

Urban Mobility and Climate Change Mitigation: Local Actions Within the Monterrey Metropolitan Area Before and After COVID-19

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City Population (Metropolitan Region)	5,341,171
City Area (Metropolitan Region)	7,657 km ²
City GDP	204 billion USD
Climate Zone	BSh (hot semi-arid)
ARC3.3 Linkages	COVID-19, Cities, and Climate Change Element

and use (Henderson, 2015), hand in hand with an increase of active mobility infrastructure through planning (UNEP-UN-Habitat, 2021; IRP, 2018). In the face of COVID-19, confinement measures forced all social realms to create conditions in favor of active mobility; this time due to public health reasons. On the other hand, new meanings attributed to automobiles emerged as a mean for social distancing, further encouraging the use of automobiles, a tendency that has remained in many cities (Manville et al., 2022; Sinko et al., 2021; Pawar et al., 2020; DLR, 2020).

In Mexico, the implementation of the second phase of the COVID-19 contingency plan, declared on March 24, 2020, required stricter measures of social distancing, confinement, and job-related restrictions (Government of Mexico, 2020). This situation translated into a decreasing trend in mobility with an increased trend in the effective time spent at home (Rangel et al., 2021). Changes in lifestyles were unavoidable, from the modalities and conditions of work to the acquisition of goods and services – with a notorious boom in home delivery services. Such changes, among many others, took place in a context in which Mexican cities began to have a more active role in designing and implementing climate change adaptation and mitigation strategies (Global Covenant of Mayors for Climate and Energy and UN-HABITAT, 2022; Prieur-Richard et al., 2019).

In the face of historical inequalities in the access to reliable health and public services (water, sanitation, transportation, public spaces, urban green areas, etcetera), the arrival of COVID-19 endorsed the need to review and strengthen health policy vis-à-vis other public policies to address the root causes of the health emergency, mostly social inequalities that generate structural vulnerabilities (Sánchez-Talanquer et al., 2021). Consequently, we analyze some sustainable mobility actions and projects carried out before and after the COVID-19 pandemic in the Monterrey Metropolitan Area (Nuevo Leon, Mexico). The projects reviewed and the interviews conducted with key actors have made it possible to assess the scope of the interventions being carried out – including the role of public space – regarding their contribution to more sustainable, inclusive, and resilient cities in the face of health events such as the COVID-19 pandemic.

Analysis, Evaluation, and Implementation.

- **In search of urban accessibility.** The deployment of a large part of Mexico’s industrial sector in Monterrey, a process that began as early as the 1950s (Garza, 1998),

Introduction. The COVID-19 pandemic prompted governments and communities to develop social distancing measures. Urban mobility, as a means of accessing goods and services, abruptly changed in response to confinement measures. Such a scenario led to strengthening connectivity schemes for remote work in non-essential activities, to improve active mobility infrastructures and to reduce capacity in public transport, all of which transformed life in public spaces. We analyze local daily mobility actions that were implemented before and during the pandemic in the Monterrey Metropolitan Area – ZMM, the second largest metropolitan area in Mexico. Specifically, mobility actions and projects carried out before and after 2020 are scrutinized, as well as how they impacted previously set urban sustainability and climate goals. In addition, key notions are outlined for achieving accessibility through planning vis-à-vis prevailing solutions and urban governance of mobility.

Brief History. Since proximity was declared a contagion factor for COVID-19 (Fang et al., 2020), in addition to the closure of borders and ports, the reduction of passenger density within public transport units was recommended (Müller et al., 2020; DeVos, 2020). The utilitarian motivations that previously affected modal split choices changed due to perceived risk of COVID-19 contagion, among other psychological aspects experienced by the population (Singh et al., 2020). Until before 2020, two positions prevailed regarding accessibility. The first, based on improving the conditions of motorized routes to reduce traffic; the second, characterized by reducing vehicle stocks

caused a rapid metropolization process as the area became a pole of attraction of both capital and labor. Nowadays, it represents about 6.6 % of the national GDP, concentrating 5.3 million inhabitants in an estimated built area of 504 km² throughout 18 municipalities that add up to a total administrative area of 7,657 km²; see Figure 1.

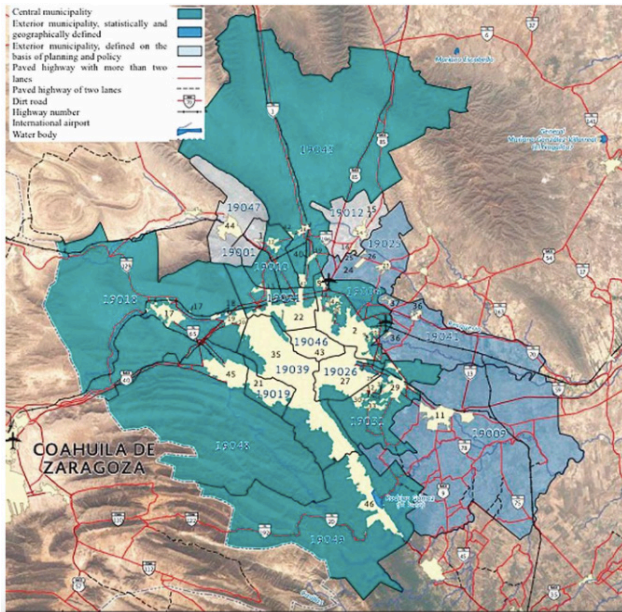


Figure 1. Monterrey Metropolitan Area

Source: www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825006792.pdf

Due to urban sprawl, the privatization of public space and the radial urban mobility model that characterizes it, coupled with the low quality of public transport service, the ZMM has stood out in recent years for its high rates of motorized mobility and degradation of air quality (INECC, 2011; Mayora, 2019). This situation has resulted in long travel distances and significant inequalities between private and public transport. It has been estimated that on average a person travels 14.1 km in private transport and 21.8 km in public transport, with typical travel times of 33 and 68 minutes respectively (SEDESU, 2020).

The Climate Change Action Program of Nuevo Leon 2010 - 2015 (a subnational level program), figures as one of the first governmental responses addressing transport impacts. The program established a goal of mitigating 1.55 million metric tons of CO₂e by 2015 from a base line of emissions of 30.3 million metric tons of CO₂e (SEDESU, 2010). To accomplish this, 20 mitigation actions in strategic sectors were planned, among which the use of energy by industry and transport stands out due to the contribution of such sectors to the total GHG emissions of the state of Nuevo Leon (representing 60% of the total) (SEDESU, 2010). Specifically in relation to transport, projected measures included: promoting an efficient management of freight transport; developing a trunk road system; facilitating public transportation; expanding Monterrey's subway system reach (Metrorrey) with feeder routes; and modernizing the city's vehicle fleet (Ibid). Despite such measures, the predominance of automobiles has not diminished, a reality that elucidates why in 2013, within the Urban Development Plan of the municipality of Monterrey, Transport Oriented Development

(TOD) zones were proposed to increase density around subway lines and BRT systems while slowing down urban sprawl and promoting public transport. It is worth noting that a recent inventory of GHG emissions at the metropolitan level was released in 2022 (Inventario de Emisiones Atmosféricas del Área Metropolitana de Monterrey). Unfortunately, data on absolute emissions is not publicly offered (preventing any evaluation over time). While the weight of different sources of GHGs and other air pollutants is reported, it is possible to corroborate that transport is still one of the main contributors.

Since the aforementioned policies and actions have not been fully implemented, the modification of the urban structure has not been significant. Imbalances in land use persist. This is due to: 1) The bulk of commercial activity and services still concentrates in the city's downtown, and 2) The growing dispersion of residential land uses, the prevailing socio-spatial segregation dynamics, and the unequal access to services, public space, and urban green areas (Aparicio & Escobar, 2016; Aparicio et al., 2011); see Figure 2.

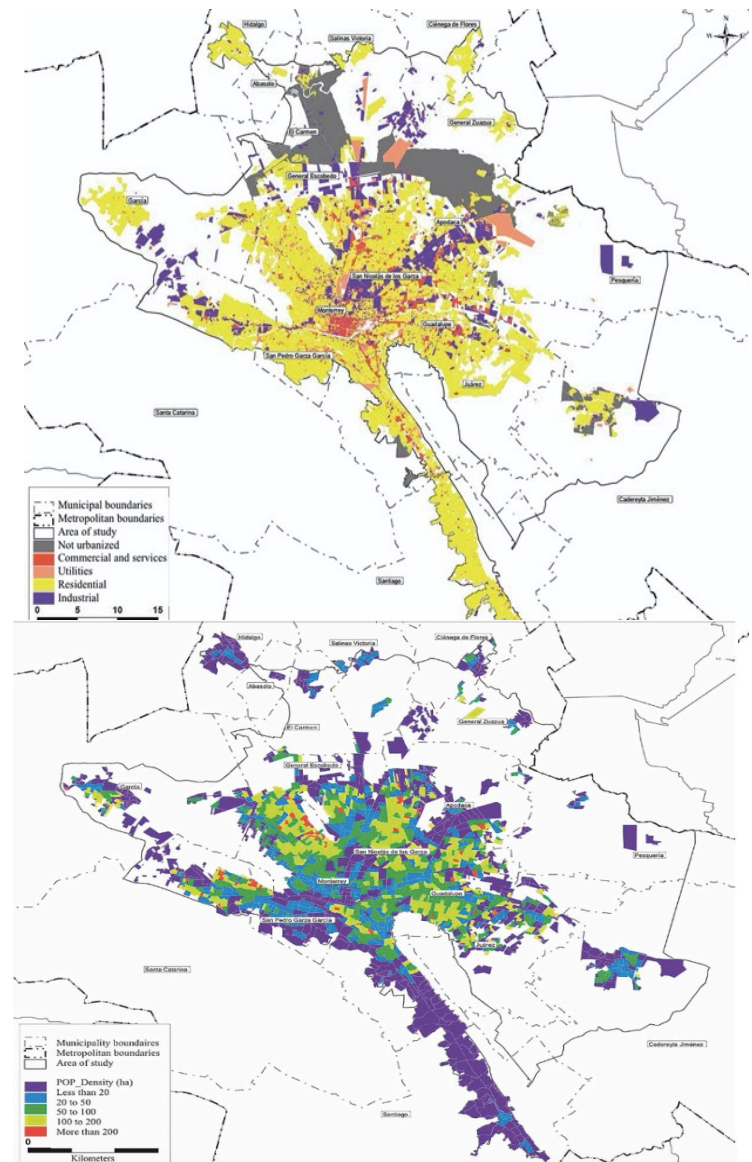


Figure 2:

Top - Lands use

Bottom - Population density in Monterrey Metropolitan Area

ZMM continues to experience an increase in automobility, car congestion, and vehicular accidents, all to the detriment of the use of public transport, which, in addition to being expensive and of poor quality (López, 2021), was reduced to 20% of its capacity during COVID-19. This in turn impacted the mobility of the most vulnerable populations, both in terms of travel times and potential risk exposure levels. The key vulnerability drivers in a disease transmission scenario in ZMM are the current urban form and urban structure (Suárez et al., 2020).

In this context, actions to improve transition spaces are particularly relevant, which according to the federal Law on Human Settlements, Territorial Planning and Urban Development, include sidewalks, walkways, squares, parks, gardens, and green areas with free access. Such spaces are indeed vital for exercising citizen rights, including the right to mobility, which in turn directly relates to the right of accessing public health, a healthy environment, as well as freedom, equality, security, and inclusion (CNDH, 2016:8).

The role played by public transport and public space is also essential in the face of the necessary post-pandemic economic reactivation. For this reason, Mexico's Constitution, in its article 11, establishes the right to free mobility throughout the territory, conferring on the Ministry of Communications and Transportation (SCT) the preparation of policies and programs to ensure such rights (CNDH, 2016).

To advance in this direction, a more robust governance for mobility seems to be necessary. The Mobility and Accessibility Institute of Nuevo León plays a central role due to its powers to plan and direct actions aimed at guaranteeing the human right to mobility that is promised in the Political Constitution of Nuevo León, but also to observe compliance with regulations regarding the transport of people and goods within the state. Additionally, Monterrey's Secretariat for Sustainable Urban Development (SEDUSO) oversees conducting urban development, mobility, and climate change actions in conjunction with surrounding municipalities. Likewise, there are non-profit organizations that can enrich governance for mobility as they are interested in promoting active mobility. Since numerous fatal road accidents are daily parts of local statistics, the objective of the latter is to defend the rights of pedestrians, cyclists, and users of public transport within a context of limited or deficient conditions for these modes of travel to be safe and affordable. Other relevant actors are universities, who, from their expertise, have created projects of great social value that contribute to a culture of sustainable mobility, as it is briefly described in the following subsection.

- **Advancing alternative mobilities.** Some interventions to promote alternative mobilities in ZMM before and during the health emergency are succinctly described below. Table 1 presents six initiatives, four implemented by local governments and two by universities, the latter of which is relevant due to the weight of study trips with respect to other travel purposes: 18% of Monterrey commuters report that the main travel purpose is study, which is placed second just after work with 44% (SEDESU, 2020). In the

following subsections these initiatives are briefly reviewed.

Government Actions. Due to the benefit granted by public transport as the means most used by the population in Latin America (Vasconcellos & Mendonça, 2016), and with the crisis it faced during the COVID-19 pandemic given its conditions, the municipality of San Pedro Garza García enabled travel alternatives that could reduce infections, while promoting physical activity to mitigate chronic aggravating diseases such as obesity or diabetes. As indicated in table 1, the implementation of 6.5 km of emergent cycling lanes and 100 free-loan bicycles was promoted by the Municipal Institute of Urban Planning with the technical advice of other organizations such as ITDP and the support of Mobike, a micro-mobility company (Aguirre et al., 2020). Next, the State Government, through the Ministry of Mobility and Transportation, announced the provision of 400 more bicycles and the projection of a metropolitan network of 95 km of emerging bike lanes in the municipalities of Monterrey, San Nicolás, Escobedo, and Santa Catarina.

In contrast, the government also decreed business activities as essential, which led to support from the private sector for increasing the provision of buses for transporting employees (López, 2021). About 4,500 public transport units were intended to serve private companies, which lessened the capacity of the municipality's public transport.

Finally, to support intermodality, the Escobedo government opted to implement a Sunday cycling route, which consisted of a circuit that connects two neighboring municipalities with the metro stations and main roads. Yet, due to the nature of the initiative, the promotion of such an intermodality was limited to leisure travel that is typical of weekends.

It is worth noting that initiatives to promote cycling had mixed results. In the case of the emergent bike path of San Pedro Garza García, it has been reported that 21.6% of the population whose main mode of travel was motorized private vehicles commuted by bicycle daily (IMPLANG, 2021). In other cases, as in the Escobedo municipality, the emergent bike path has been criticized by cyclists who have requested modifications to increase their connectivity and security by placing the path on the sides of streets, not in the middle. In the San Nicolás municipality, after the COVID-19 lockdown, 21 km of emergent bike paths were abandoned. An unfinished bike path in Nogalar is simply not used as it does not fulfill its intended connectivity function (reaching the UANL). In the meantime, a project of 117 km of green corridors, parks, and bike paths at a metropolitan scale has been promised with an estimated investment of 1,000 million pesos. The project, which is to be completed by 2024, received the prize for the best initiative for public space by "Alcaldes de México." The expected benefits of sustainable mobility are yet to be seen.

Universities' Actions. Mobility in Monterrey has been pursued through the provision of road infrastructure, an increase in car lanes on main roads, including roads of controlled access (privatized). Building pedestrian bridges has been one of the "solutions," as it has been thought to

Table 1. Actions and projects for promoting mobility in Monterrey Metropolitan Area before and during COVID-19 emergency.

<i>Action or Project</i>	<i>Locality</i>	<i>Type of actor</i>	<i>Entity</i>	<i>Objective</i>	<i>Before 2020</i>	<i>After 2020</i>	<i>Area of influence</i>
"Distrito Tec"	Complete streets	Monterrey	University	ITESM	Fight insecurity crisis	x	Municipal
	Cycling connectivity	Monterrey	University	ITESM		x	
"Connecting UANL: bicycle roads and pocket-parks "	San Nicolás de los Garza	University	UANL	Increasing active mobility and intermodality or the use of more than one form of carrier	x		Campus of the university
"Reducing public transport units demand"	Monterrey	Government	IMPLANC	Increasing the number of buses for transporting employees		x	Metropolitan
"Green corridors: complete streets "	Monterrey	Government	IMPLANC	Enhancing active mobility and intermodality		x	Municipal
"Emergent Cycling route "	San Pedro Garza García	Government	IMPLANC	Enhancing active mobility and intermodality		x	Municipal
"Sunday cycling route "	Escobedo	Government	IMPLANC	Promoting physical activity		x	Municipal

ITESM: Monterrey Institute of Technology and Higher Education (tec.mx)

UANL: Autonomous University of Nuevo Leon (www.uanl.mx)

IMPLANC: Municipal Institute for Urban Planning and Coexistence of Monterrey (www.implancmtj.org)

Source: authors' own elaboration based on information provided by local actors.

reduce urban road congestion. A paradigm shift in Monterrey has been recently taking place. For example, the Monterrey Institute of Technology and Higher Education (ITESM), developed the "Tec District" project with the goal to achieve universal accessibility in accordance with the hierarchy of the mobility pyramid (which prioritizes active mobility, followed by public transport). This initiative pursues a sustainable and safe form of mobility involving 24 neighborhoods, 26,371 inhabitants, 452 hectares, and 11,206 homes through the design of complete streets, mini parks, markets, and traveling exhibitions, prioritizing active mobility (walking and micro-mobility). In the words of the ITESM director of mobility, "... the project arose from the academy, from the students of the Faculty of Architecture and Urbanism, and in the course of its development, the municipality of Monterrey supported institutionally in certain stages" (interview: April 24, 2022). Since then, ITESM has sought to expand the scope of the project, leading the implementation of an articulated bike path circuit that connects the university's campus (Distrito Tec) and downtown Monterrey in February 2021.

Unfortunately, ITESM's initiative was prolonged indefinitely and reevaluated in the face of the COVID-19 pandemic to the extent that ITESM's community has changed the way of moving on and off campus. The foundation of a more respectful and inclusive mobility culture by attaining an increase in public transport and bike trips with a reduction in car trips has been recognized, for example by the WRI Ross Prize for Cities due to the valuable incidence of the above-mentioned bike path circuit on urban transformation practices.

Furthermore, the Autonomous University of Nuevo León (UANL) sought to rethink its mobility in 2017 to explore paths of action for optimizing travel times, reducing car use, and offering public secure spaces that encourage social interaction. Based on a study of the modal distribution of its community, which in 2017 revealed that 79% of its staff and 26% of its students traveled by car, it developed a platform called "Conecta UANL." The initiative considered the construction of 12,000 m² of new pedestrian areas, 3.2 km of bicycle roads, a bicycle loan program, a multimodal

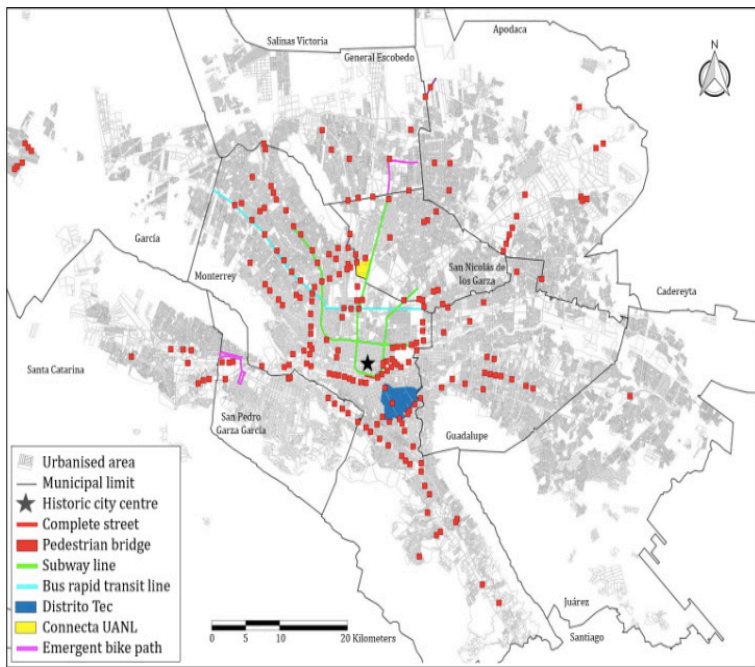


Figure 3: *Mobility infrastructure and implemented projects in the Monterrey Metropolitan Area before and after the COVID-19 emergency.*

Source: authors' own elaboration based on INEGI (2020), IMPLANC (2013), UANL (2019), information distilled from interviews to local actors, and personal insights.

comprehensive mobility system, among other actions, all aiming to generate a paradigm shift with respect to the motorized mobility model that prevails in ZZM. Although all activities were suspended during the COVID-19 pandemic, the University persevered in developing the project, seeking to extend its social scope and its contribution to mitigate climate change (UANL aims to reduce 30% of its GHG emissions through a diversity of actions, including active mobility, energy efficiency, and revegetation; see: <http://sds.uanl.mx>). In 2020, UANL occupied the 18th position of the UI GreenMetric World University Rankings for its outstanding role in advancing sustainability through infrastructure, energy, and transportation (University of Indonesia, 2021).

These universities' initiatives show positive results regarding their efforts to attain sustainable mobility even during the pandemic, as they provided affordable alternatives for the population in their daily commutes. Actions being taken by the UANL and ITESM focused on improving intermodality and advancing sustainable micro-mobility hand in hand with vital education, the creation of social awareness, identity and sense of place.

Nevertheless, the decisions of local governments that put the interests of business actors above those of society, show contradictory positions that in turn expose the lack of coordination between different actors. That lack of articulation explains why most of the benefits are observed only in the proximity radios of the interventions and without a comprehensive understanding of the problem, mostly at a metropolitan scale in which 29% of all

trips generate. This situation led, particularly during COVID-19, to an increase in waiting times for urban routes up 30 minutes, leaving the entire metropolitan area without access to safe mobility alternatives and encouraging the use of cars.

Figure 3 shows the spatial distribution of mobility-related actions or projects mentioned above.

Future Implementation and Concluding Thoughts: Towards an urban sustainable mobility. Trends of increased car ownership and reduced use of public transport observed during COVID-19 have not been reversed, a situation that sets the pattern of stagnation in the incipient sustainability goals held in Monterrey. As a lesson learned, it can be pointed out the unsustainable and unfair nature of the “hypermodern” model promoted in Monterrey, which has intensified land, energy, and other resources consumption and amplified the generation of waste and emissions. It has also mostly benefited a fragment of the population, making the most vulnerable invisible, the latter a central point in the debate opened in June 2022 regarding the initiative for developing a climate action plan for ZMM. Several studies on ZMM show how urban deficiencies of a disorderly growth – generated by the separation of land uses, numerous vacant lots, and low density—have caused long journeys and made the public transport system underutilized. In addition, the recent recognition of the right to active modes of movement has suffered setbacks by reducing the length of pedestrian paths, from 19.6 km in 2011 to 17.4 km in 2020 (INEGI, 2020). In contrast, the city's pedestrian bridges, which were 134 in 2013, have increased to 309 in 2020, revealing the prioritization of automobility. Another key factor is the location of jobs, since they are concentrated in the municipalities of Monterrey, San Pedro and San Nicolas de los Garza, while current housing development trends are towards the periphery, coupled with the increasingly evident depopulation of the metropolitan center.

Considering the observed circumstances in the Monterrey Metropolitan Area, it is difficult for the analyzed actions and projects on sustainable mobility to gain the prominence required to significantly contribute to local climate change action. Despite being the second most populous metropolitan area in Mexico, which heavily depends on motorized mobility, a situation that favors the growing economic, environmental, and ideological gap between practices and sustainability, work must be done on accessibility, encouraging resources to be allocated primarily to the decarbonization of the city, for which a change of ideology will be necessary as the symbolism attributed to the car continues to be determinant in everyday practices.

In such a scenario, achieving accessibility will require the creation of short, medium, and long-term urban development plans that prioritize comprehensive planning and management of the territory, encouraging the advancement of mixed land uses and appropriate medium densities that enable the formation of urban centers and highly articulated urban subcenters through mass public transportation systems

(ideally electrified). Such centers and sub-centers will have to be created as employment-generating spaces, with sufficient and quality public services and infrastructure to reverse the concentration of employment in central areas, hand-in-hand with the phenomenon of dispersion of residential uses in the periphery. This model of urban transformation is what has been called by the IRP (2018) as “strategic intensification,” in a way the backbone of the 15-minute city.

Moreover, in addition to impeding the privatization of neighborhoods that fragment urban space (urban self-segregation of high and middle-income classes in 2018 represented 10.6% of the total urbanized area; Pfannenstien et al., 2018), it is also essential to stop the proliferation of larger roads and other interventions that promote automobiles. Likewise, more affordable, socially inclusive, and safe active mobility projects are required to enable connectivity with public transport systems, which in turn must be improved and extended when appropriate. In this way, progress could be made in fulfilling the right to mobility through a city that is designed on a human scale to promote the advancement of increasingly efficient, affordable, accessible, and sustainable mobility schemes at both the local and metropolitan scales.

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Additional Data

- **Gross National Income (GNI):** 24,970 USD [2023]
 - **Population Density:** 697.5 people/km² [2020]
 - **Gini Coefficient:** 43.5 [2022]
 - **Human Development Index (HDI):** 0.781 (High) [2022]
 - **Type of Climate Intervention:** (Hybrid) Adaptation and Mitigation
-