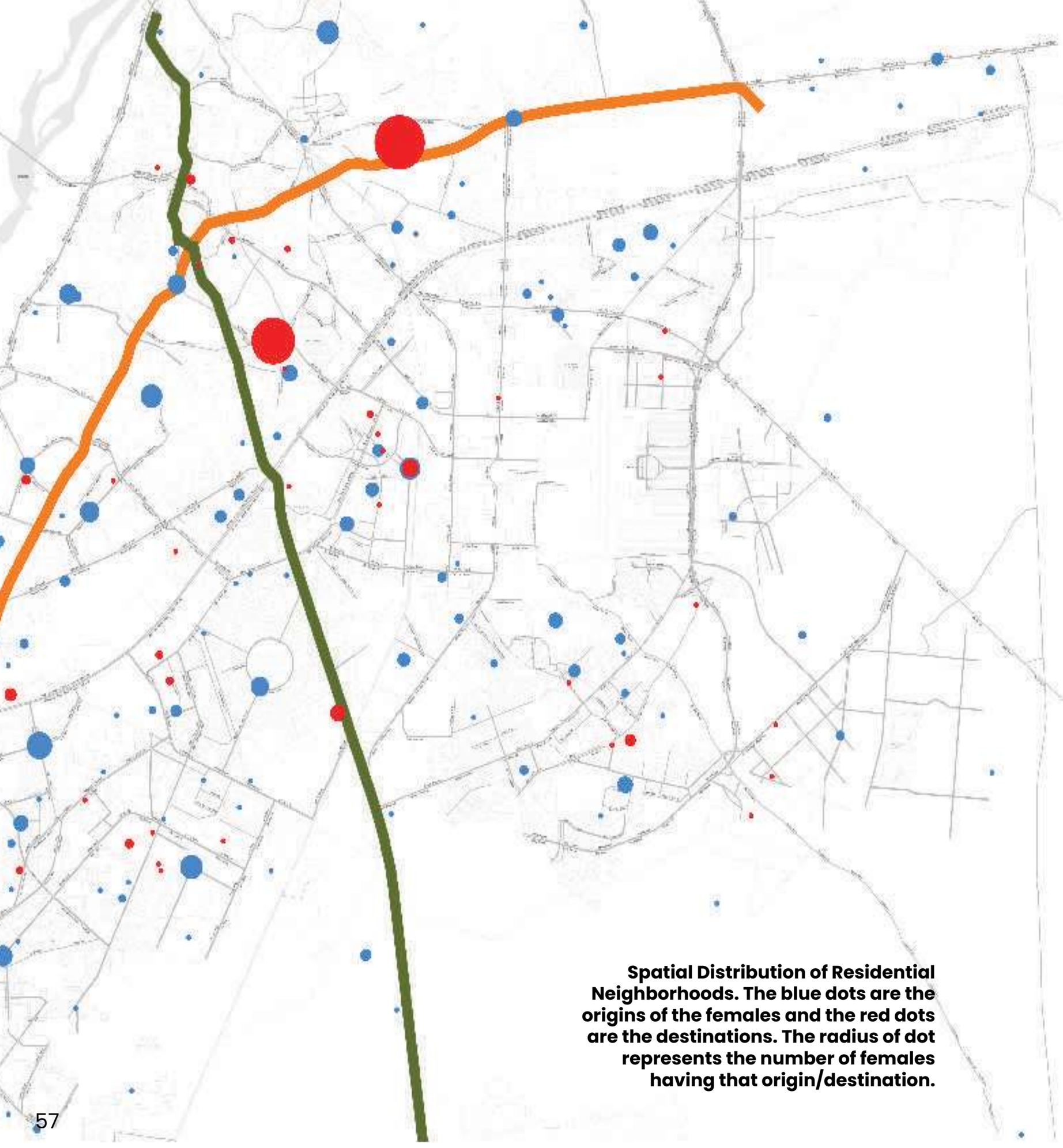
Pedestrian Management



Urraan: Gendered Tech and Urban Mobility

Female mobility refers to the movement and transportation patterns of women within urban and rural environments. It encompasses various modes of transportation, including walking, cycling, public transit, and private vehicles. Understanding female mobility is essential for promoting gender equality, social inclusion, and sustainable urban development. Hence, this research thread was aimed to gain an in-depth understanding of the challenges women experience while utilizing public transport in Pakistan (starting with Lahore), and to use this understanding for exploring potential solutions to the female mobility problems. To this end, we aimed to assess where women might face obstacles while travelling via public transport by collecting data through surveys, improving user-experience through revamping the Punjab Women Safety App, and conducting a women safety audit to collect better and specific crowdsourced geospatial data. The Urraan: Women in Urban Mobility thread aims to adopt a more holistic approach to what might constitute an ideal public transport experience for women, and to address these gaps with tangible interventions that can easily be replicated across regions, and broad awareness campaigns that highlight some lesser-known issues regarding women's travel experiences. On any given day, women in Pakistan are more likely to stay at home than travel. The lack of adequate, affordable commuting opportunities severely curbs the ability of local women to participate in the labor force, to avail education, to carry out important errands, and to engage in independent activities. While women travel less often in totality, they are 30% more likely to use public transport (wagons, buses, coasters), the Orange line, and the Metrobus green line), and 150% more likely to use other modes of transport such as rickshaws or qingqis. Therefore, feasible transport interventions are needed to ensure a sustainable and inclusive transportation system.

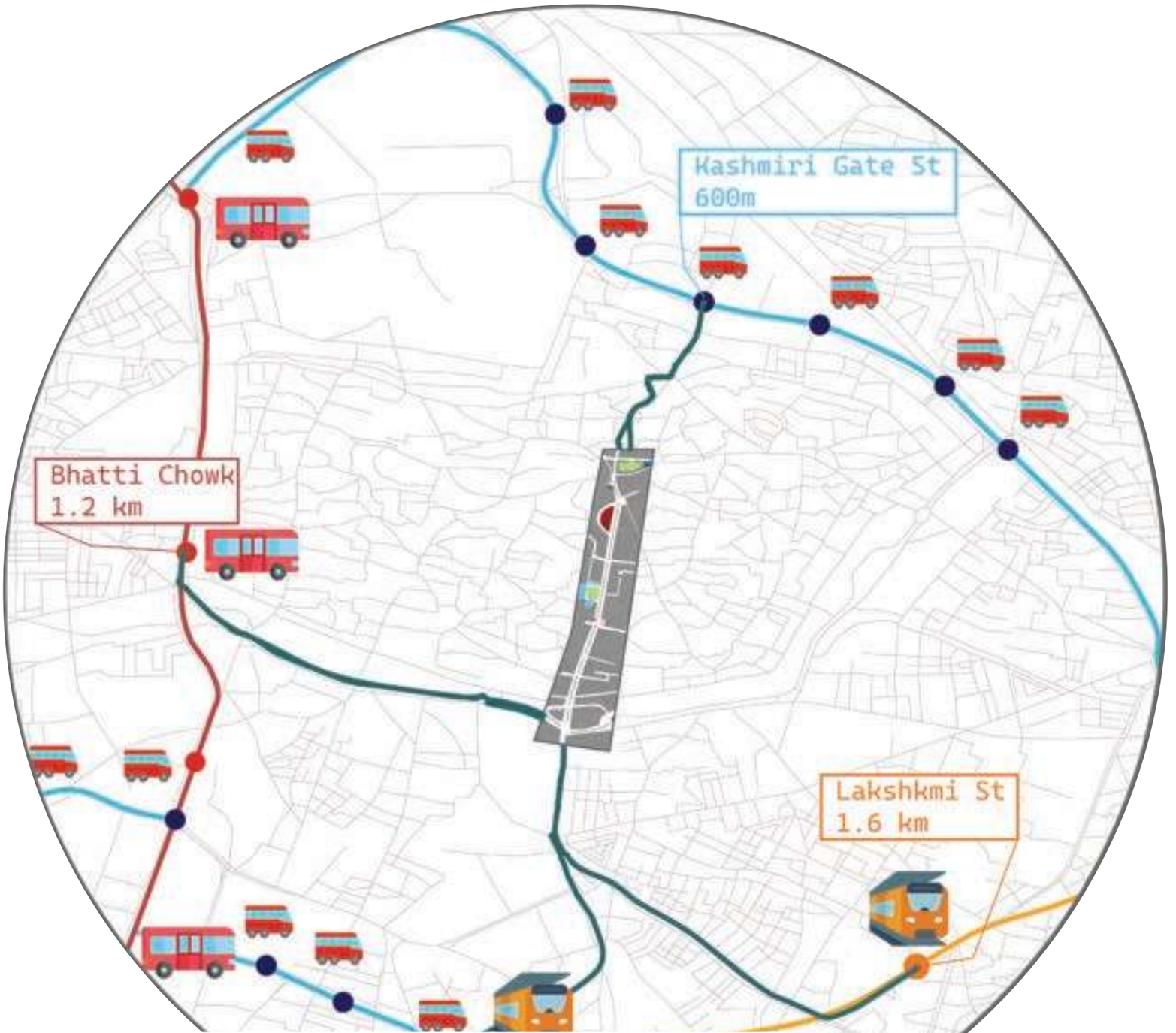




Spatial Distribution of Residential Neighborhoods. The blue dots are the origins of the females and the red dots are the destinations. The radius of dot represents the number of females having that origin/destination.

Reimagining Shah Alam Market

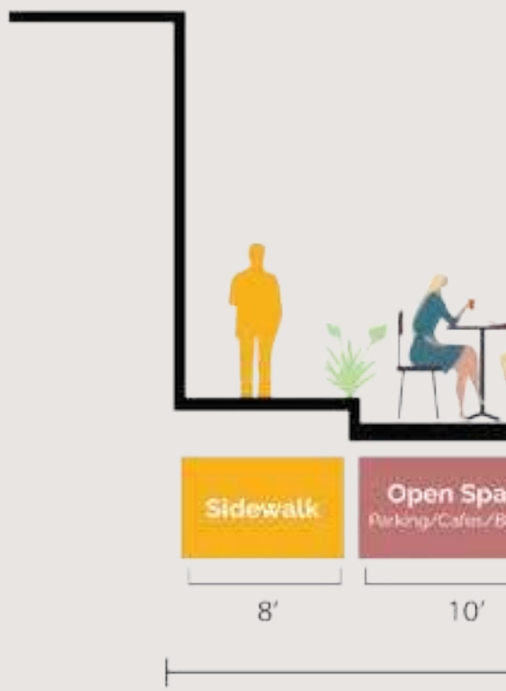
The Shah Alam Market is a vital hub for commerce and community engagement within its locality. However, as urbanization reshapes the cityscape, traffic congestion, pollution, and pedestrian safety concerns have emerged as significant challenges affecting the market's accessibility and functionality. This study began by evaluating accessibility across various transportation modes and the diverse land uses surrounding the market, then examining intricate details of road design, including sidewalks, crosswalks, and medians, as well as the condition of dedicated parking plazas and roadside parking facilities. Additionally, the market's general usability and visual appeal were assessed through the lens of a complete street checklist, ensuring a comprehensive understanding of its urban fabric. A thorough traffic analysis, parking assessment, and traffic simulation using PTV Vissim were conducted to gauge the current level of service and forecast future traffic demands. These insights informed discussions on potential traffic improvement scenarios, paving the way for a more efficient and sustainable traffic management approach. Mobility solutions were explored, encompassing both hard and soft interventions to foster a pedestrian-friendly environment. Recommendations included traffic calming measures such as dedicated pedestrian crossings and loading/unloading zones, as well as the promotion of green infrastructure to create a safer and more inviting space for pedestrians.

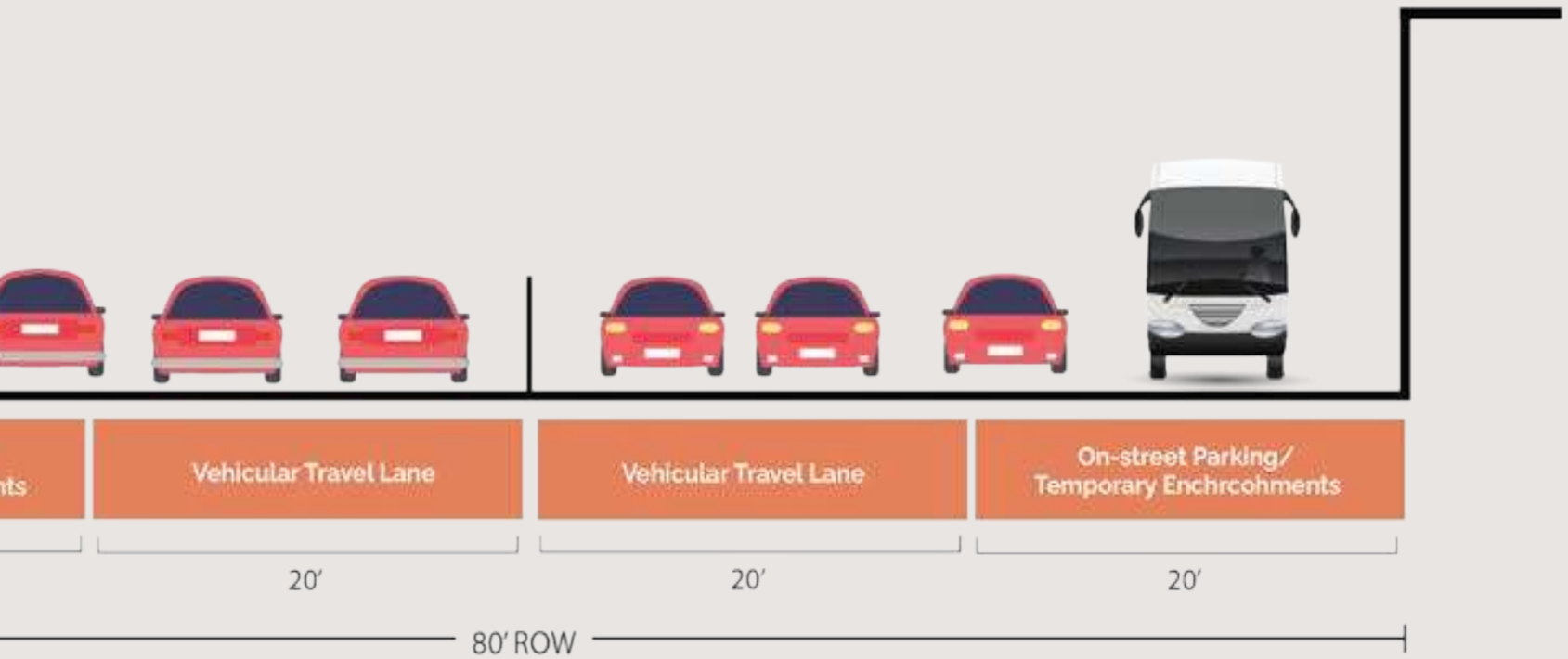


The visual represents the accessibility and road connectivity of Shah Alam Market. Situated between Lohari Gate and Mochi Gate, Shah Alam Market is accessible via Circular Road, which connects all the gates of the walled city. A one-way route originating from Mayo Chowk directly connects to the Shah Alam entrance. The market is predominantly accessed by private vehicles, including cars and motorbikes. Additionally, Shah Alam Market is easily accessible via public transport, and the Orange Line train stations are located nearby.

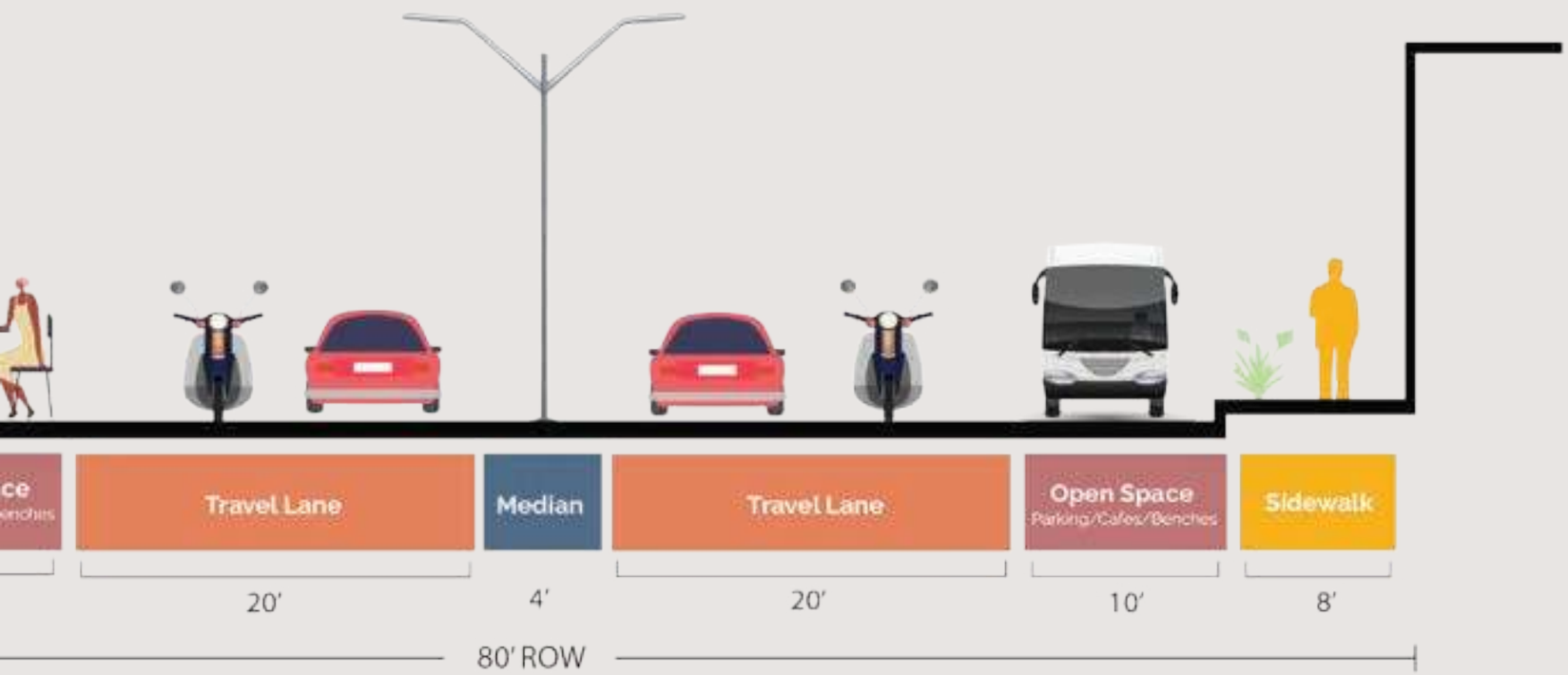
Reclaim

Reclaiming streets refers to initiatives aimed at revitalizing and improving urban streetscapes. This could involve redesigning streets to make them more pedestrian-friendly, adding green spaces, etc. The goal is to make streets more vibrant and accessible, fostering a sense of community. In Shah Alam, we propose repurposing travel lanes to create wider pedestrian spaces, reducing the space for vehicle lanes. Transforming streets into pedestrian-friendly zones, enhancing walkability and safety. The figure shows an existing road cross-section of Shah Alam Market where the right of way is 80 ft, dedicated for vehicular traffic and parking. Activating the street is key to creating vibrant, walkable, and inclusive urban spaces. We propose well-structured sidewalks and public spaces with amenities like benches to encourage pedestrian engagement. Wider sidewalks and plazas with seating and greenery will foster social interaction. Installing benches and other street furniture will create comfortable resting spots. Some street sections may become pedestrian-only zones during specific hours, controlled by bollards or retractable barriers. Outdoor cafes and dining areas can also be established to extend seating onto the sidewalk, creating a lively dining experience.

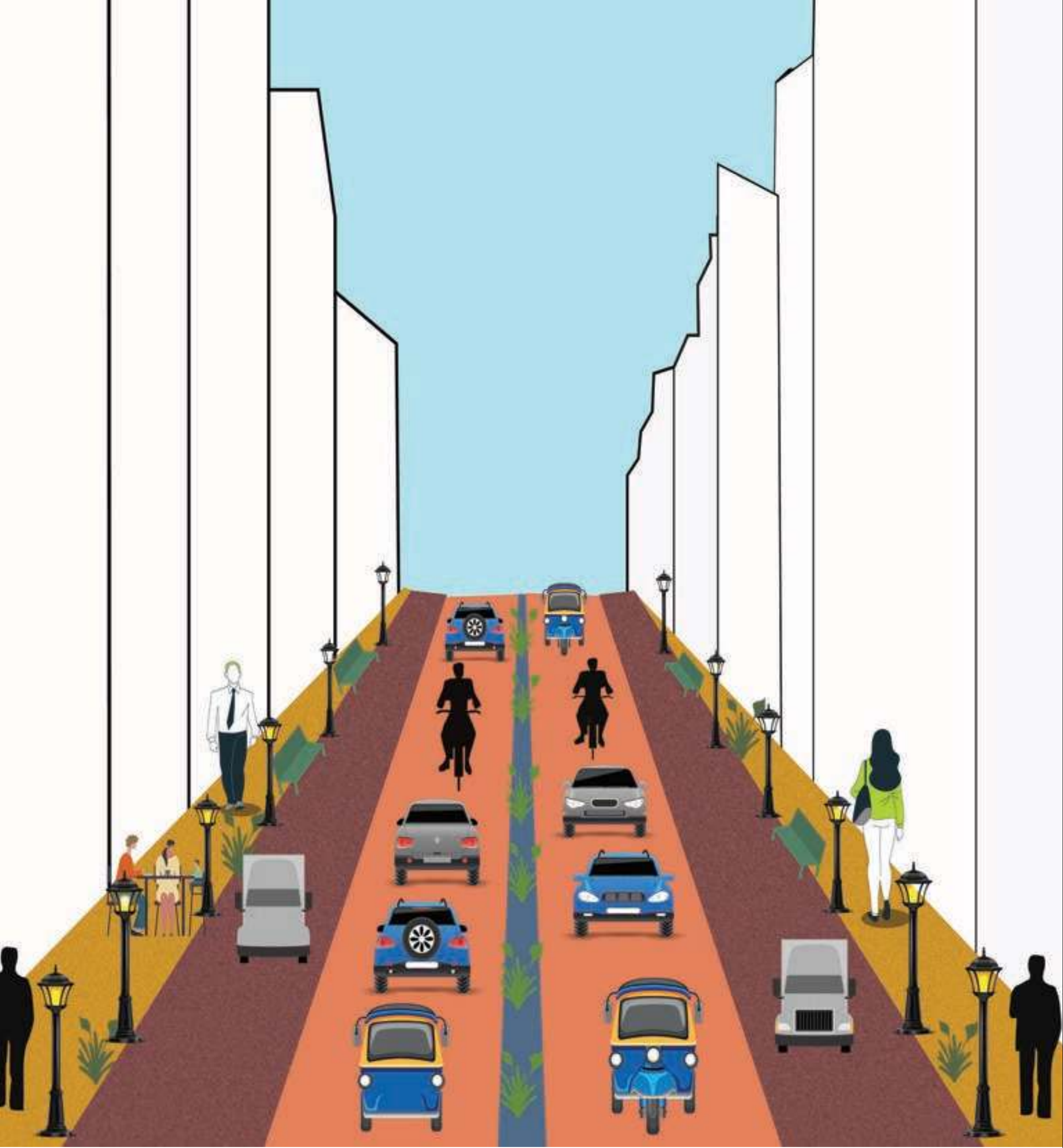


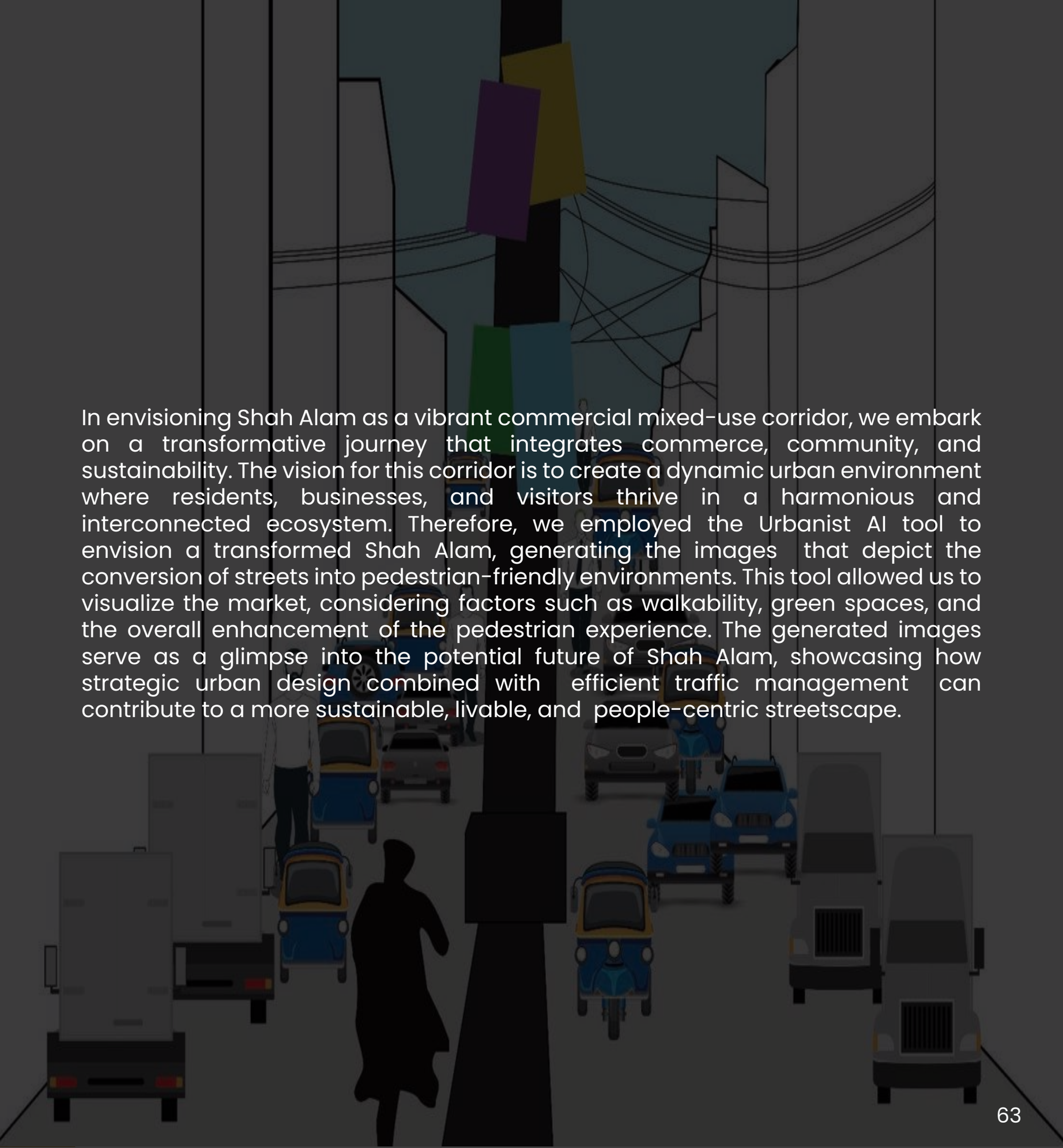


Existing Road Crossection



Proposed Road Crossection





In envisioning Shah Alam as a vibrant commercial mixed-use corridor, we embark on a transformative journey that integrates commerce, community, and sustainability. The vision for this corridor is to create a dynamic urban environment where residents, businesses, and visitors thrive in a harmonious and interconnected ecosystem. Therefore, we employed the Urbanist AI tool to envision a transformed Shah Alam, generating the images that depict the conversion of streets into pedestrian-friendly environments. This tool allowed us to visualize the market, considering factors such as walkability, green spaces, and the overall enhancement of the pedestrian experience. The generated images serve as a glimpse into the potential future of Shah Alam, showcasing how strategic urban design combined with efficient traffic management can contribute to a more sustainable, livable, and people-centric streetscape.

AI-Generated Images for Shah Alam Reimagination

Before


After


Before


After


Before

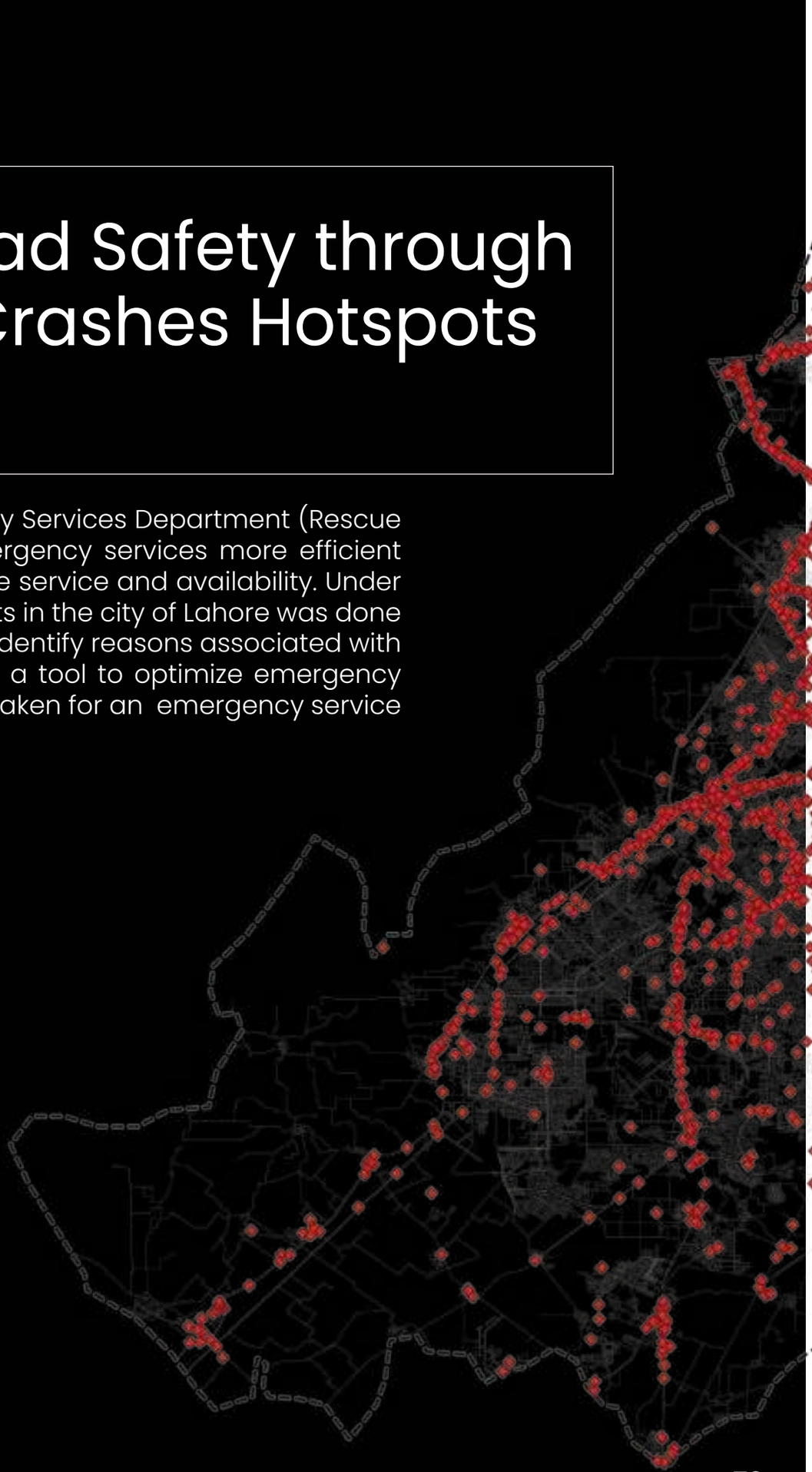

After

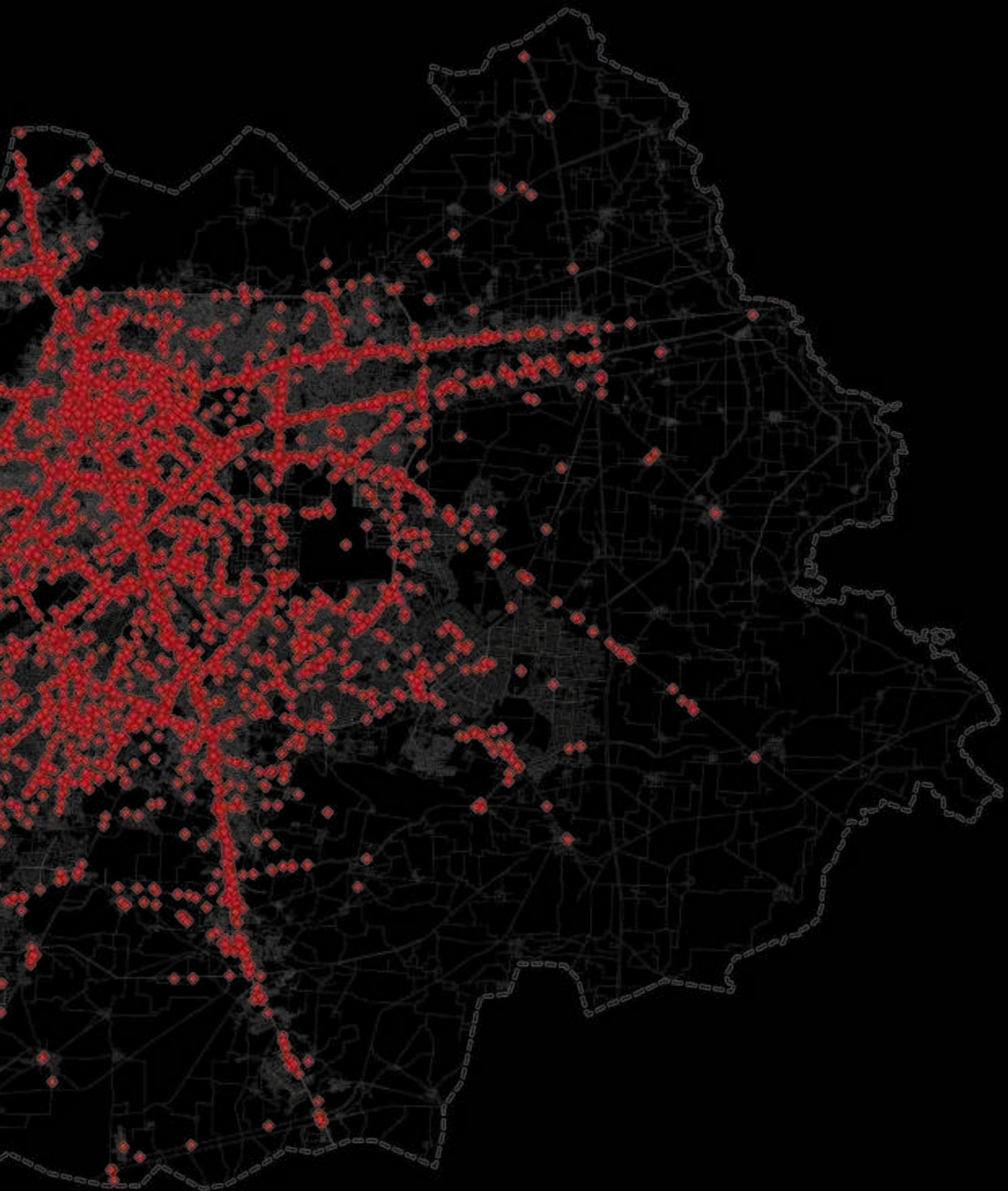

Before


After

Imporving Road Safety through Road Traffic Crashes Hotspots Identification

Incollaboration with Punjab Emergency Services Department (Rescue 1122), CITY aimed at making the emergency services more efficient and reliable by optimizing ambulance service and availability. Under this research, a study of RTC blackspots in the city of Lahore was done by conducting subsequent audits to identify reasons associated with the blackspots. Next was to develop a tool to optimize emergency rescue services by reducing the time taken for an emergency service to arrive at the spot of accident

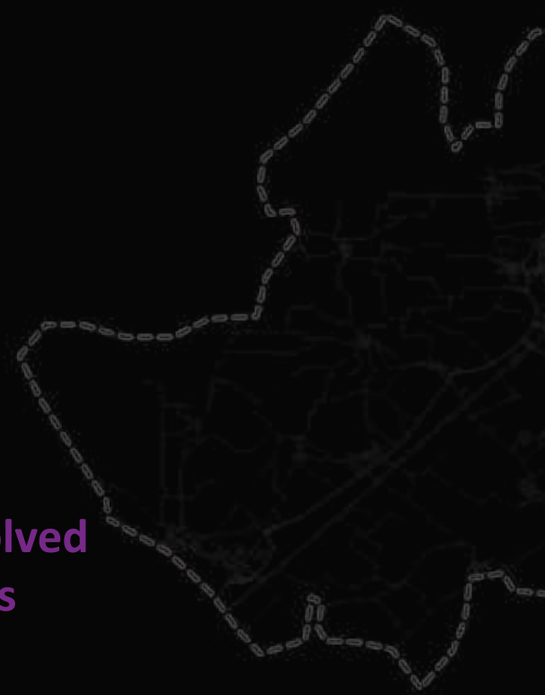




Road Traffic Crash (RTC) of Lahore

Major RTC Blackspots Locations

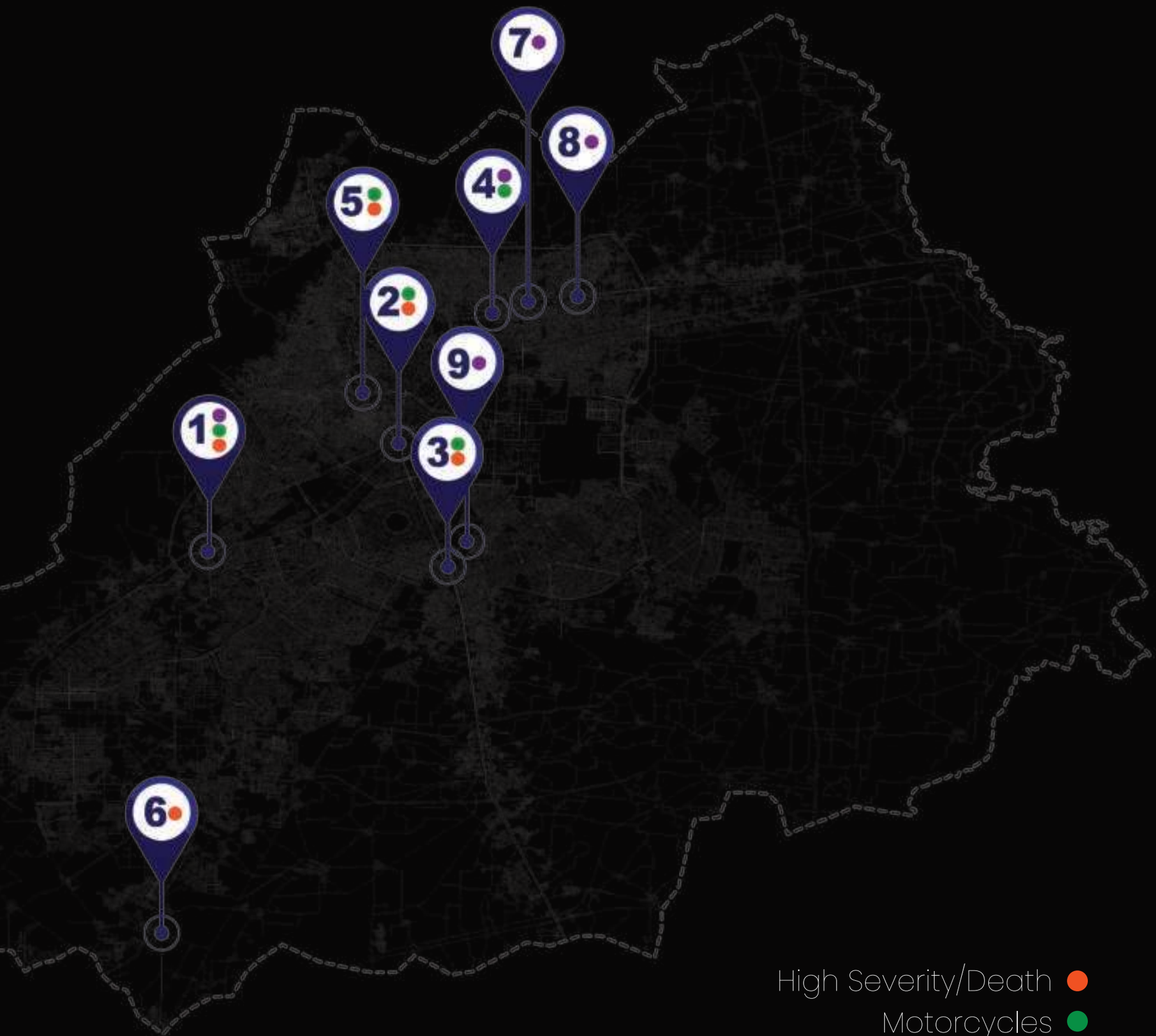
1. Canal Rd (near Thokar Flyover)
2. Canal Rd x Ferozpur Rd
3. Walton Rd (near Qainchi metro bus station)
4. G.T. Rd x Bhogiwal Rd
5. Link Ferozpur Rd
6. Opp.1122 station (near Raiwind Rd)
7. G.T. Rd (opp. Shalamar Garden)
8. G.T. Rd x Bund Road
9. Walton Rd x Khayaban-e-Iqbal Rd



61.34 % Accidents Involved Bikes

32.43% Accidents resulted Shifted to hospital / Death

5.69% Accidents involved Pedestrians



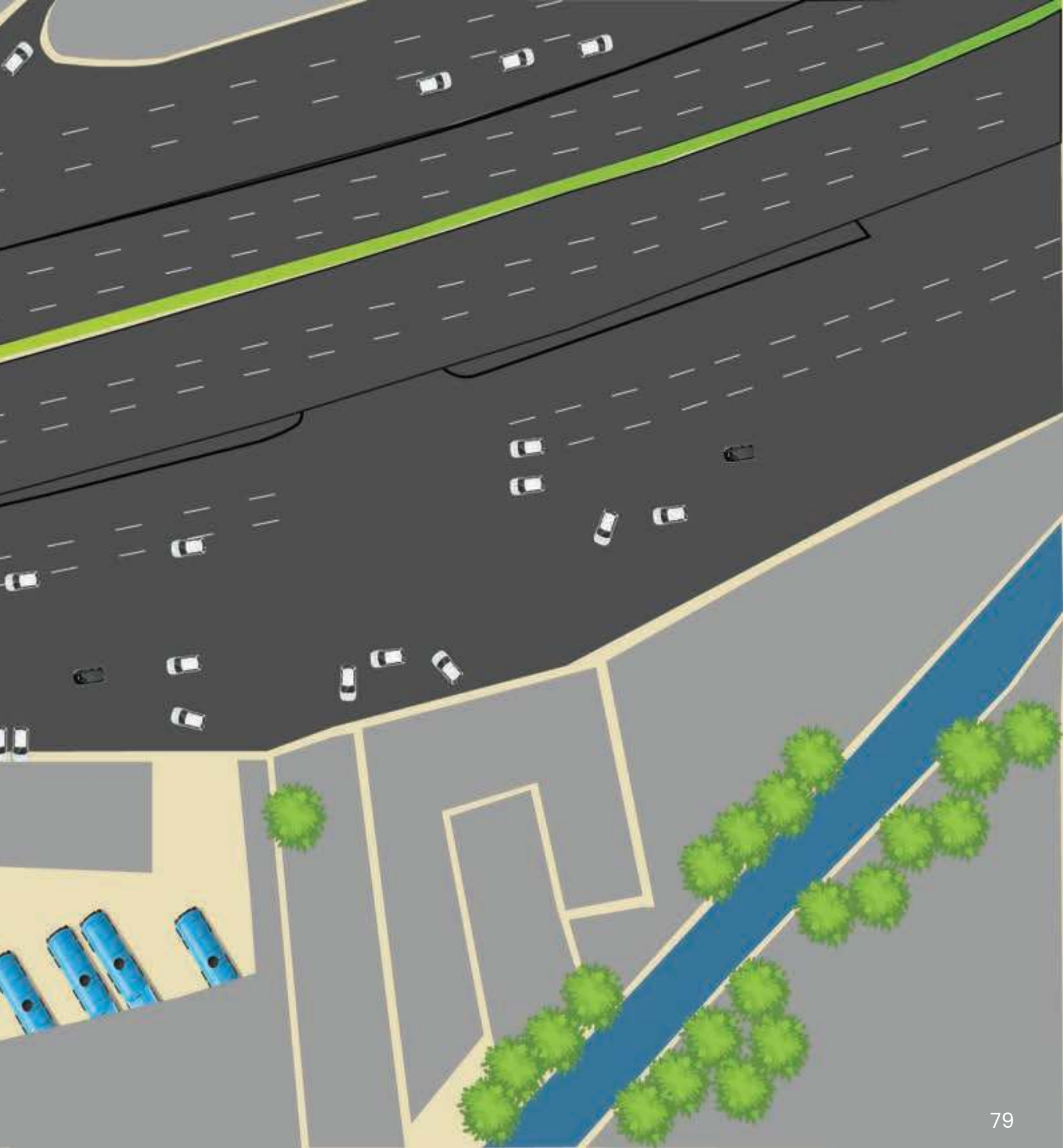
RTC Blackspot (Oct 2022 - Mar. 2023)

REIMAGINING

THOKAR

The research thread on road safety provided us with developing accident hotspots for Lahore. Thokar being the top accident hotspot in Lahore was used as a case study area for developing road safety interventions focused on pedestrian infrastructure and traffic calming measures. Hence focused on interventions, thokar area was reimagined.

Before



After

After reimagining the Thokar area, several key interventions were identified to enhance road safety and create a more pedestrian-friendly environment. These interventions included pedestrian crossings, sidewalks and footpaths, traffic calming measures, public spaces and greenery, and street lighting.

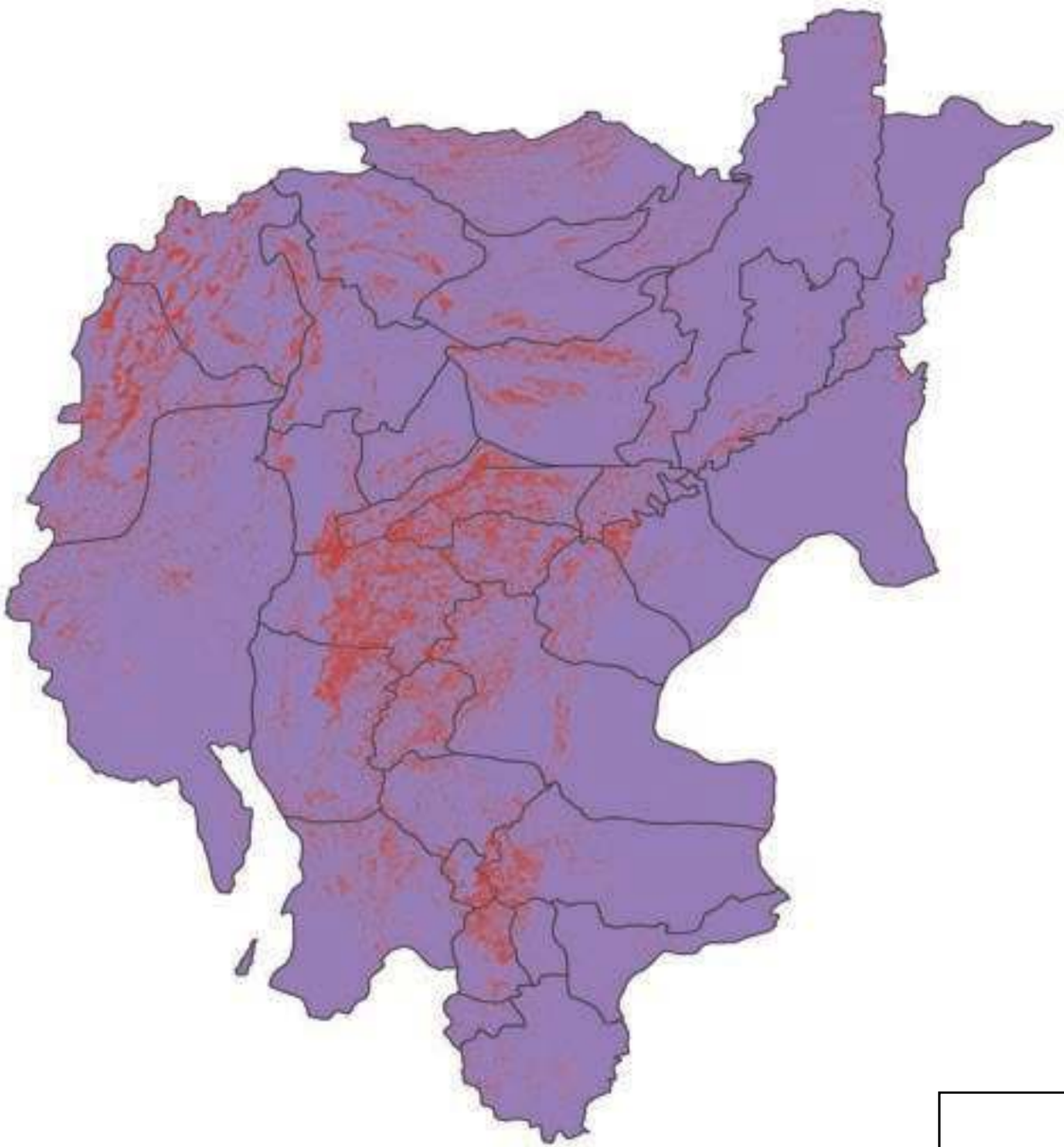
Before

After

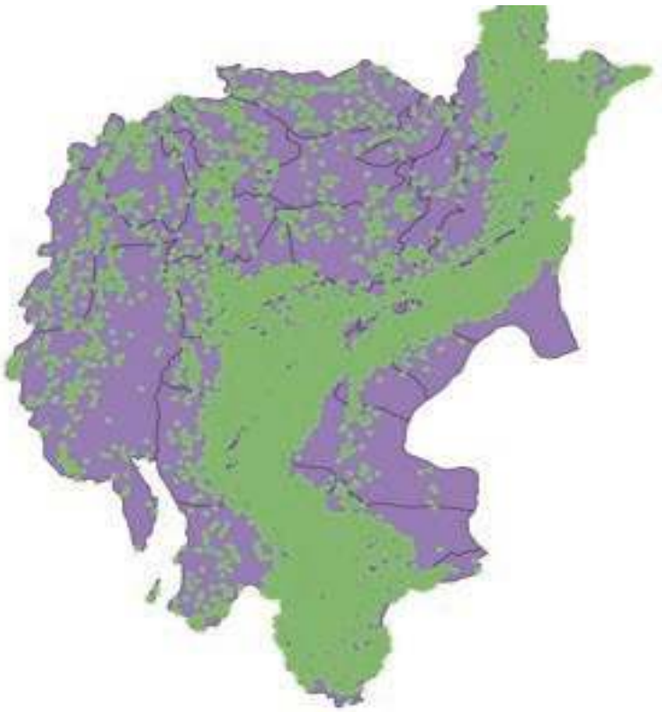
Visualizing Flood Impacts

To inform effective disaster management policies, CITY developed a tool that uses open-source data for spatial impact assessment of floods on population and infrastructure. A pilot study was done for Sindh, Pakistan to demonstrate the impacts of the devastating floods of 2022. Open-source imagery of Sentinel and Landsat (both optical and SAR) were used to locate the flooded regions. On the other hand, th open-source WorldPop population data and the Open-Street-Maps road network data were used to measure the affected population and roads.

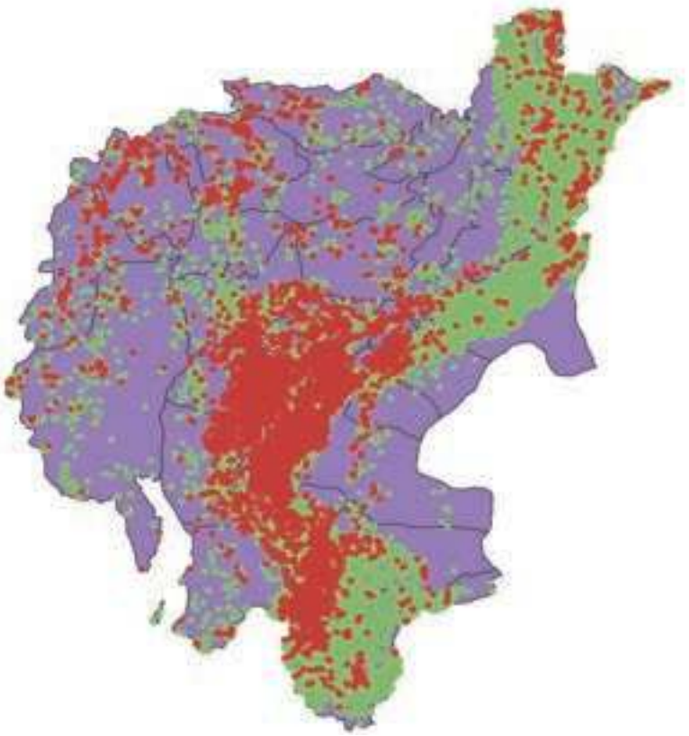
The use of open-source datasets makes the methodology replicable for any region of the country.



(a) Flood mapping in Sindh using Sentinel and Landsat imagery (August 2022)

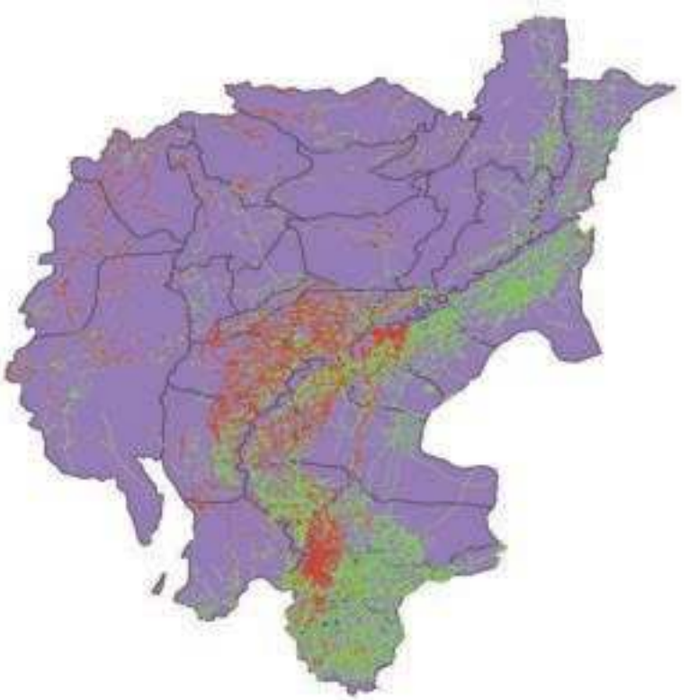


(b) Sindh population distribution as per WorldPop



(c) Affected population (in red)

(d) Road network from Open Street Maps.



(e) Affected roads (in red)

Overall results indicated that almost 31% of Sindh's population and 1500 km of the road network were impacted by the 2022 floods. The worst impacted district was Jakobabad.

Detecting Tree Canopy and Green Spaces (Islamabad)

Rooted in Data: Enhancing Urban Greenery for a Sustainable Future

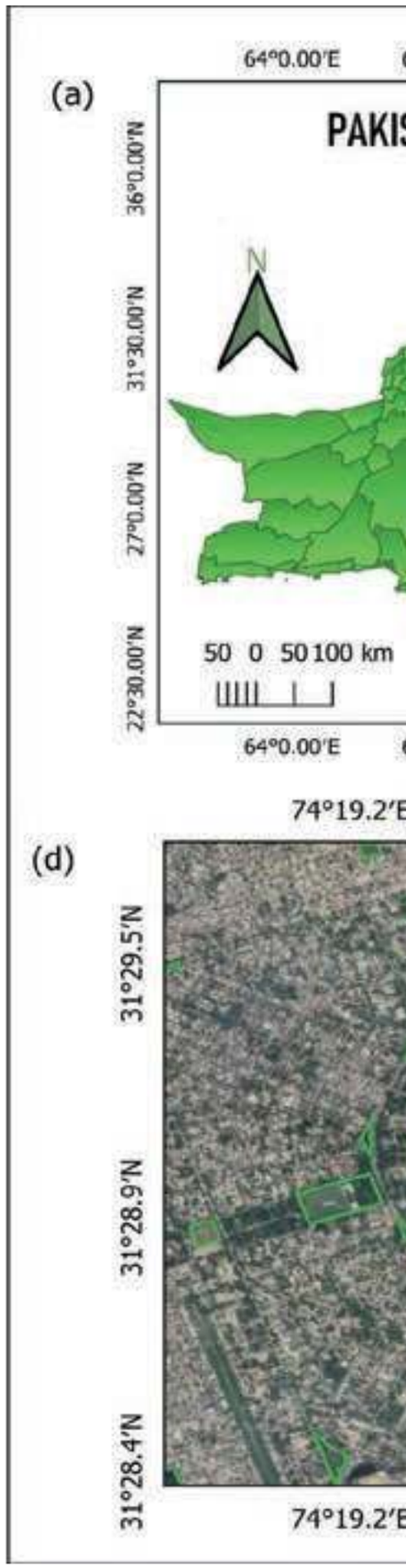
The detection of green spaces allows for comprehensive studies on their impact on Land Surface Temperatures (LSTs) and other environmental factors, including air quality, over time. By analyzing these detected green spaces, we can better understand their influence on urban microclimates and environmental health. This data empowers us to plan for sustainable cities by making informed decisions regarding the scale, location, and quality of green spaces that need to be introduced. To advance our understanding and management of urban green spaces using cutting-edge methods and technology we detected urban green spaces by utilizing remote sensing techniques and advanced deep learning models, creating a comprehensive framework for cities across Pakistan. By extracting satellite images from Google Earth spanning the last ten years for the F7 Sector in Islamabad, we were able to create a comprehensive dataset. We annotated a subset of these images and applied extensive data pre-processing and augmentation to generate multiple datasets.

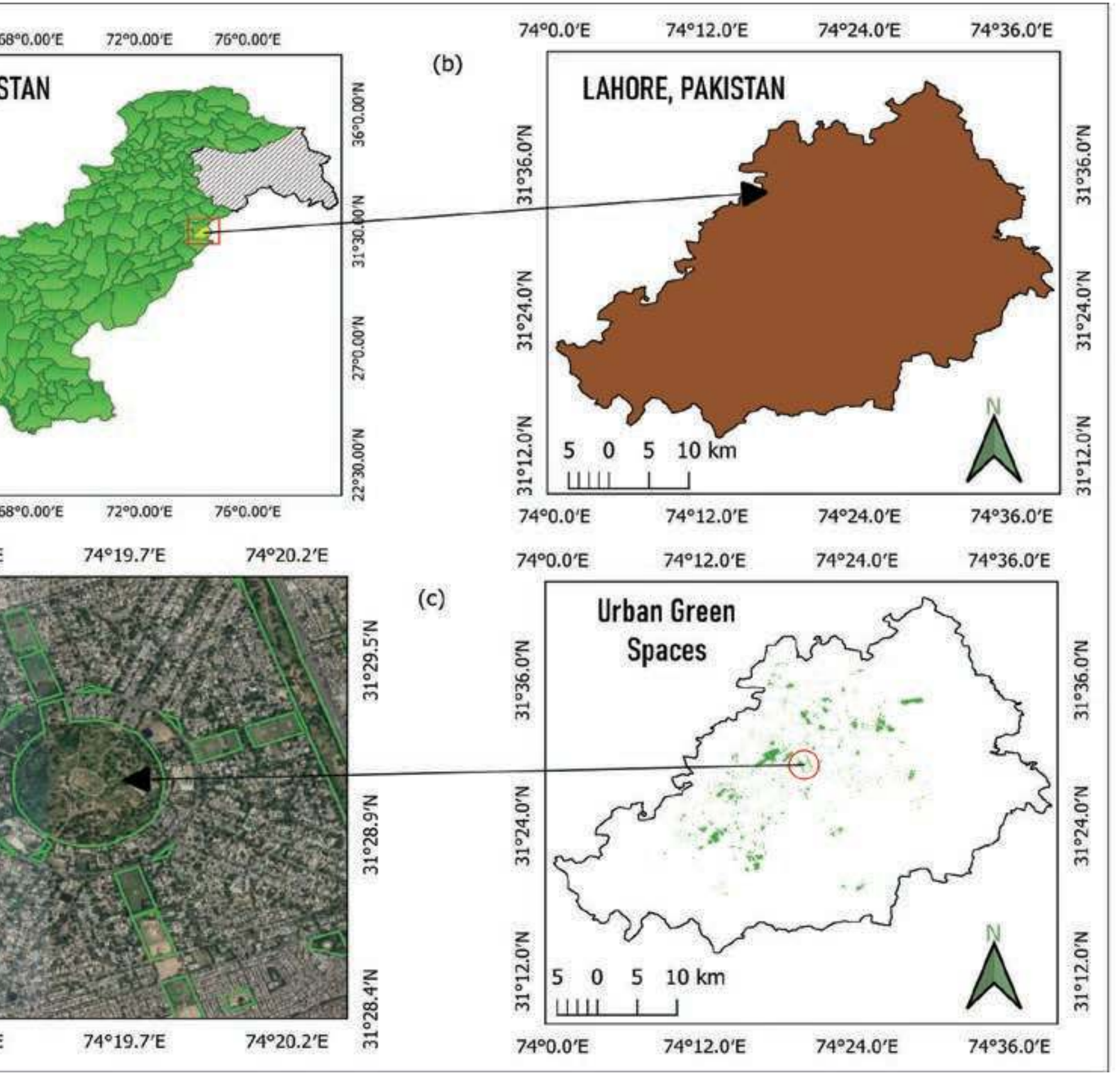
Estimating Tree Cover In Urban Areas Using Satellite Imagery

Accurately estimating tree cover in urban environments is crucial for informed urban planning and management. Our study of tree cover estimation study opened new possibilities for optimizing green spaces in cities, leading to improved sustainability and a healthier environment. By employing a multi-spectral random forest classifier with carefully selected features and a built-up region filter, we achieved remarkable results. Our method outperformed conventional random forest classifiers and even advanced techniques like the European Space Agency (ESA) WorldCover 10m 2020 product and DeepLabv3 deep learning architecture. The team put their approach to the test using Sentinel-2 satellite imagery of the at Lahore University of Management Sciences (LUMS) campus. The findings were impressive, highlighting the accuracy and effectiveness of our methodology.

Green spaces' connections with LST

Urban Green Spaces (UGSs) play a crucial role in mitigating the adverse impacts of climatic phenomena, including extreme weather events, heatwaves, and urban heat islands. To investigate the impact of UGSs, we conducted research that assessed their cooling effects on the urban thermal environment using a combination of remote sensing and statistical techniques. We measured the cooling effects of 1,179 UGSs in Lahore, Pakistan (as shown in figure), using quantifiable parameters and examined the spatial indicators that influence their cooling efficacy. Our findings from the thermal and greenness assessment revealed that spatial features such as vegetation density and proximity to nearby green spaces significantly impact the cooling capacity of UGSs. Given the severe health risks posed by urban heat islands, particularly in megacities, this research aims to inform governments and urban planners about the current state of UGSs and provide insights to improve their cooling capacity.

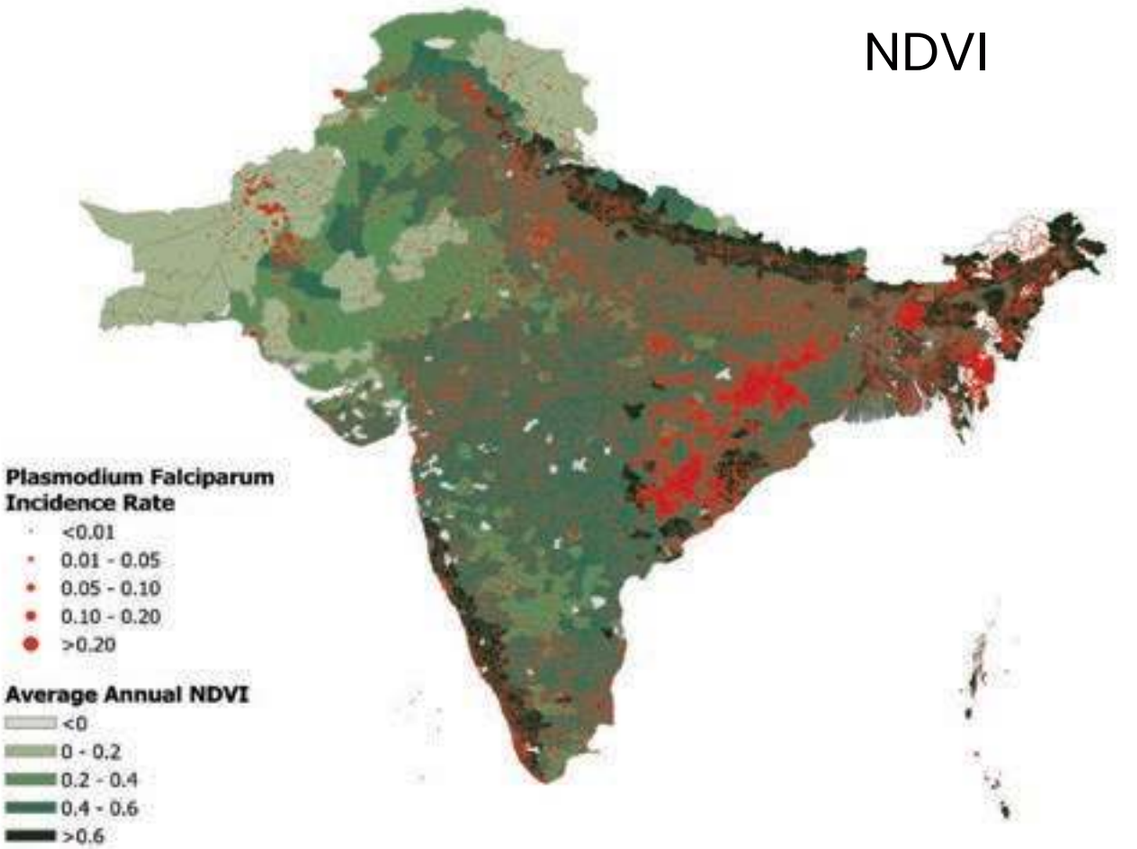


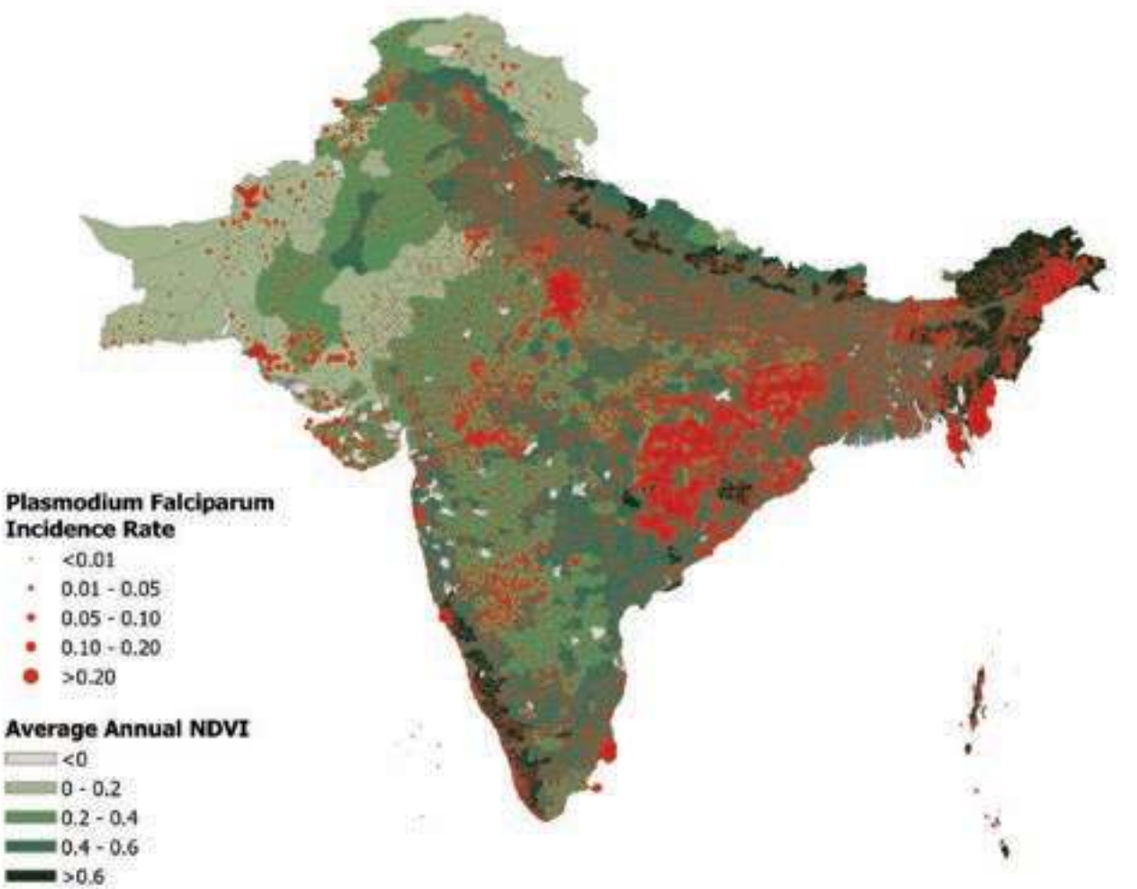

68°0.00'E
72°0.00'E
76°0.00'E
STAN
36°0.00'N
31°30.00'N
27°0.00'N
22°30.00'N
(b)
74°0.0'E
74°12.0'E
74°24.0'E
74°36.0'E
LAHORE, PAKISTAN
31°36.0'N
31°24.0'N
31°12.0'N
5 0 5 10 km
N
74°19.7'E
74°20.2'E
(c)
31°29.5'N
31°28.9'N
31°28.4'N
Urban Green Spaces

Malaria Outbreaks Predictions

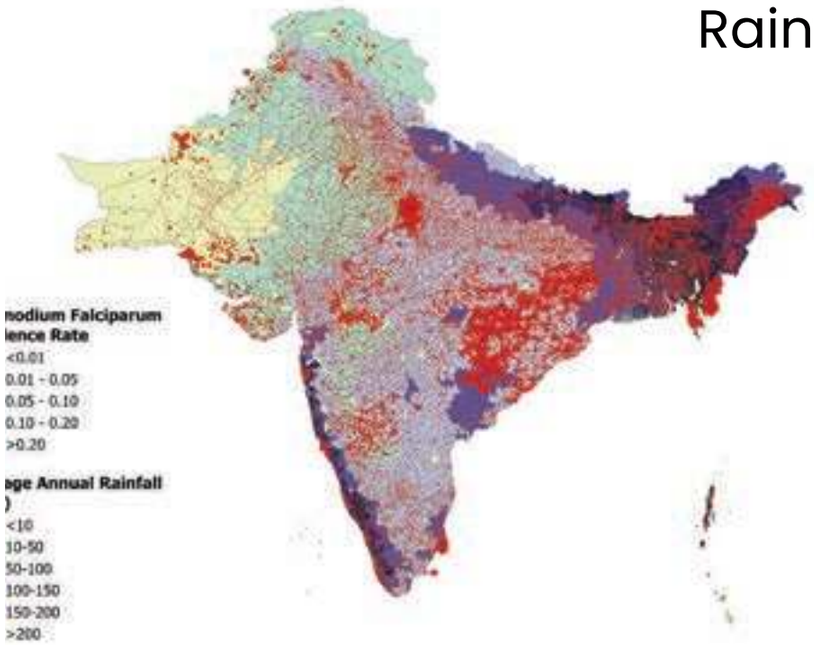
We AI to improve malaria prediction by integrating geo-referenced environmental factors with Health survey datasets.
Country-specific deep learning based models were produced for Bangladesh, India, and Pakistan with prediction accuracy of 80% for districts in Pakistan. The research aims to significantly improve the ability to predict and combat malaria outbreaks, especially in resource limited settings where accurate and real-time forecasting can save lives.

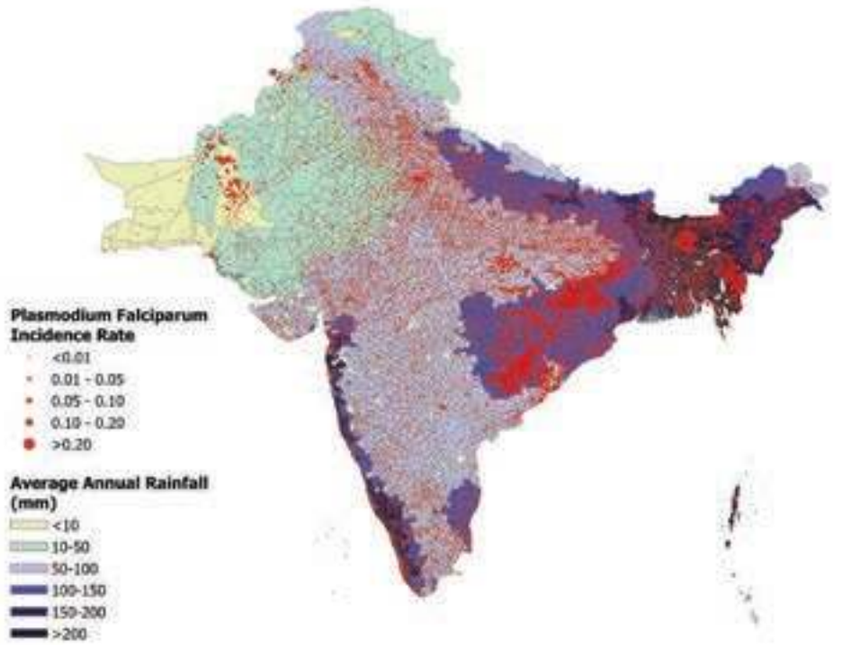
NDVI



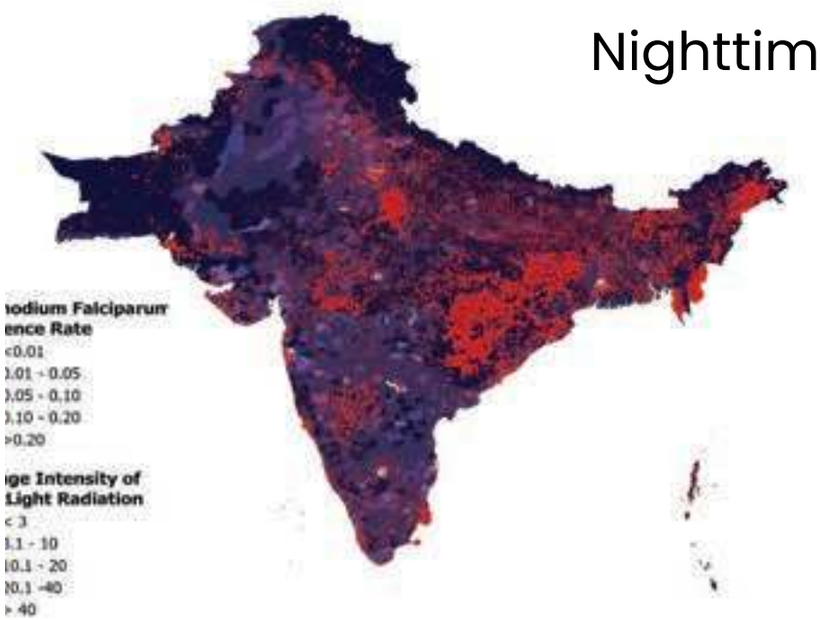


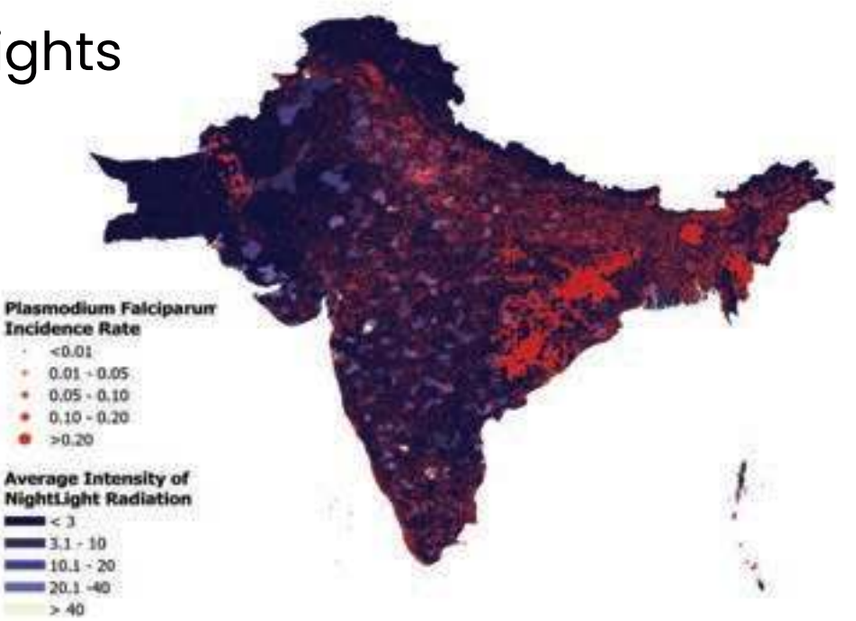
Rainfall





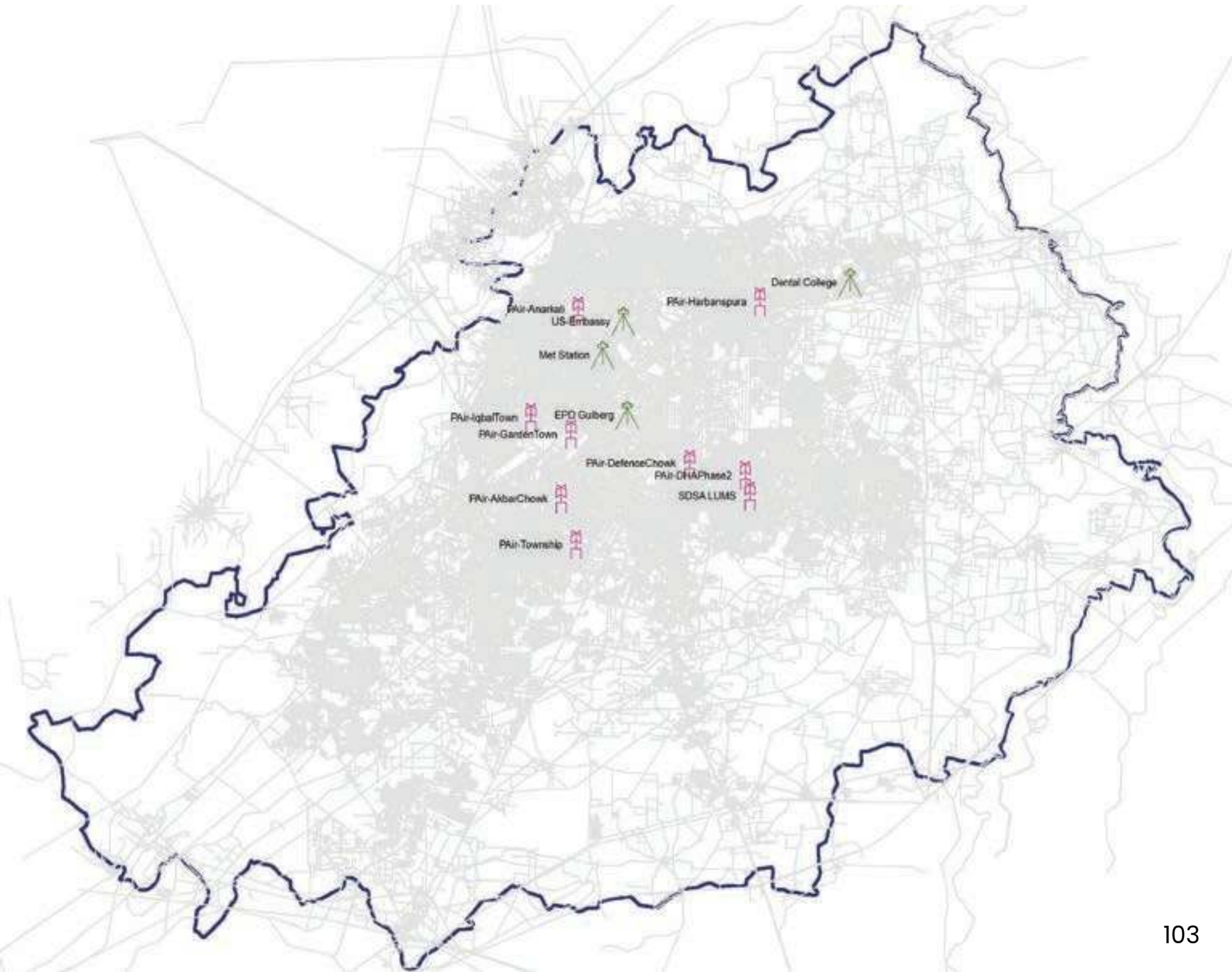
Nighttime Lights



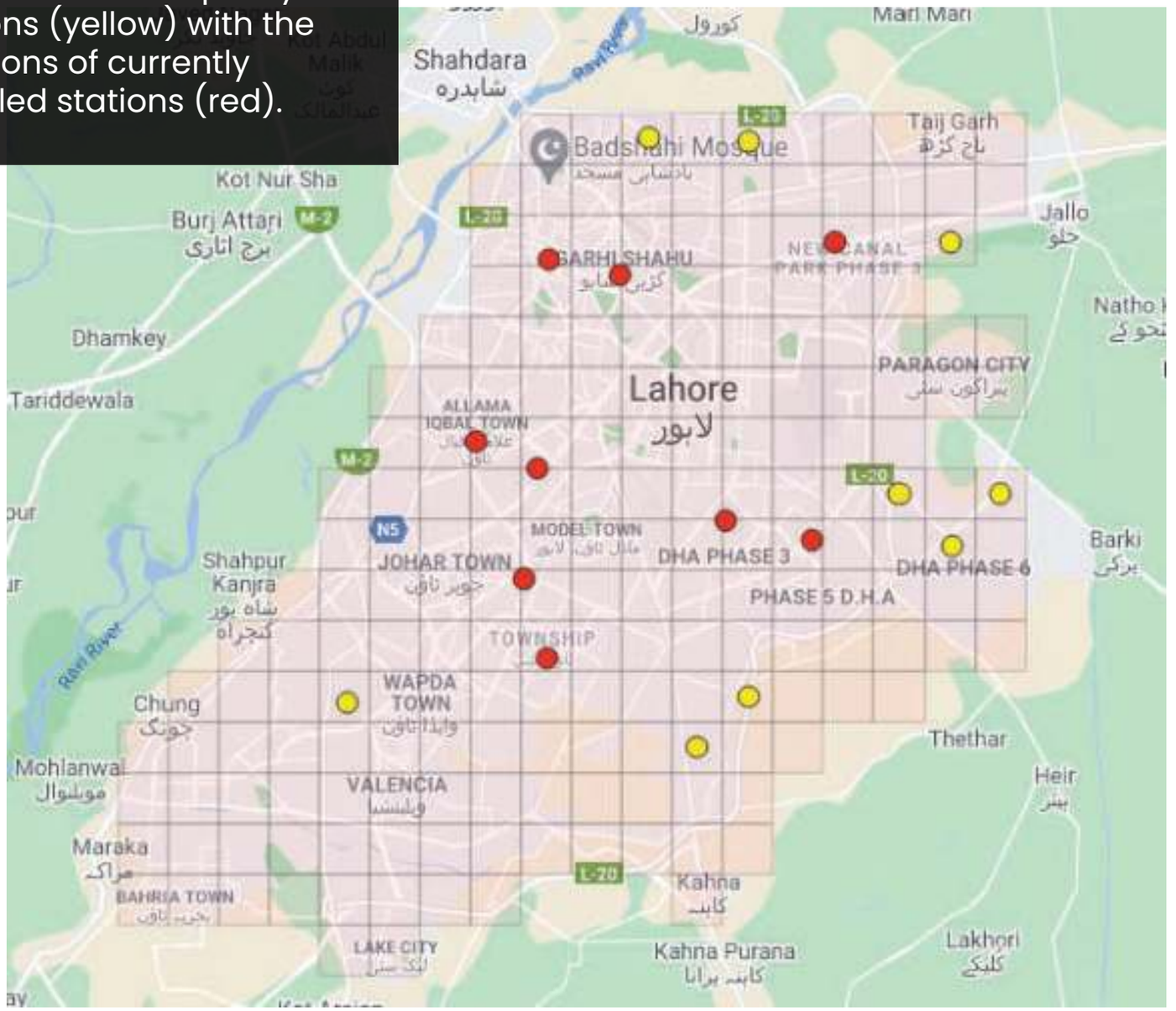


Monitoring Air Quality

Air pollution has emerged as a significant issue in the subcontinent. Multiple Pakistani cities have made the list of the world's most polluted cities in recent years. According to the “2023 World Air Quality Report” published by IQAir, a Swiss air quality monitoring organization, Lahore ranks as the world's fifth most polluted city, and the most polluted mega-city. The annual pollution levels at 99.5 micrograms per cubic meter (ug/m3) stand at 20 times higher than WHO guidelines!. The current state of Lahore's air quality puts the lives of the city's 11 million residents in grave danger. For the most part of the last three years, the air quality index (AQI) stayed between poor to severe.



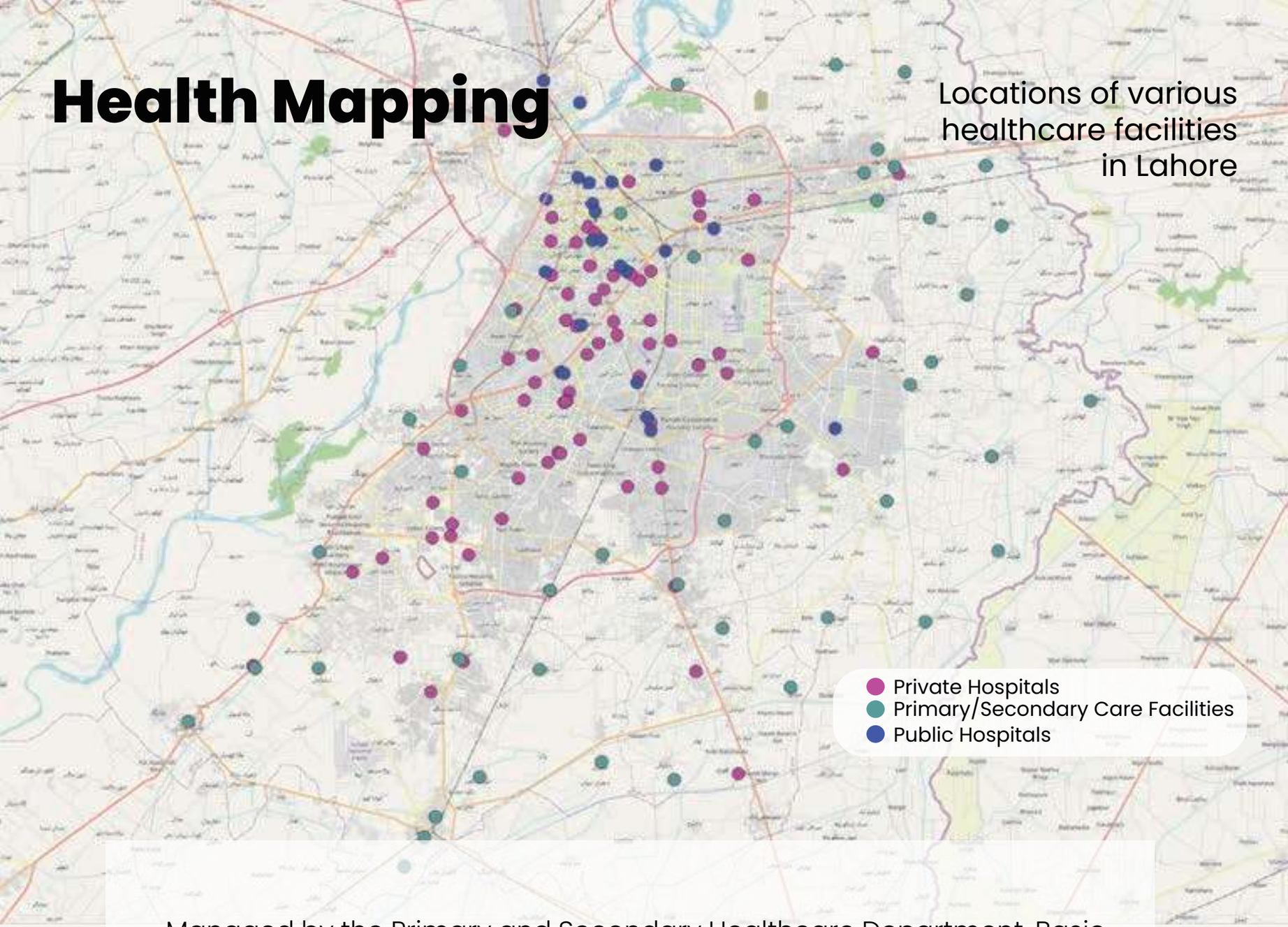
Recommended locations for installation of air quality stations (yellow) with the locations of currently installed stations (red).



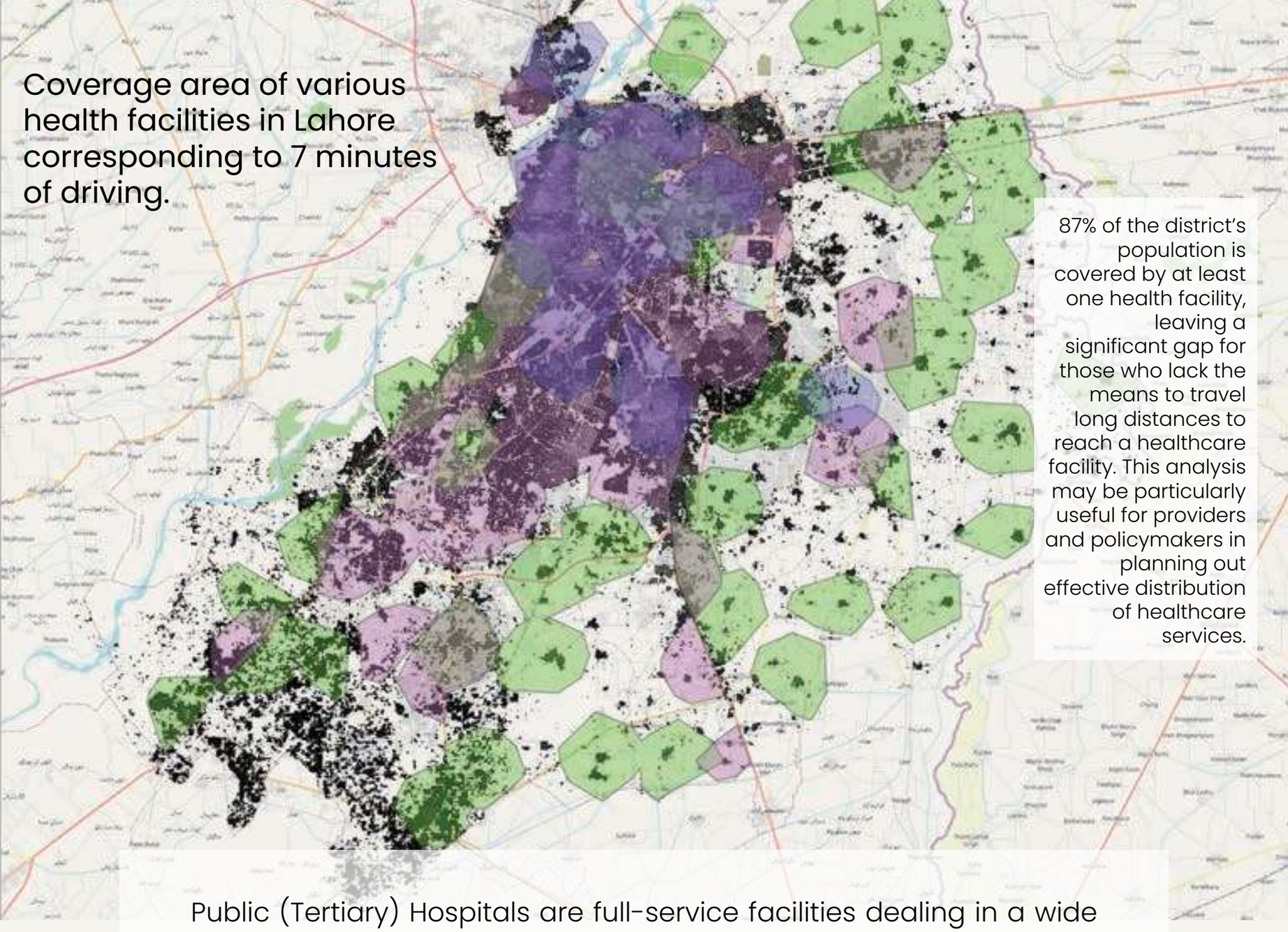
This research project on Air Quality Monitoring focused on the discrepancies and anomalies between the various air monitoring sensors' results (in Lahore) through a data driven approach and suggested affordable equipment for monitoring air quality and finally, selected the best locations for equipment installation for a fair representation of air quality. Our work focused on developing a data-driven location recommendation system using historical air quality measurements, as well as locations of traffic congestion hotspots, industries, and existing air quality measurement stations.

Health Mapping

Locations of various healthcare facilities in Lahore



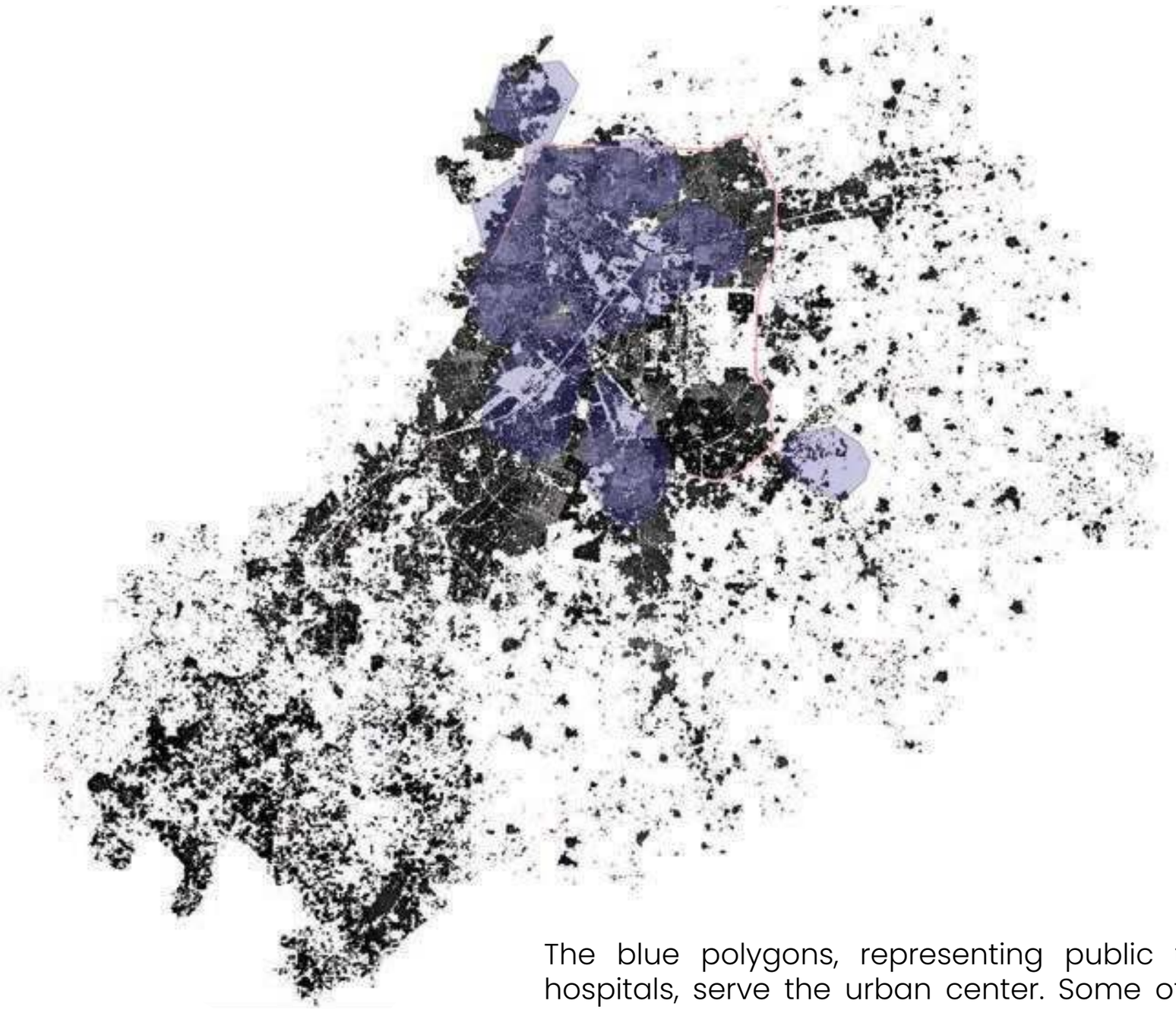
Managed by the Primary and Secondary Healthcare Department, Basic Health Units (BHUs) and Rural Health Centers (RHCs) serve has the first point of contact for medical assistance, especially in rural and semi urban settlements. These facilities often lack expensive machinery such as MRIs or doctors trained in specialized areas such as neurosurgery. They are, however, key for public health programs such as immunization and awareness campaigns, and in providing urgent healthcare such as maternal care, trauma care and referrals to specialized facilities when the need arises.



Coverage area of various health facilities in Lahore corresponding to 7 minutes of driving.

87% of the district's population is covered by at least one health facility, leaving a significant gap for those who lack the means to travel long distances to reach a healthcare facility. This analysis may be particularly useful for providers and policymakers in planning out effective distribution of healthcare services.

Public (Tertiary) Hospitals are full-service facilities dealing in a wide range of specializations from burn wards to oncology to neurosurgery. These are naturally, larger in size and available staff and serve a large segment of the population. Due to budget constraints, some specialized services are distributed among these hospitals to avoid spreading equipment and maintenance costs and to prevent hospitals from being too crowded, Private hospitals are often either businesses with a profit motive or non-profit that receive funding from private donors and trusts. These facilities serve to fill the gap in the market that publicly funded facilities are unable to fulfill.

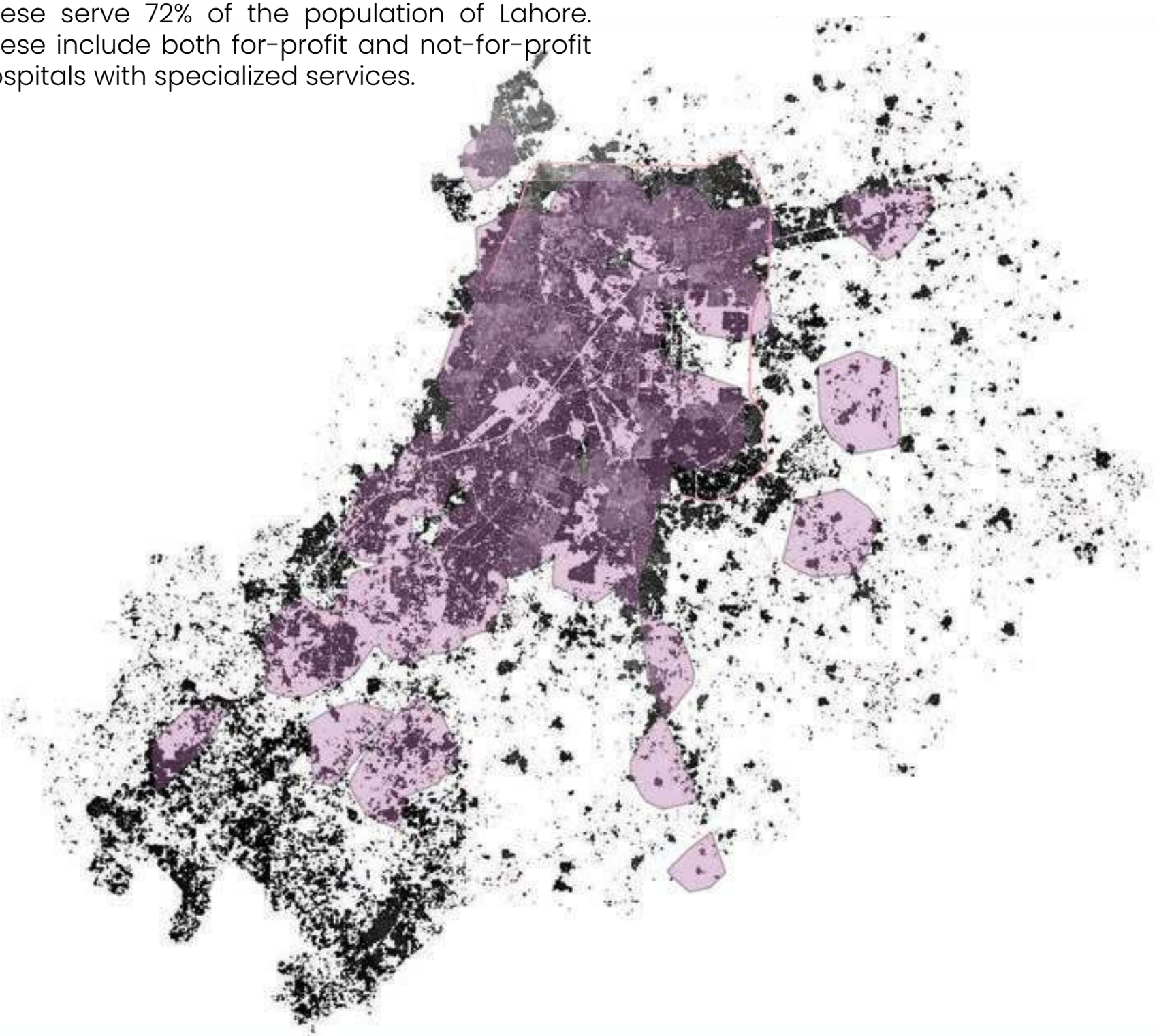


The blue polygons, representing public tertiary hospitals, serve the urban center. Some of these hospitals are more than a century old, hence their placement. 50% of the city's population is served by public hospitals. These hospitals also include specialized treatment centers for diseases such as cancer (in Mayo hospital and Jinnah hospital), Neurology (in General Hospital), and respiratory diseases (in Gulab Devi hospital) among others.

Population Coverage Public Hospitals

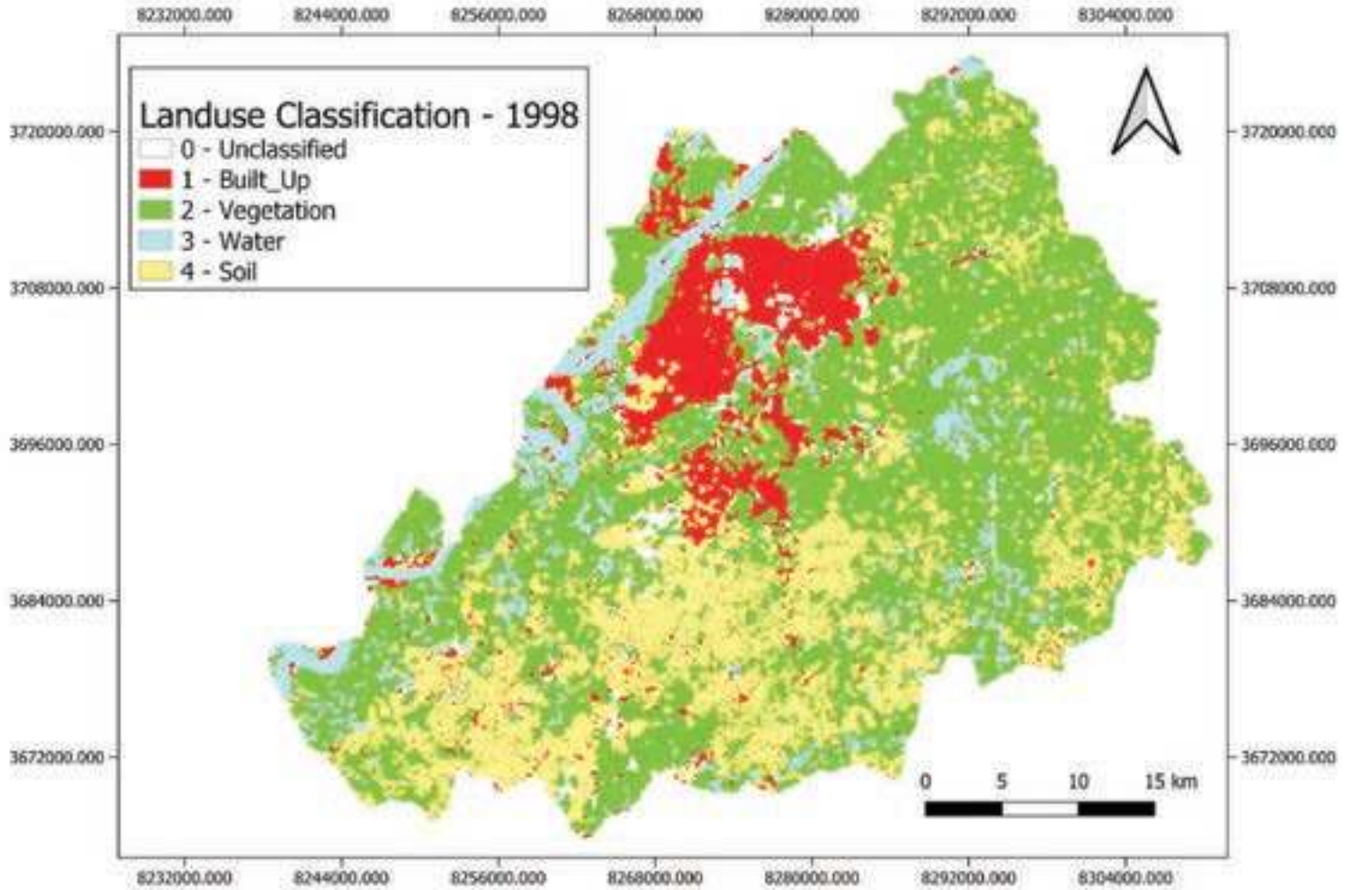
Population Coverage Private Hospitals

The remainder and the largest segment by area and population coverage is private hospitals. These serve 72% of the population of Lahore. These include both for-profit and not-for-profit hospitals with specialized services.



Classifying Land Cover

This research focused on conducting land cover classification by utilizing advancements in remote sensing technology and satellite data. Land cover, defined as the categorization of land units based on their properties or suitability for specific purposes, plays a pivotal role in various analyses and applications. In our study, we aimed to classify land into four distinct categories: Built-up, Vegetation, Water, and Soil. This classification serves multiple purposes, including tracking changes in living patterns within countries or cities over time. Furthermore, it can act as a covariate to assess the effects of changes in living standards and quality. For instance, when combined with Land Surface Temperature data, it allows us to examine the influence of temporal changes in land cover on urban heating patterns. Additionally, each land cover class can serve as a covariate in numerous studies. For example, the water class can help quantify water availability for different agricultural fields. This comprehensive land cover classification not only aids in understanding land dynamics but also facilitates informed decision-making in resource management and planning processes. The land use classification maps for Lahore in the years 1998 and 2021 provide a visual representation of how the city's land cover has evolved over time. By comparing these maps, we can observe significant changes in land use with respect to different classes.


Landuse Classification - 1998
0 - Unclassified
1 - Built_Up
2 - Vegetation
3 - Water
4 - Soil
8232000.000
8244000.000
8256000.000
8268000.000
8280000.000
8292000.000
8304000.000
3720000.000
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3684000.000
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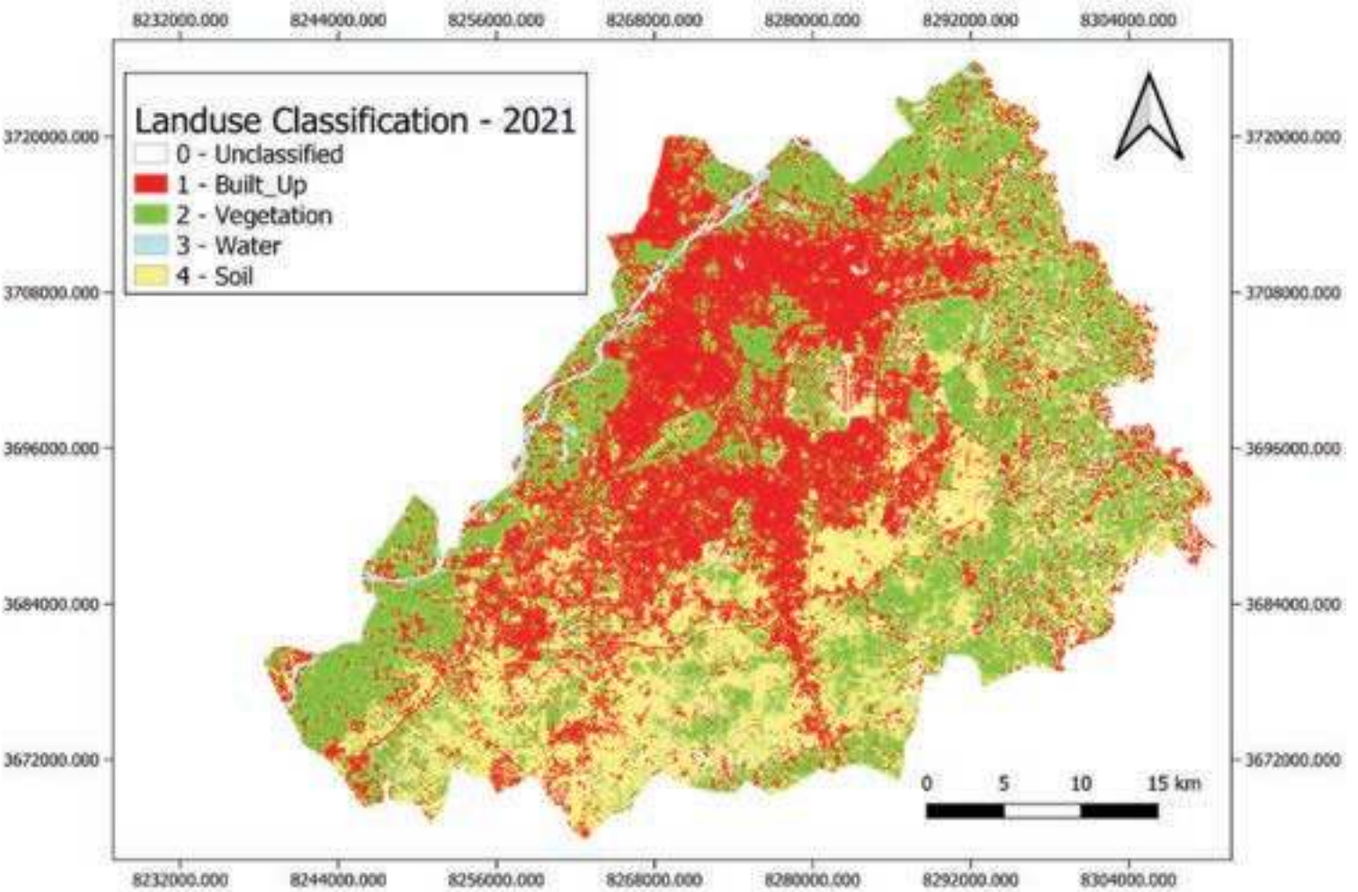
0 5 10 15 km


Landuse Classification - 2021
0 - Unclassified
1 - Built_Up
2 - Vegetation
3 - Water
4 - Soil
8232000.000
8244000.000
8256000.000
8268000.000
8280000.000
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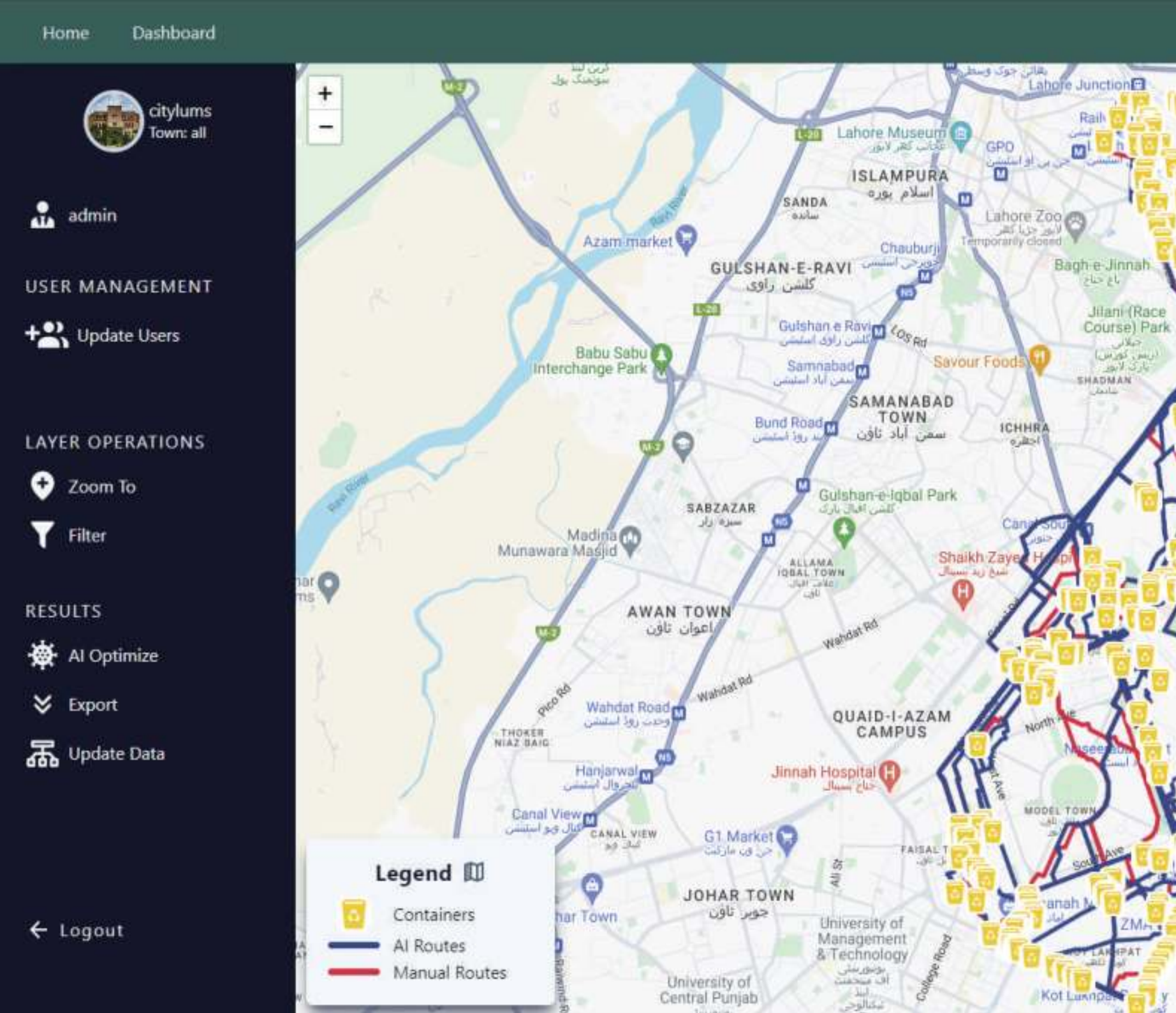
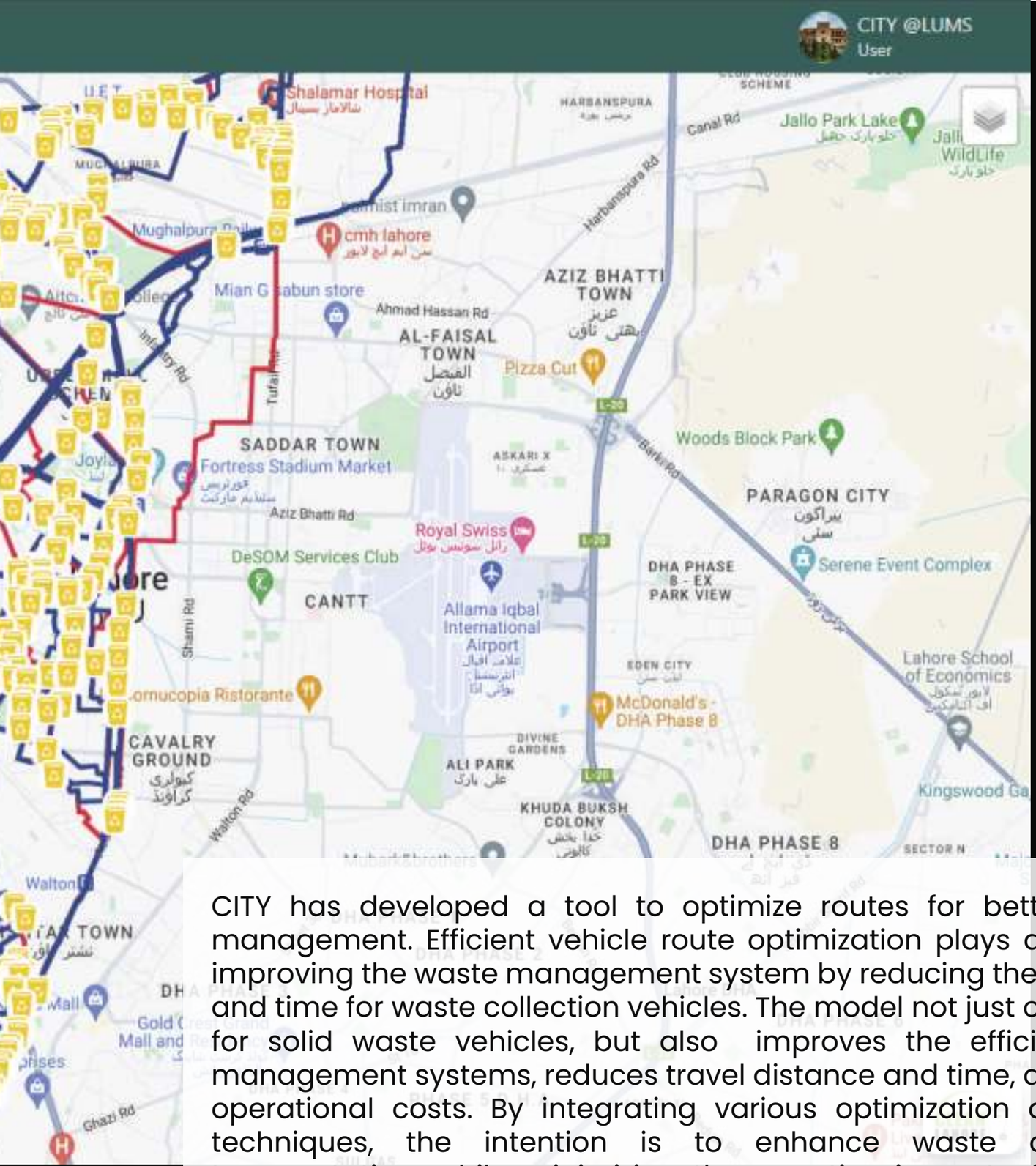


Optimizing Solid Waste Management Vehicle Routes



CITY has developed a tool to optimize routes for better solid waste management. Efficient vehicle route optimization plays a crucial role in improving the waste management system by reducing the travel distance and time for waste collection vehicles. The model not just optimizes routes for solid waste vehicles, but also improves the efficiency of waste management systems, reduces travel distance and time, and minimizes operational costs. By integrating various optimization algorithms and techniques, the intention is to enhance waste collection and transportation, while minimizing the negative impact of waste on the environment and public health. The ultimate goal is to create sustainable waste management systems that are cost-effective, efficient, and responsive to the needs of urban areas. The model has sucessfully been developed for Lahore Waste Management Company, our esteemed collaborators.

2020

CITY partnered with atomcamp in organizing the AI and Data Science for City Management event in Islamabad.

On the eve of World Environment Day, CITY participates in a panel discussion hosted by IEEE GRSS Lahore Chapter at ITU.

CITY Achieves n

CITY signs MOU with Walled City of Lahore Authority

CITY organizes a two-day workshop on AI for City Management for public-sector officials from across Pakistan

Dr. Momin Uppal representd CITY at LUMS as a panelist in a dialogue on on Big Questions in Climate Change: How to resolve climate change at the lowest cost? conducted by IEEE GRSS Lahore Chapter at Information Technology University.

CITY delivers training on "GIS-based tools for Resource Allocation and Route Planning of Waste Collection Vehicles" at the Department of Urban and Regional Planning, University of Peshawar.

CITY participates in World Town Planning Day organised by Sheher Saaz Private Limited.

ew heights

CITY Organizes World Cities Day Event on October 30th, 2023

CITY Organizes dynamic capacity-building workshop on data-driven tools for enhancing road safety for Punjab Emergency Services Department (RESCUE 1122).

Building Resilient Cities for a Healthy Urban Future

04 FOSTERING URBAN WELLBEING

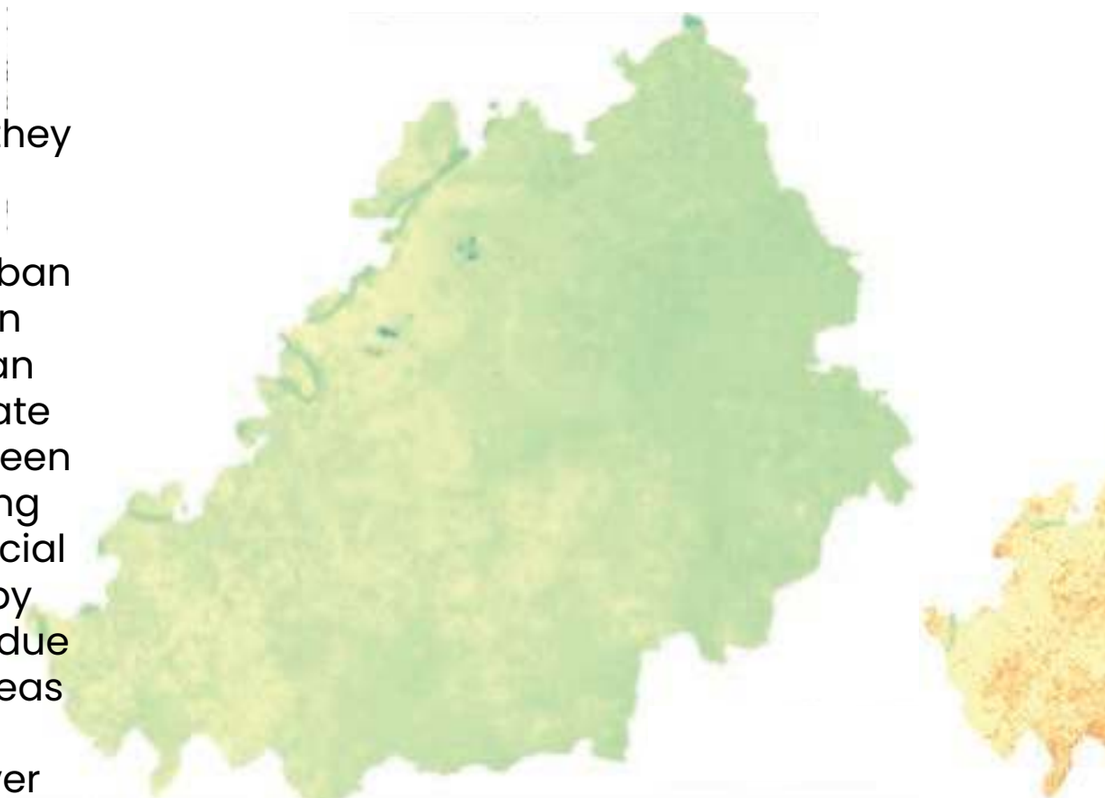
Urban environment and Health

Through the use of technology, CITY has been tackling some of the pressing challenges facing urban well-being. Research threads include, but are not limited to, air quality monitoring, optimizing resource allocation for solid waste management, automated detection of green spaces using satellite imagery, investigating the links of urban green spaces with land surface temperatures, analyzing disease prevalence, and investigating population coverage of health-care facilities in Lahore.


Detecting Tree Canopy and Green Spaces
Monitoring Air Quality
Identifying Public Urban Sentiments
Smartly Allocating Solid Waste Management Bins
Quantifying Household Emissions
Optimizing Solid Waste Management Vehicle Routes
Visualizing Flood Impacts
Urban Green Spaces Connection with LSTs
Malaria Outbreak Predictions
Analyzing Temporal Evolution of LSTs

Analyzing Temporal Evolution of LSTs

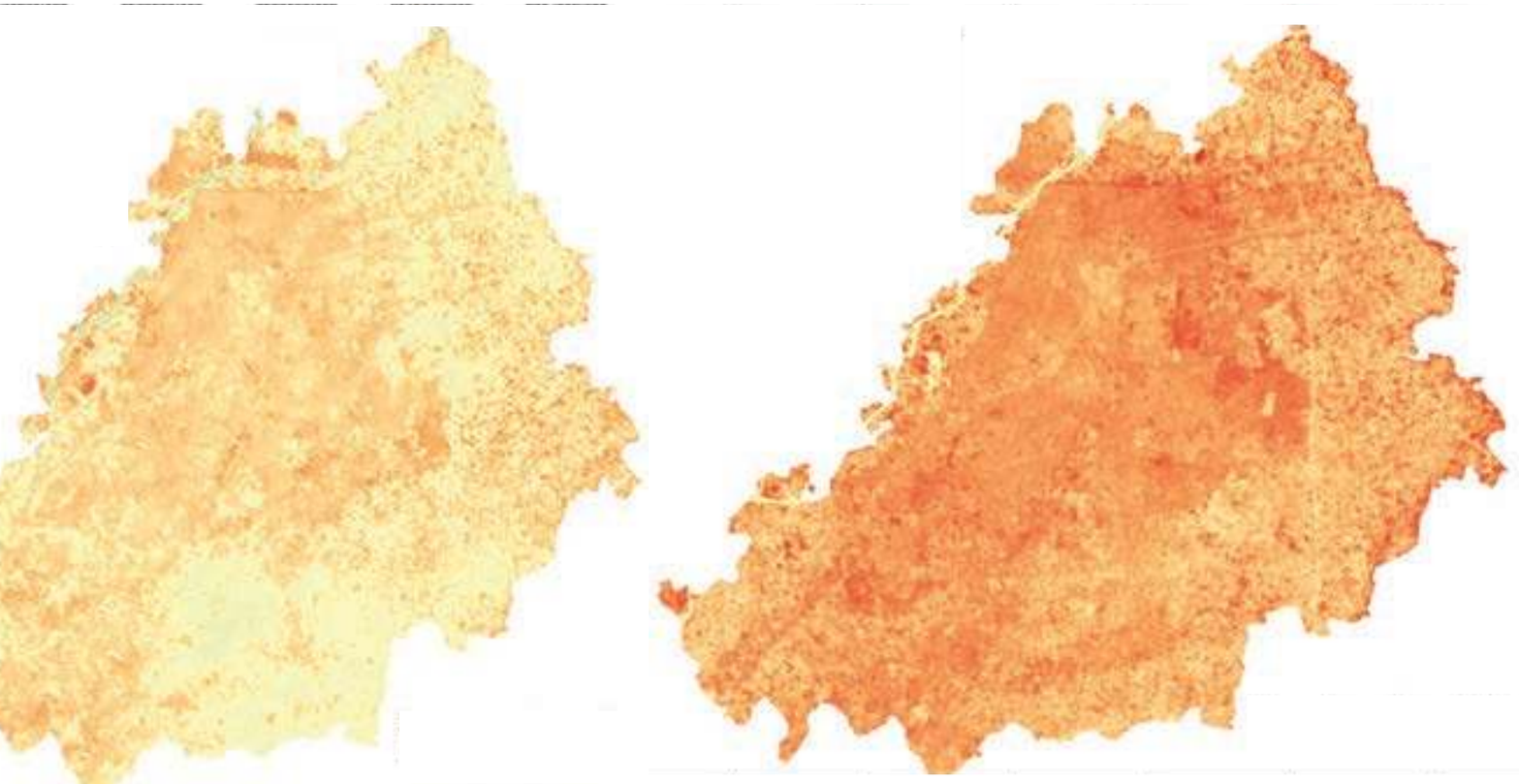
This research thread aims to assess the impact of land use and land cover (LULC) changes on the land surface temperature (LST) for Lahore. Urban expansion, both horizontal and vertical, is straining natural resources by replacing agricultural and vegetated lands. While these LULC transformations positively impact the urban economy, they significantl harm the urban environment. The most immediate implications of urban land onversion are changes in LST and the formation of Urban Heat Islands (UHI), which create temperature disparities between urban centers and surrounding non-urban areas. LST is a crucial climatic variable influenced by different land uses, primarily due to the conversion of green areas into artificial surfaces. CITY analyzed the LST of Lahore over the years. Lahore, the second largest city in Pakistan with a population of approximately 11 million faces frequent and severe heat waves. The severity of changes in LST over the years is evident in these visuals.



Land Surface Temperature 1998

These maps depict land surface temperatures for the years 1998, 2010, and 2021. The colors clearly illustrate a significant and alarming increase in LST over time.
Data Source: Landsat 5 and Landsat 8

45 Degrees Celsius



Land Surface Temperature 2010

Land Surface Temperature 2021

17 Degrees Celsius

CITY displays its work at Lahore Design Festival 2024

CITY hosts an enlightening session on tackling "Big Questions in Climate Change"

CITY Transforms: Sha

The event features diverse speakers offering unique perspectives, fostering a richer understanding of collective action

CITY signs MOU with CITY Pulse Pvt. Ltd.

CITY participates in a panel discussion on climate resilience in infrastructure planning, organized by MHRC and SEED

aping the Urban Future

CITY exhibits their vehicle routing tool in LWMC Roadshow 2024

Social Media Narratives: Engaging Through Stories

05 Engaging Communities

Urban Dictionary

Unraveling intricacies in urban planning and design through social media engagement. Empowering professionals and enthusiasts with informed insights.

Centre for Urban Informatics, Technology and Policy @ LUMS

Tactical Urbanism

Search

Tactical Urbanism

Tactical urbanism is an approach to urban planning & design focused on low-cost, temporary interventions to improve, activate & reclaim public spaces. These are typically small-scale, action oriented interventions & can include projects like installation of parklets, street murals, or pedestrian-friendly infrastructure to test new ideas & engage the community in the placemaking process.

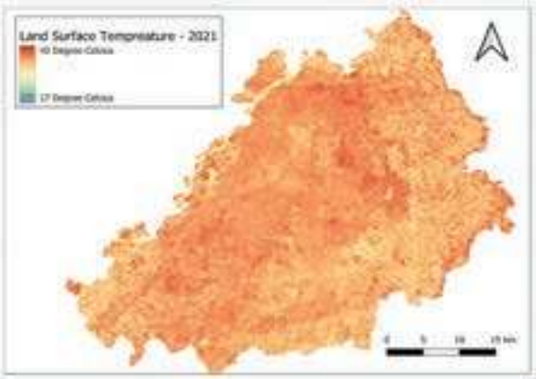
CITY at LUMS

Centre for Urban Informatics, Technology and Policy @ LUMS

Urban Heat Island (UHI)

Urban Heat Island (UHI)

An urban heat island (UHI) is a phenomenon where urban areas experience higher temperatures than their rural surroundings. This is mainly caused by factors such as heat-absorbing surfaces, human activities, and the modification of land surfaces in cities. Urbanization leads to the replacement of natural elements with heat-retaining materials, reducing vegetation and soil, and disrupting cooling processes.



CITY at LUMS

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Urban Fight of the Century

Urban Fight of the Century

The "urban fight of the century" refers to the ideological battle between Jane Jacobs and Robert Moses in mid-20th century New York City. Jane Jacobs advocated forcommunity-oriented, people-centric urban planning, while Robert Moses supported large-scale, top-down projects. Jacobs' ideas ultimately influenced a shift towards more community-focused urban development, making her a significant figure in urban planning history.

CITY at LUMS

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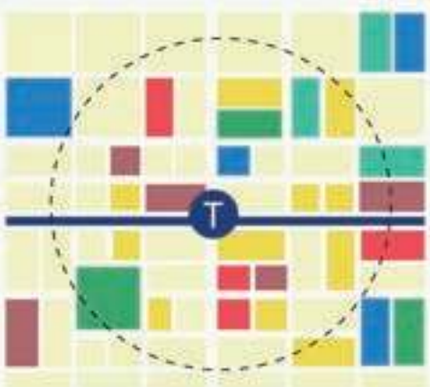
Transit Oriented Development

Transit Oriented Development

Transit-Oriented Development (TOD) is an urban planning & development approach focused on creating vibrant, sustainable and well-connected communities around public transportation hubs, such as subway stations, bus stops, and commuter rail stations. The primary goal is to encourage people to use public transportation & reduce their dependency on private vehicles while fostering economic, social, & environmental benefits.



Non-TOD (Land uses not organised around transit)

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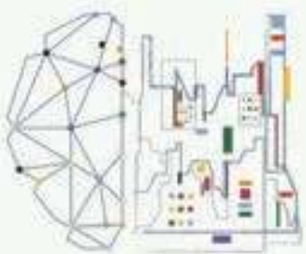
Neurourbanism

Neurourbanism

Neurourbanism represents an emerging interdisciplinary area of research that delves into the interplay between urban living and mental health. Its central objective is to gain a comprehensive understanding of how diverse urban living elements, such as transportation, access to natural environments, pedestrian-friendly infrastructure, & architectural design, etc. can influence the mental well-being of urban residents.



CITY at LUMS

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Micro-mobility

Micro-mobility

Micro-mobility refers to a category of small, lightweight transportation modes that are designed for short-distance travel within urban areas. These vehicles are typically used for trips that are too short to drive a car but may be too long to walk comfortably. Micro-mobility solutions are often seen as alternatives to traditional modes of transportation, offering a more convenient and eco-friendly option for short urban journeys.

CITY at LUMS

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Multi-Modal Transportation Network

Multi-Modal Transportation Network

A multimodal transportation network is a city's inclusive system that caters all type of transport users including pedestrians, cyclists, bus riders, and drivers. While promoting ease of movement for all type of road user, it makes city travel accessible for all, and also reduces traffic congestion. This approach recognizes the paradigm shift in transportation planning, which prioritizes pedestrians & non-motorized modes of transport over cars - creating a transportation network that is more sustainable, livable, and people-centric.

Existing Paradigm

CITY at LUMS

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Biophilic Design

Biophilic Design

Design that seeks to bridge our urban lives with nature by incorporating the elements like greenery, water features, light, and wildlife into the built environment. This innovative urban philosophy enhances well-being, health, and sustainability by nurturing our innate connection to the natural world.

CITY at LUMS

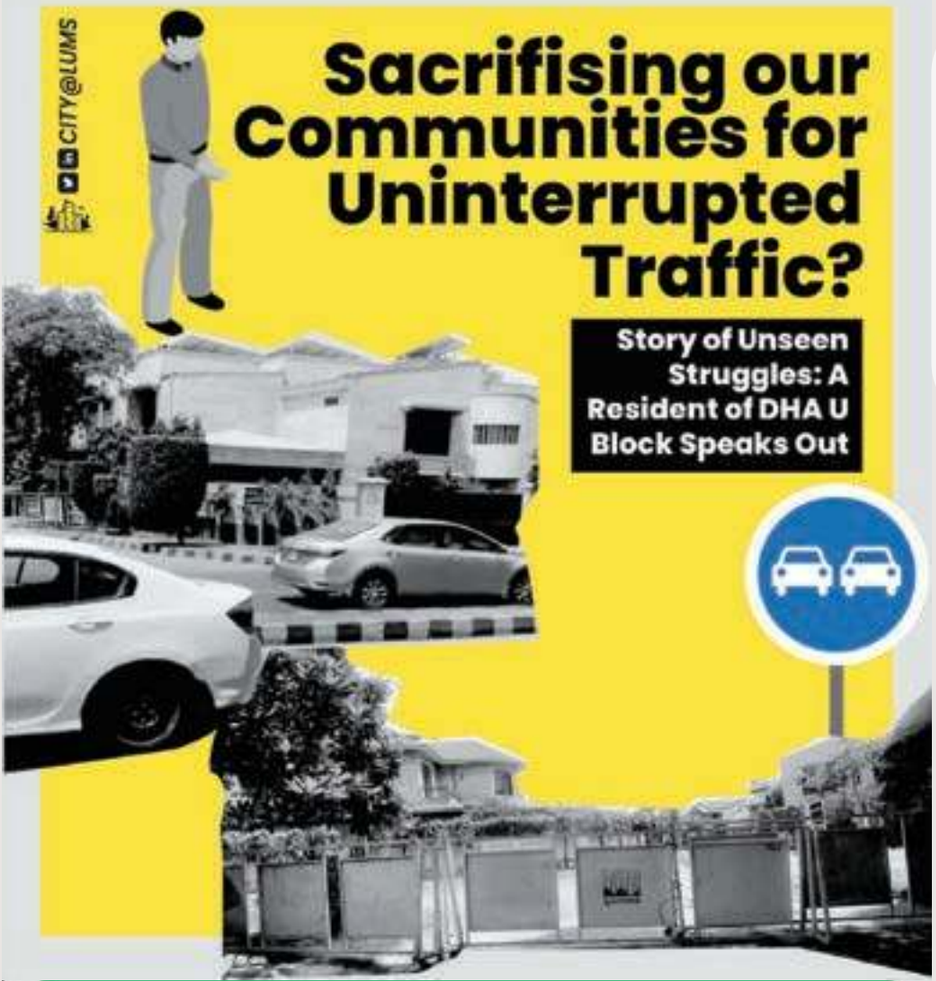
Centre for Urban Informatics, Technology and Policy @ LUMS

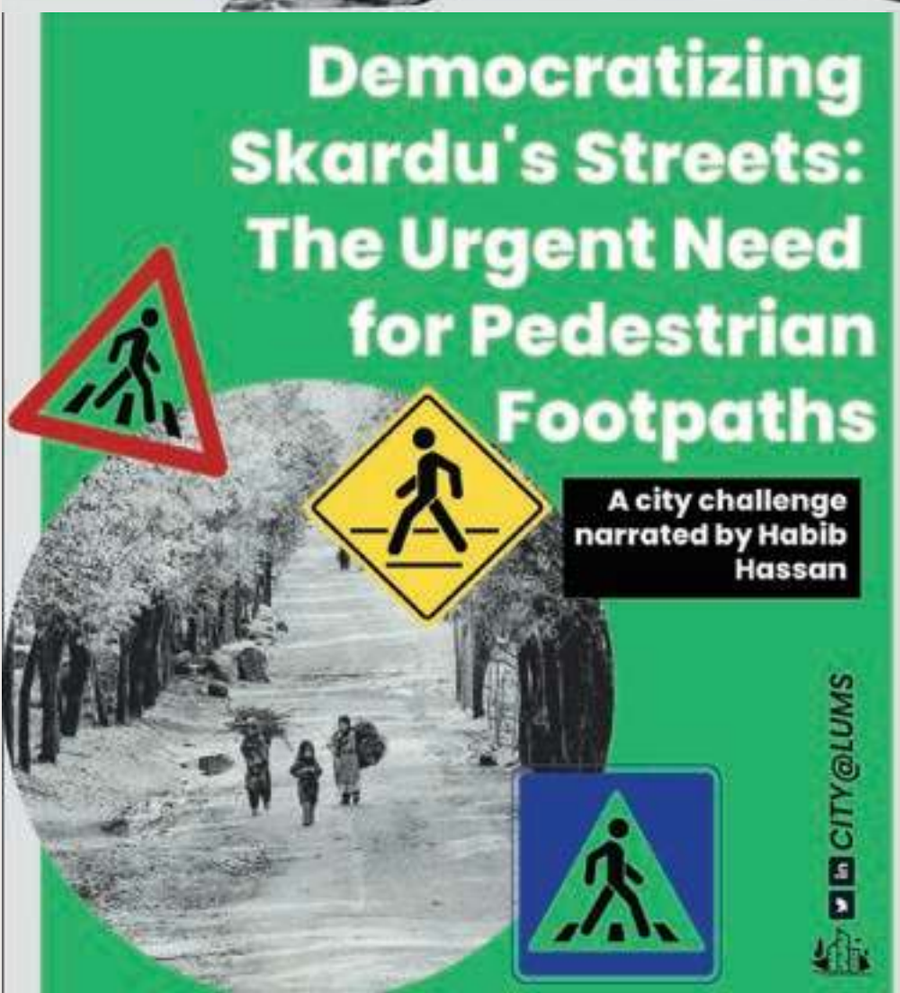
15 Minute City

15 Minute City

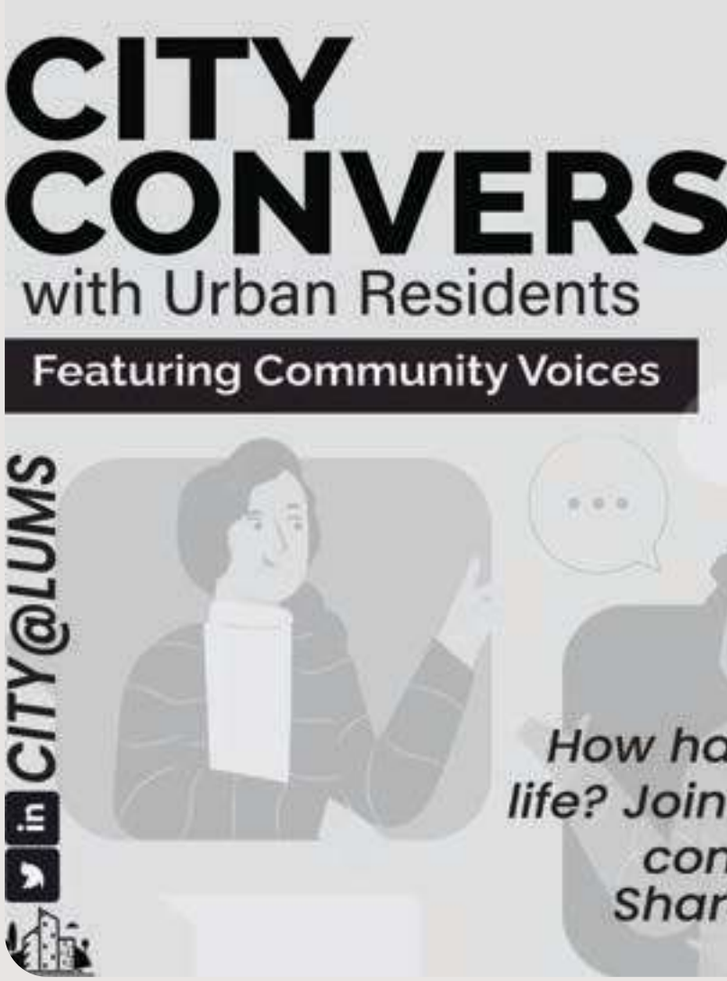
A 15-minute city is a urban planning concept that aims to create cities where residents can access most of their daily needs within a 15-minute walk or bike ride from their homes. The idea is to design cities in a way that reduces the need for extensive car travel and promotes a more sustainable and livable urban environment.

CITY at LUMS

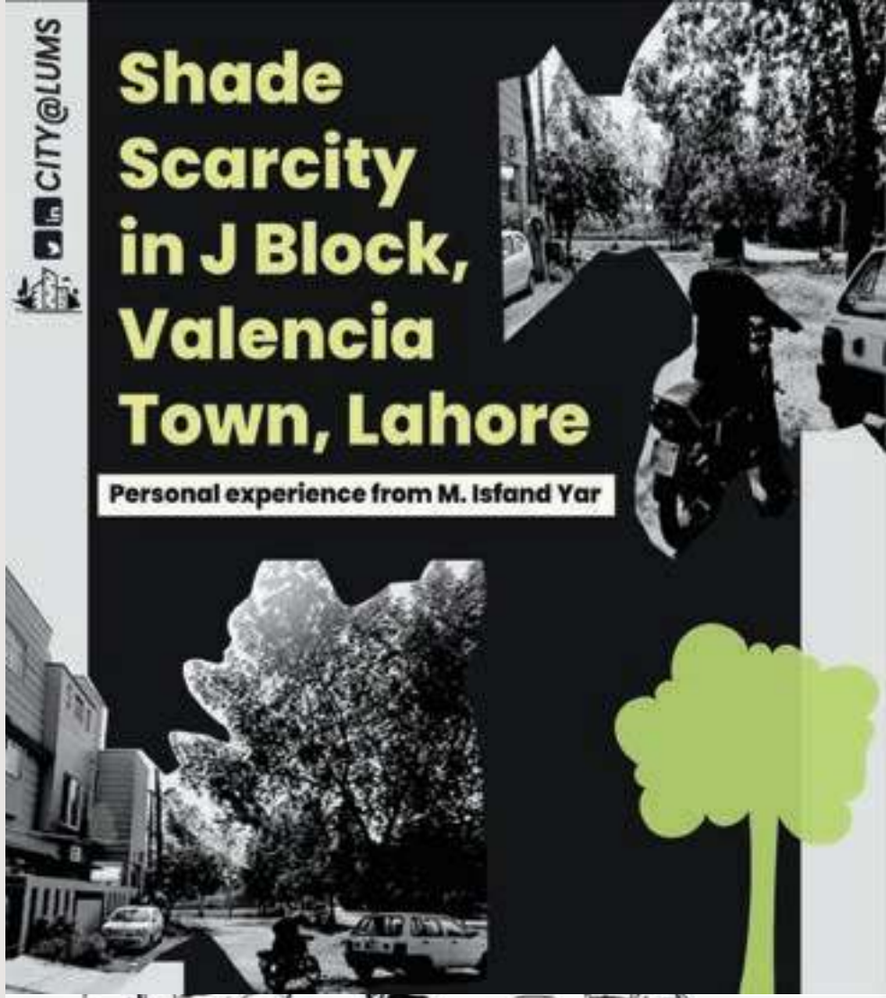


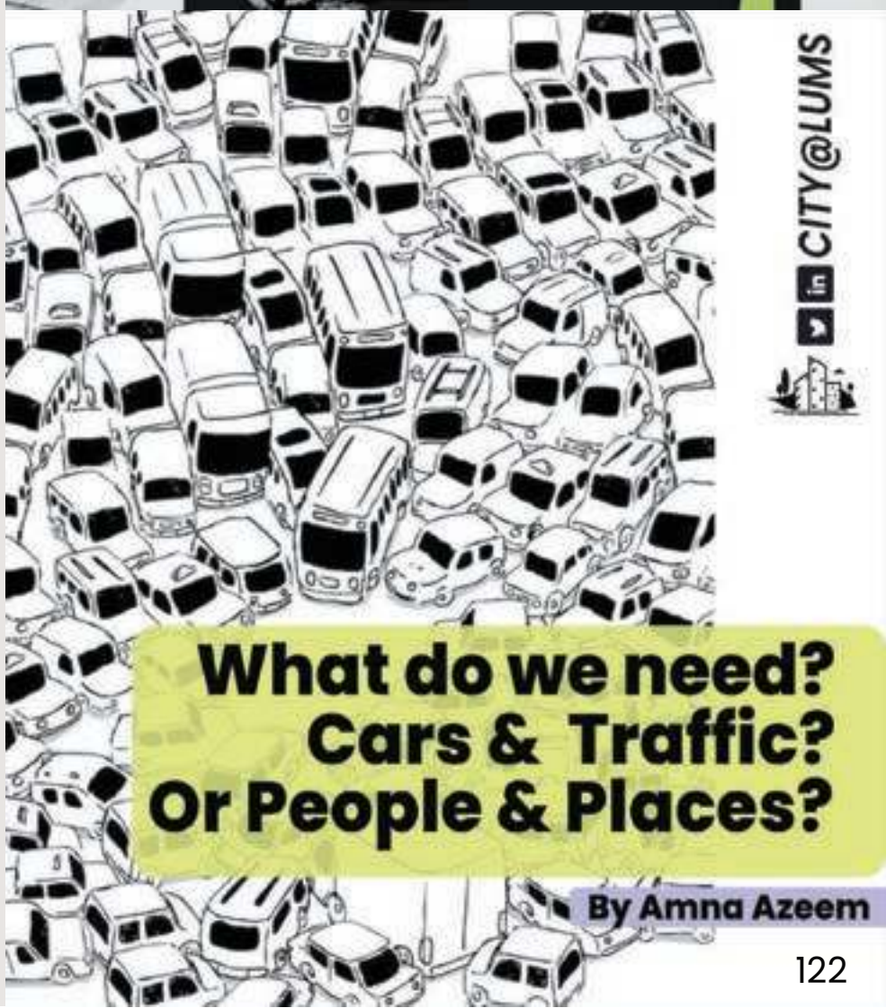


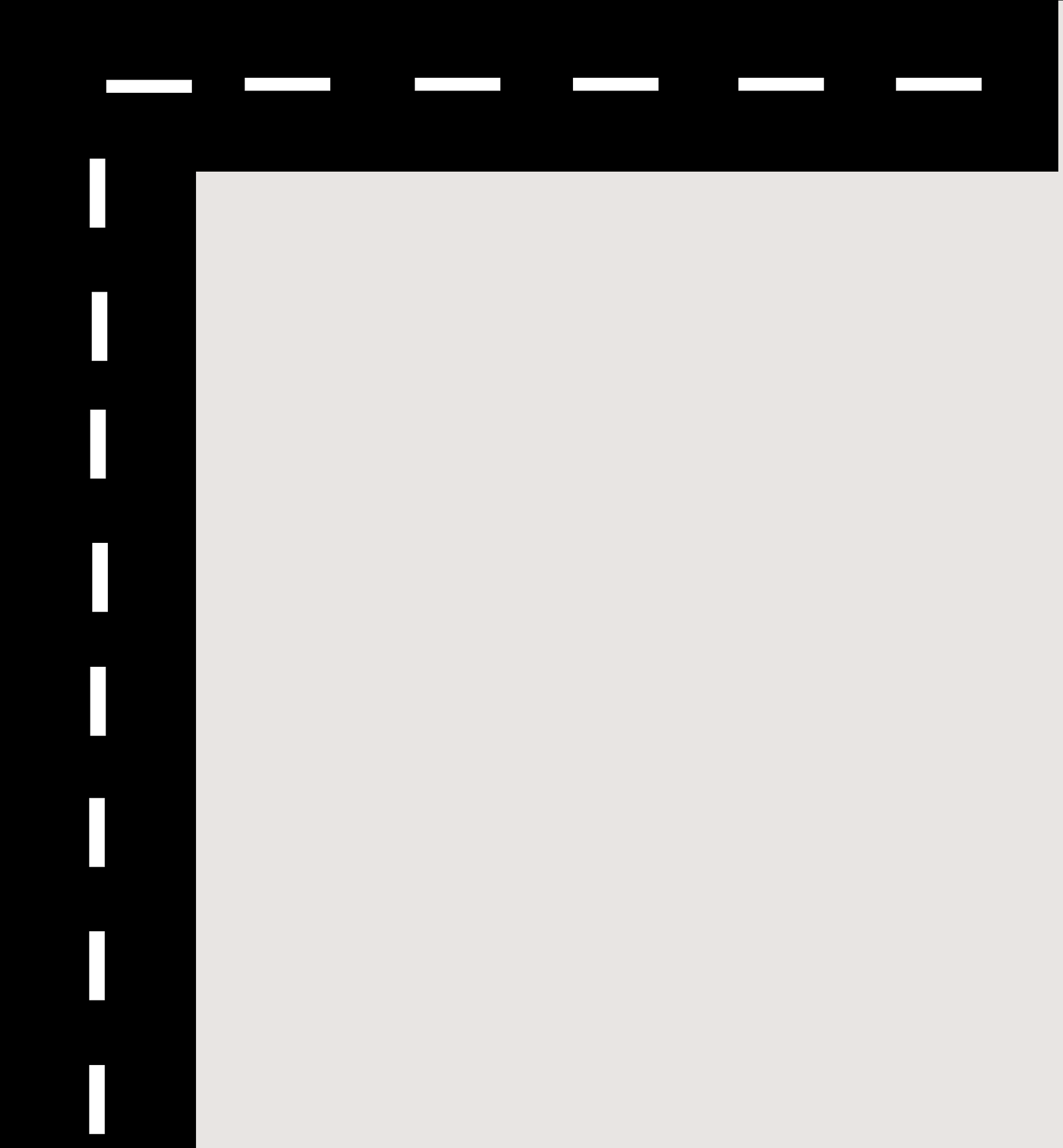
Through "CITY Conversations" initiative, inviting diverse voices of the city—including women, men, the elderly, caregivers, or anyone passionate about shaping the future of their neighborhood—to tell us their stories!



Why Stories? Because at CITY we believe in the power of storytelling to influence change. Not only do they humanize urban challenges and connect people on an emotional level, but through storytelling, we invite individual experiences and community narratives to highlight the impact of policies, developments, and social issues, making them more relatable and compelling.







06 CONCLUSION

CITY Atlas: Reflecting on the Purpose

This atlas represents the visualization and maps stemming from three years of ongoing research work of CITY. Falling under the three crucial urban themes of urban development and growth, urban mobility, and urban environment and health, it offers a visual representation of research findings, and data insights to a wider audience including policymakers, urban planners, researchers, and the general public. Communicating complex urban issues in an accessible and visually engaging manner, serves as a valuable resource for promoting evidence-based decision-making, fostering sustainable urban development, and enhancing the quality of life in cities.

CITY Innovates: Pioneering Urban Solutions

Pioneering urban solutions embodies our commitment to pushing the boundaries of urban development. Through innovative thinking, cutting-edge technologies, and collaborative partnerships, we are paving the way for transformative change in our city. From sustainable infrastructure to inclusive design, our pioneering solutions aim to address complex urban challenges and create a more resilient, equitable, and vibrant urban landscape. Together, we are shaping the future of our city and inspiring innovation.

CITY Connects: Bridging Urban Communities

While the atlas serves as a visual representation of our collective work, its deeper purpose lies in bridging communities and stakeholders. By showcasing diverse perspectives, insights, and initiatives, the atlas acts as a catalyst for dialogue, cooperation, and mutual understanding. It aims to serve as a bridge, connecting residents, policymakers, businesses, and organizations, and empowering them to work together towards a shared vision of a thriving, inclusive urban environment.

CITY Explores: Discovering Urban Opportunities

With the City Atlas as our foundation, we strive to uncover innovative solutions, identify emerging trends, and address pressing challenges facing urban communities. Our pursuit of urban excellence knows no bounds, and we are eager to collaborate with stakeholders, researchers, and visionaries to shape the future of our cities. Together, let us explore urban opportunities, ignite creativity, and pioneer transformative change that enriches the lives of all urban dwellers.

Gratitude to the Visionary Team

Present & Past Researchers

Engineers

Transport Planners

Public Policy Makers

Data Analysts

Planners

al Analysts

CORE RESEARCH TEAM

mina arif

Mina is an Urban & Environmental Planner on a mission to bring environmental and climate consciousness into the heart of urban design. Graduating from York University with a distinction in Environmental Planning for the Global South, her research delineates the socio-spatial barriers to sustainable and equitable urban design for cities in the global south. She has worked with the Ministry of Natural Resources Canada, TREC Canada and RBI on Grant Management, Liaison Building, SDGs and Policy.

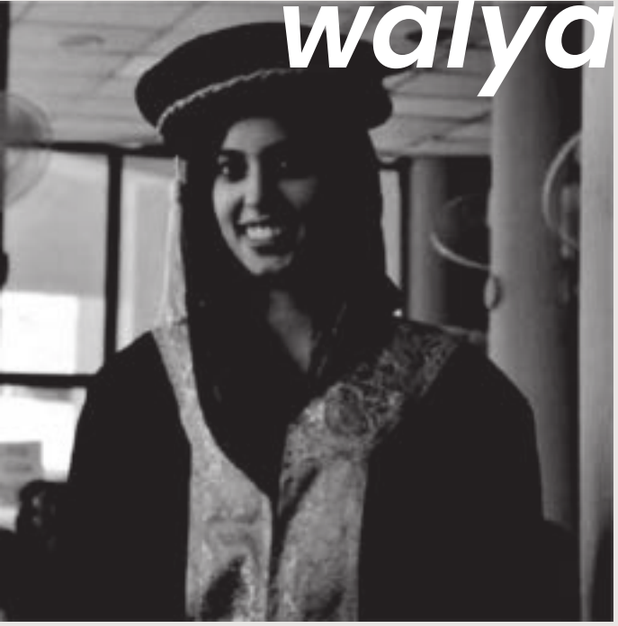
m. ahmad waseem

Ahmad, an expert in Computer Vision, AI, and GIS, brings a diverse range of skills from various domains to our team. He is deeply passionate about developing AI-based solutions to address the challenges faced by our cities that can not only enhance the performance of local government and authorities but will also positively impact the lives of general public. Ahmad firmly believes that through cutting-edge research and technology, we can collectively make a difference — a recent testament being his successful optimization of Solid Waste Management (SWM) operations for the Lahore Waste Management Company (LWMC). In addition to his technical expertise, Ahmad excels in communication and teaching, having conducted multiple training sessions for senior government sector employees. Furthermore, his invaluable research skills are evident in his contribution to four of our research papers published at top international venues. As the most experienced member of our team at CITY, Ahmad has played a crucial role in almost every technical development we've undertaken. Currently serving as a team lead, he effectively manages various technical projects with different research assistants and he is at the forefront of initiatives such as footprint detection and cooling effect of urban green spaces.

Talha Quddoos is a transportation engineer and data science enthusiast with a focus on urban planning and sustainable transportation. His background in Transportation Engineering from UET Lahore and Space Science from Punjab University Lahore gives him a unique perspective on the challenges being faced by our transportation systems. With a passion for creating safe, sustainable, and inclusive transportation systems, he honed skills in cartography, geospatial technologies such as ArcGIS, QGIS, ArcGIS pro, Google Earth Engine, SAR, and UAV surveying/photogrammetry. His experience in solving complex transportation problems and developing innovative solutions has prepared him for any challenge that comes his way.

m. talha quddoos

walya sadiq



Walya Sadiq, an accomplished Channel Program Manager, brings over six years of expertise in business development and supply chain. Specializing in developing and implementing channel strategies to enhance revenue and market share, Walya is recognized for proficiency in data analytics, relationship management, and marketing. With a successful track record in identifying opportunities, building partnerships, and optimizing supply chain operations, Walya's achievements include a noteworthy social media campaign resulting in a 50% increase in website traffic and PKR 500K in new business. Passionate about delivering value to organizations, Walya is dedicated to continuous improvement and innovation. At CITY, she serves as a project manager.

Ibrahim is a qualified data analyst, having worked in startups and in research during and after the completion of his undergraduate degree. He is experienced in spatiotemporal data analytics and is proficient in Python,R, Excel, QGIS, and MATLAB. His prior experience in product management brings with him a diverse skillset ranging from product development, workflow management, data analytics, creating slide decks and communication. He is an avid reader, writer, researcher, hiker, and admirer of art.

m. ibrahim

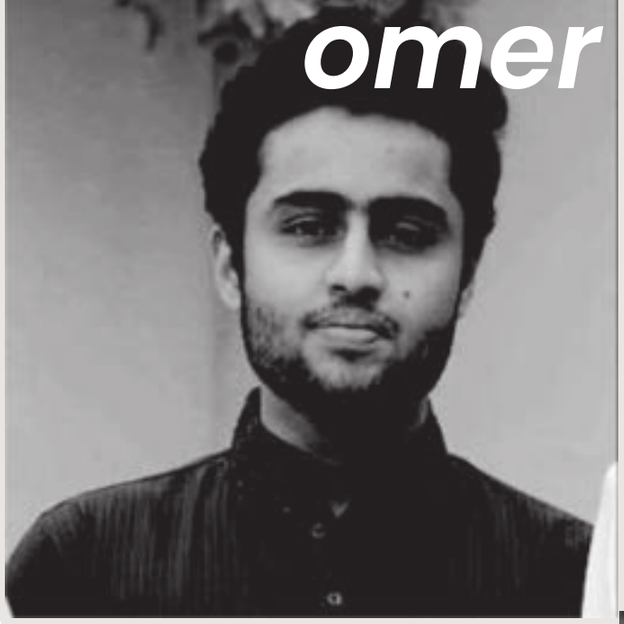
Amna, an Urban & Regional Planner, brings diverse experience from local to international forums. Passionate about human-centric, sustainable cities, her undergraduate research on Neuro-urbanism explored the impact of city living on well-being. Actively engaged on social media (@urbanistamna), she founded a magazine "Ignite", organized global conscious cities events, and joined the Commonwealth Sustainable Cities Initiative. Internationally recognized, Amna represented Pakistan twice, featured in The Prince's Foundation UK interview, BBC Travel, and contributed to the Quarantine Atlas by Bloomberg City Lab USA. She led the child-friendly cities agenda in London's Urban 95 Residency recently. At CITY, Amna's research is focused on road safety and the walled city's pedestrianization. Additionally, she manages social media and leads the

amna azeem

fatima naweed

Fatima is a Computer Science graduate from LUMS with a keen interest in Computer Vision, Graphics, and developing machine learning models. During her two-year tenure as a Research Assistant, she accomplished significant projects. In her first year, she developed a model extracting valuable information from audio calls recorded in helpline centers across various areas of Pakistan. In her second year, her focus shifted to researching early warning forest fire detection systems using detection models and PTZ cameras. While an undergraduate, she served as a Teaching Assistant for multiple courses and pursued specialized studies in Distributed Systems, Deep Learning, Computer Graphics, Computer Vision, and Machine Learning, undertaking specific development projects in these fields. At CITY, Fatima is currently engaged in a project titled "AI-Driven Insights on GreenSpaces Decline," utilizing a machine-learning model to explore the effects of rapid urbanization and visualize the evolution of green spaces.

omer abdul jalil



Omer, passionate and determined to explore the field of Machine Learning, joined CITY right after graduating from LUMS in June'23. At CITY he has developed various solutions in our Vision in Mobility thread. Along with development, he has continued to conduct research in the field. With a passion for working towards robust and generalizable algorithms, he has focused on foundation models, and self-supervised techniques.

Saifulah, an ML and NLP enthusiast, and an excellent researcher has been a part of CITY for nearly 6 months. Graduating with a bachelors in Computer Science from LUMS, he joined CITY to enhance his knowledge in addition to solving real world problems. His research experience along with his creativity has led him to become a valuable member of our team. His main work has been in time series forecasting problems, which have a spatial aspect as well. He has an interest in robustness and adversarial machine learning, in which he has around 2 years of research experience.

safiullah shakeel

hamza rafi

Hamza is an deep learning and data analyst enthusiast who has been an part of CITY since August of 2023. After earnining his bachelors in Electrical Engineering from LUMS, he joined CITY to polish his skillset on diverse set of projects. Hamza aims to solve numerous local problems present in urban sectors such as traffic flow forecasting by proposing learning-based solutions. Furthermore, he also contributes to deep learning theory by leading the projects around generative models such as Stable Diffusion to improve their generation capability in the most reliable way possible. Hamza has multi-year experience in deep learning and proficiency in applying deep learning methodologies across various domainns make him an indispensible member of CITY.

Hamza, driven and ambitious in the realm of ML and signal processing, embarked on his journey with CITY immediately following his graduation from LUMS in June '23. At CITY, his research has mainly been focused on predicting natural disasters that envelope the urban lifestyle. Specifically, utilizing satellite imagery to pinpoint areas of high flood susceptibility along with incorporating hydrological factors of the study area. His expertise also lie in data manipulation tools such as QGIS, GEE, Sentinel Application Platform (SNAP). He has a deep seated interest in model generalizability through transfer learning and weakly supervised techniques.

Osama Ahmad is a proficient Embedded System Engineer with a strong background in microcontroller and embedded AI. His professional experience includes roles in research and product development, where he contributed significantly to IoT, machine vision, and AI projects. His academic qualifications include a Bachelor's in Mechatronics & Control Engineering and a Master's in Electrical and Electronics Engineering. Osama's expertise in Artificial Intelligence and Computer Vision is highlighted through his work on innovative projects like traffic monitoring, congestion analysis, and AI-based quality inspection in construction.

osama ahmed

hamza rashid

sana riaz

Sana Riaz is a PhD Planning student and a Faculty of Arts & Science Top (FAST) Doctoral Fellow at the University of Toronto. She is currently exploring and researching the space at intersection of transportation and climate change. Formerly, she worked as an urban policy consultant at the Center for Urban Informatics, Technology and Policy (CITY) at Lahore University of Management Sciences (LUMS). Her past work experiences involve transit-oriented development, female mobility, spatial data informatics, and urban policy-making, within cities in Pakistan. She is also very interested in land & housing, spatial city growth, environmental sustainability, and solid waste management issues. She has experience across different industries such as IGOs, academia, government, and the private sector, including organizations such as the World Bank, the NYU Marron Institute, and the Punjab Urban Unit. Her alma maters are LUMS, New York University, and IHS Erasmus University, Rotterdam, where she studied Finance, Urban Planning, and Equitable Housing.

mustafa siduqqui

Mustafa, a committed researcher at CITY at LUMS, is deeply passionate about deep learning. Having graduated with a degree in Electrical Engineering in the 2023 batch from LUMS, he has been part of the City research team for six months. His research has mainly been focused on route optimization and Neural network design using Deep Unfolding. His drive comes from a desire to understand how the brain works, believing that we can only truly grasp the brain's workings by replicating them. He joined CITY, seeing it as the ideal place to both apply deep learning models in practical scenarios and engage in theoretical research on the latest topics in the field.

Manaal Ahmed is a 4Cities Erasmus Mundus Scholar. She writes about sustainable urban development, public space, urban protests and urban mobility. At CITY, she worked on road safety research thread, made the road safety policy guidelines, worked on the underpass redesigns and also wrote articles.

manaal ahmed

huzaifa khan suri

Huzaifa is a Machine Learning Engineer with a robust background in Data Science. He currently advance healthcare innovations at UIUC in collaboration with Mayo Clinic. He specialize in developing predictive models that improve diagnostic accuracies and patient outcomes. His recent work includes enhancing retinal image analysis for melanoma risk prediction. He worked at CITY from August 2021 to June 2022, where he worked on multiple threads such as ambulance allocation, hotspot analyses, etc.

Abdur Rehman is a MASc. Computer Engineering Research candidate at the University of Waterloo. He has expertise in Hardware and Software development for ARM and RISC-V architectures. He is also an expert in Hardware Software Debugging, Virtualization, Hypervisors, Performance Isolation, Mixed Criticality Systems and RTOSes (FreeRTOS and Zephyr RTOS). His hands-on experience includes leading firmware and hardware projects for Electric Vehicle Fleet Management Device. He was part of City from December 2021 to July 2022 where he worked on deployment of air quality sensors, which was a crucial to monitor AQI across the city. He also published a research paper where he investigated the problem of finding appropriate locations for sensor deployment for optimal coverage of Air Quality. His research got published at SDSC 2022, In Proceedings of 7th International Conference on Smart Data and Smart Cities.

Abdullah is Master's graduate from UC Berkeley in Data Science with over 3 years of experience as a Data Scientist. He is skilled in handling large datasets across tabular, text, vision, and image-to-text modalities. His expertise includes computer vision, natural language processing, and traditional machine learning. He was a part of CITY from May 2021 to July 2022, where he worked on multiple research projects including traffic flow modelling, studying impacts of school closure on environment, etc.

abdullah azhar

abdur rehman

eesha atif

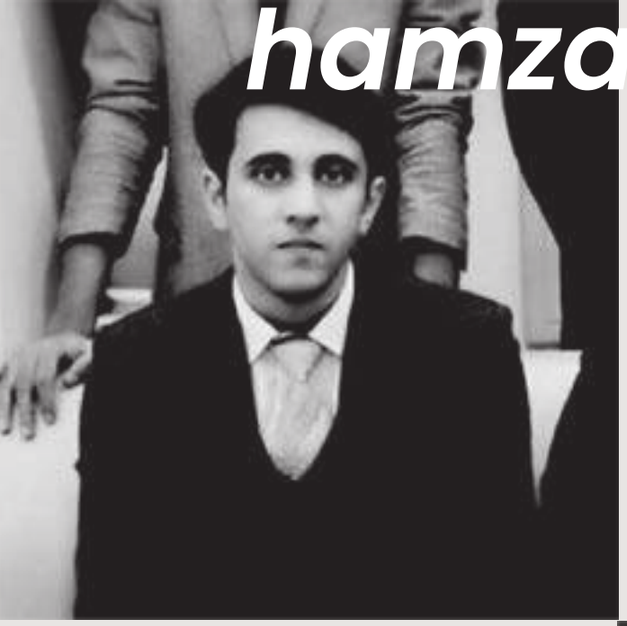
Eesha is a Grad Student at North Carolina State University, USA. She has expertise in data analytics, signal processing, and team management. She was part of CITY from August 2021 to June 2022 where she worked on creating technological foundations of multiple projects leading to sustainable urban development. She used advanced socio-economic mapping using tools like ArcGIS, MATLAB, and QGIS to prepare population heatmaps using census data.

ali khalid

Ali is a PhD student at the Rechester Institute of Technology (RIT), Rochester, USA. He is currently on revolutionizing autonomous driving using advanced computer vision and deep learning methods. He has profound set of expertise in 3D vision, Deep Learning, and Machine Learning. He was a part of CITY from July 2021 to June 2022, where he laid technological foundations for several research projects that involved image classification and segmentation using deep learning models. Not only this. Ali developed a toolset that could extract road network for any city from freely available satellite data.

Shoaib is a PhD student at Arizona State University (ASU), Arizona, USA. Shoaib has diverse set of expertise from wireless networking to deep learning and computer vision. He excels in developing mathematical models for complex optimization problems that eventually quality training of deep learning models. He was part of CITY from June 2021 to Nov 2022. His main area of research at CITY was to develop deep-unfolded models which drastically reduce the need of very large dataset for training the models. He published two research papers including top venues such as Signal Processing Letters.

shoaib imran



hamza mansoor

Hamza is a proficient Python developer with a strong foundation in web frameworks including Django, Flask, and FastAPI. His expertise lies in building robust REST APIs that meet the demands of modern web applications. In addition to this, he also has expertise in data science and machine learning that aid in driving decision-making and innovation. He was member of City from Jan 2022 to Mar 2023, where he was involved in multiple research projects including smartly allocating waste bins, optimizing routes for waste collection, etc. He laid the technical foundations for the route optimization thread which lead to collaboration with LWMC and helped them same tons of fuel.

salman bashir

Salman is currently working as a research associate at Information Technology University (ITU), Lahore Pakistan. He is an engineering graduate with interests in Data Analytics, Data Science, and Machine Learning. In addition to this, he has profound expertise in spatial data analytics and tools such as QGIS, ArcGIS, etc. He was part of CITY from June 2022 to Sep 2022 where he worked on POI extraction as well as coverage analyses.

sheraz hassan

Sheraz is a PhD Candidate at Georgia Institute of Technology, Atlanta, Georgia, US. He has expertise in both machine learning and hardware design, specializing in the development of cost-effective healthcare wearable computing solutions. He holds a strong passion for everaging cutting-edge technology to enhance healthcare accessibility and affordability. He was part of CITY from Aug 2021 to July 2023 where he worked on the design of machine learning models for various applications, such as taxi demand prediction, robust heart rate estimation, noise cancellation, and environmental sound classification. Additionally, he implemented deep learning models for comprehensive data analysis and post-processing.

m. hameed

Hameed is working as Lead Artificial Intelligence & Machine Learning Engineer at Intellia. He has profound expertise in developing and fine tuning Large Language Models (LLMs). He has also worked on chromaDb, langchain, and RAGs. In addition, he also excels in computer vision and deep learning and has done several projects in that domain in the past. He was part of CITY from Oct 2022 to Apr 2023, where he lead the project of parking automation that aimed at detecting free slots in parking using advanced deep learning toolsets.

ul rahman

Abdul Rahman is a Fulbright scholar at the University of Pennsylvania, studying Social Policy and Data Analytics. His expertise lies in the domain of data science and public policy, working on several projects related to health vulnerability mapping and flood damage assessment, in partnership with organizations like the World Bank and the Gates Foundation. He worked at CITY from July 2021 to June 2023, focusing on developing machine learning-based policy solutions for the logistics industry and creating high-resolution population density estimates for efficient disease spread mapping.

Muhammad Umer is an accomplished Machine Learning Engineer specializing in Computer Vision, currently serving as a Senior Machine Learning Engineer at Aerodyne, the leading drone service provider globally. He played a pivotal role in the development of DRONOS, a cutting-edge SaaS product. At Aerodyne, Muhammad Umer is majorly working on designing and implementing advanced ML models and customized algorithms for diverse inspection tasks tailored to client needs. Previously, from July 2022 to December 2022, Muhammad Umer worked at CITY, where he worked on different tasks, including ambulance allocation simulations to optimize response times, hotspot analysis, and satellite-based road network extraction. His expertise spans the intersection of AI and real-world applications, consistently delivering impactful solutions across complex domains.

muhammad umer

ir basheer

Dr. Muhammad Aamir Basheer is an urban and transport planner. He currently holds the position of Assistant Professor at the Department of Architecture and City Design, King Fahd University of Petroleum and Minerals (KFUPM). He specializes in smart cities, transit-oriented development, sustainable urban development, mode choice behavior, and road safety. He worked at CITY from August 2021 to September 2022, where he made significant contribution to the field of data-driven urban development. His work was published in the 7th International Conference on Smart Data and Smart Cities (SDSC).

Ishaq is a senior data scientist with expertise in computer vision, NLP, time series and LP optimization. He is currently working for systems limited at their Telecom customer named Etisalat UAE. He worked at CITY from sept 2021 to July 2022, developed realtime traffic analytics system.

m. Ishaq khan

Saif is a Computer Science PhD student at the University of Illinois Urbana-Champaign. His research interests revolve around wireless networks capable of sensing and communication and is working on problems that utilize signal processing and machine learning in wireless systems. He worked at CITY from September 2022 to November 2022 where he led projects related to wireless sensing and machine learning.

Saif ur rehman

usman nazir

Usman Nazir currently holds the position of Assistant Professor at the School of Computer and IT, Beaconhouse National University (BNU). His research interests lie at the intersection of computer vision, remote sensing, and deep learning. He is passionate about developing efficient techniques to extract socio-economic indicators from remote sensing data at large-scale. Center for AI Research (CAIR) is Usman's research group at BNU, where he leads efforts to advance AI research and its practical applications. His career includes impactful initiatives such as poverty mapping and climate crisis mitigation, often collaborating with prestigious institutions like the University of Oxford and University of London, UK. In addition to his research endeavors, he is teaching advanced courses in these areas. Usman Nazir completed his split-site Ph.D. in Computer Science through a collaborative program between Lahore University of Management Sciences (LUMS) in Pakistan and the University of Leeds in the United Kingdom. Committed to leveraging technology for societal improvement, Usman's work has been recognized through achievements such as receiving the Facebook CV4GC award. His research has been published in numerous esteemed journals and conferences, underscoring his contributions to the field.

m. usama

Dr. Muhammad Usama is an associate professor of computer science at FAST-NU, Pakistan. He received his PhD from Information Technology University (ITU), Punjab, Pakistan, and has also held a postdoctoral research associate position at the University of Edinburgh, UK. His research interests include affective computing, social network analysis, urban computing, and adversarial machine learning. His recent work focuses on the application of large language models for affective computing and the ethical issues arising from these technologies. His most recent publications have appeared in prestigious venues such as IEEE CIM, IEEE GRSM, IEEE GRSL, IEEE COMST, IEEE Network, and IEEE TAI, as well as notable conferences including IEEE INFOCOM, ACM CoNext, IEEE LCN, and IEEE/ACM ASONAM, among others. From July 2021 to August 2022, Dr. Usama worked at CITY, where he contributed to multiple projects, including studying urban air quality, measuring the air quality in Lahore, and understanding the impact of social networks on urban satisfaction. He is also passionate about understanding and measuring air quality for various pollutants and has recently begun working on hyperspectral image classification problems, further expanding his research portfolio.

Afaf is a communications expert and led CITY's research initiative on female mobility with 800+ participants, conducting primary research, awareness campaigns, workshops and knowledge dissemination regarding the impact of the urban transport network on women. She has spearheaded data-driven policy-making efforts for multiple verticals, including Transportation, Solid Waste Management, Air Quality, Sprawl, and Logistics, by effectively bridging the gap between data collected through various technologies and its practical application. She also led user-testing initiatives on the Women Safety App to the Punjab Safe Cities Authority, ensuring its accessibility and suitability for women.

afaf ehsan

AFTERWORD

As I reflect on my three-year journey at CITY, I'm filled with pride and awe at the tremendous progress we've made. From the moment I joined, I knew we were embarking on something groundbreaking. Our team tackled ambitious projects, often with little to no publicly available data. Undeterred, we worked tirelessly, pouring our hearts and souls into creating datasets from scratch. Our diverse team of planners, urban developers, AI engineers, and policymakers brought unique perspectives, enabling us to achieve our lofty goals.

Take Building Footprints Extraction, for instance. When we started, there was no precedent for Pakistani cities. We manually developed data, trained deep learning models, and achieved phenomenal results, even surpassing state-of-the-art models. This was just the beginning. We went on to tackle Population Disaggregation, Waste Management, and more, pushing boundaries and making a significant impact locally and globally.

As I look back, I'm struck by the journey of our team, which started with just 12-13 dedicated individuals. Today, our work is making headlines, and our center is a hub of innovation. I feel privileged to have been part of this journey, witnessing the power of collaboration, determination, and creativity. CITY's progress is a testament to the potential of visionary thinking and collective effort. I'm honored to have been a part of this remarkable story.

■ ■ ■

Muhammad Ahmed Waseem

CO

2021

- Higher Education Comission
- Lahore Waste Management Company
- Punjab Emergency Services Department (Rescue 1122)
- National Transport Research Centre
- Punjab Safe City Authority
- M&P Courier

2022

- Careem
- Chugtai Labs
- Trans Karachi

LLABORATORS

- ***Walled City of Lahore Authority***

- ***City Pulse Pvt. Ltd***

2023

2024

The Higher Education Commission of Pakistan is an independent, autonomous, and constitutionally established institution of primary funding, overseeing, regulating, and accrediting the higher education efforts in Pakistan.

The Punjab Safe Cities Authority (PSCA) established under the Punjab Safe Cities Ordinance 2015, is an autonomous Government body that aims to improve public safety and security in the Punjab, Pakistan. The Safe City is a concept for returning security and quality of life to today's complex cities through the use of technology, infrastructure, personnel and processes.

The Punjab Emergency Service (Rescue 1122) is the leading emergency service of South Asia. Rescue 1122 has been established under the Punjab Emergency Service Act 2006 for professional management of emergencies such as road traffic crashes, medical emergencies, building collapse, fire, hazardous material incidents, explosions, flood & water rescue and animal rescue etc.

National Transport Research Centre (NTRC) was established in June 1974 in the Planning and Development Division, as one of its Technical Sections, to provide much needed research and development (R&D) support for planning and appraisal of transport sector projects/plans in a coordinated and cost effective manner. NTRC was transferred to the Communications Division in November 1992. It is effectively functioning as an R&D Wing of the Ministry of Communications.

City District Government Lahore (CDGL) established LWMC under section 42 of the Companies Ordinance 1984 on 19th March 2010. LWMC aims to develop an integrated system of solid waste management to ensure efficient collection, transportation, recovery, treatment and disposal of the waste generated in Lahore.

M&P Express Logistics, also known as Muller & Phipps Pakistan (Private) Limited, is a multinational logistics, sales, and distribution company in Pakistan. Founded in 1986, the company has over 2,500 employees, including more than 1,200 couriers, and serves over 1,300 locations across Pakistan. M&P Express Logistics offers local and international courier services, as well as value-added services like cardwala and a personal shopper.

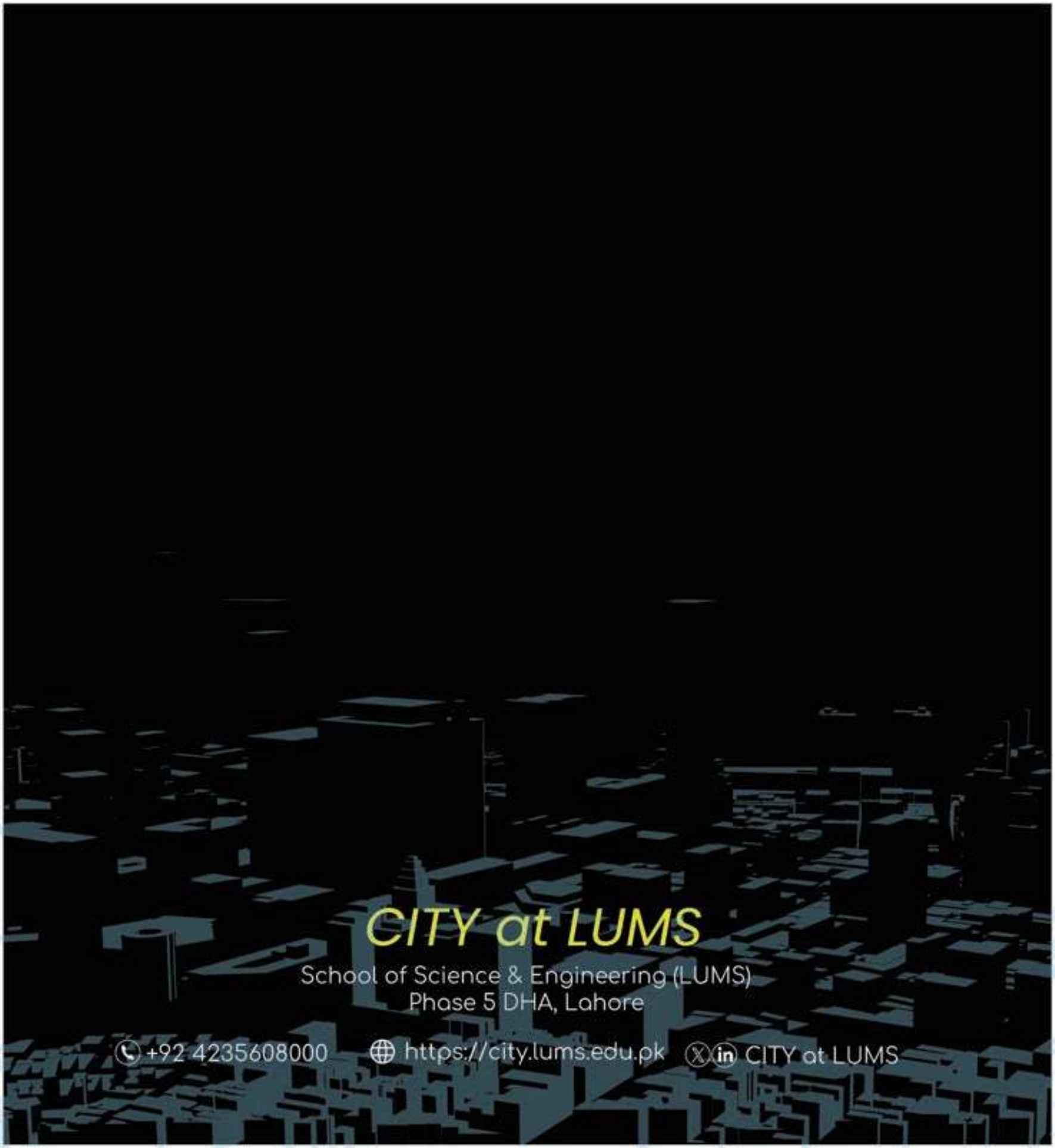
Careem is a company that offers a marketplace of local drivers that passengers can use to request rides, see the cost, and have it charged to their preferred credit card. Careem also offers bike sharing, food ordering, logistics for companies, e-commerce shopping, parcel delivery, and recharge.

TransKarachi is a Public Sector Company owned by the Government of Sindh and the implementation agency responsible for the Karachi Red Line BRT.

Chughtai Labs is diagnostic lab in Pakistan for diabetes tests, kidney function tests and more, equipped with state-of-the-art technology.

WCLA works autonomously and was established in 2012 after Provincial Assembly of the Punjab amended the Walled City of Lahore Bill 2011 to create the authority. It looks after the heritage sites in the area and specifies penalties for damaging buildings and runs the functions of the Old City of Lahore.

City Pulse is a City and Regional Planning firm with a vision for the future. We specialize in innovative solutions that bring fresh energy to development projects, guiding them from concept to completion. Our team of skilled urban planners, GIS specialists, and surveyors work together seamlessly to create sustainable and functional spaces that will thrive.



CITY at LUMS

School of Science & Engineering (LUMS)
Phase 5 DHA, Lahore

+92 4235608000 https://city.lums.edu.pk CITY at LUMS