Spatial Planning and Transport-Related Social Exclusion: the case of Mexico City-airport suburban railway line extension

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A B S T R A C T

The planning and development of means of transport between the city and the airport has played a fundamental role in the economy of cities. In recent years, this planning has focused on the search for sustainable public transport that integrates the majority of the population in the urban area. From a socio-economic point of view, the question of social inclusion of the transport systems has been discussed in the last 20 years in Geography of Transports studies where new methodologies have been developed such as the transport-related social exclusion that includes concepts of accessibility and equity (Church et al, 2000; Lucas, 2019). However, the case studies carried out under this approach have not yet addressed the situation of inclusion or exclusion of the urban space located near mass transit lines projects connecting two economic poles. Therefore, this research addresses the issue of integration of the metropolitan areas crossed by transport rail networks that link the airport with the city centre by looking at spatial planning. In particular, this research aim to focus on how spatial planning in the implementation of suburban railway connecting Mexico City to the new airport impacts the urban space it crosses. Specifically, this paper will be looking at the Transport-Related Social Exclusion approach as well as the accessibility and the right to mobility to understand the relationship between space and transport for proposing improvement in spatial planning policies using quantitative methods such as spatial analysis through GIS and qualitative methods such as transport project assessment. In conclusion, this work shows the beneficial impacts in the study area close to the new train stations at the end of the 2 constructions phases thanks to a joint application between urban development policies and programmes and the suburban train construction project, however, the rest of the study area may continue to be socially excluded.

Keywords: Transport-related social exclusion approach, accessibility, right to mobility, sustainable mobility, city-airport railway, social exclusion.

A B S T R A K T

Die Planung und Entwicklung von Verkehrsmitteln zwischen der Stadt und dem Flughafen hat eine grundlegende Rolle in der Wirtschaft von Städten gespielt. In den letzten Jahren hat sich diese Planung auf die Suche nach einem nachhaltigen öffentlichen Verkehr konzentriert, der die Mehrheit der Bevölkerung im Stadtgebiet integriert. Aus sozioökonomischer Sicht wurde die Frage der sozialen Inklusion der Verkehrssysteme in den letzten 20 Jahren in Studien zur Geographie des Verkehrs diskutiert, in denen neue Methoden entwickelt wurden, wie z. B. die verkehrsbedingte soziale Ausgrenzung, die Konzepte der Zugänglichkeit und Gerechtigkeit umfasst (Church et al, 2000; Lucas, 2019). Die im Rahmen dieses Ansatzes durchgeführten Fallstudien haben sich jedoch noch nicht mit der Situation der Inklusion oder Exklusion des städtischen Raums befasst, der sich in der Nähe von Nahverkehrsprojekten befindet, die zwei wirtschaftliche Pole verbinden. Daher befasst sich diese Forschung mit der Frage der Integration des städtischen Raums, der von Verkehrsschienennetzen durchquert wird, die den Flughafen mit dem Stadtzentrum verbinden, indem sie die Raumplanung betrachtet. Im Besonderen zielt diese Forschung darauf ab, sich darauf zu konzentrieren, wie sich die Raumplanung bei der Implementierung der Vorortbahn, die Mexiko-Stadt mit dem neuen Flughafen verbindet, auf den städtischen Raum auswirkt, den sie durchquert. Konkret werden in dieser Arbeit der Ansatz der verkehrsbedingten sozialen Ausgrenzung sowie die Zugänglichkeit und das Recht auf Mobilität betrachtet, um die Beziehung zwischen Raum und Verkehr zu verstehen und Verbesserungen in der Raumplanungspolitik vorzuschlagen, wobei quantitative Methoden wie die Raumanalyse durch GIS und qualitative Methoden wie die Bewertung von Verkehrsprojekten eingesetzt werden. Zusammenfassend zeigt diese Arbeit die positiven Auswirkungen im Untersuchungsgebiet in der Nähe der neuen Bahnhöfe am Ende der 2 Bauphasen dank einer gemeinsamen Anwendung zwischen Stadtentwicklungspolitik und -programmen und dem S-Bahn-Bauprojekt, jedoch kann der Rest des Untersuchungsgebiets weiterhin sozial ausgegrenzt sein.

Stichworte: Verkehrsbezogener Ansatz zur sozialen Ausgrenzung, Barrierefreiheit, Recht auf Mobilität, nachhaltige Mobilität, Stadt-Flughafen-Bahn, soziale Ausgrenzung.

Table of Contents

Introduction

The planning of urban public transport systems has been an aspect that cities have taken into consideration throughout their history in order to be able to move more quickly and efficiently. In recent years, this planning has focused on the search for sustainable public transport that integrates the majority of the population in the urban area where environmental and socio-economic aspects are taken into consideration for its implementation. The Mexico City Metropolitan Area has several modes of transport to serve the urban population, with the metro being the backbone of the transport system.

The construction of the New Mexico City Airport (AIFA) in the Northern Zone of the Metropolitan Area will be a new economic centre for that part of the city. To connect the city centre with the new airport, it is planned to expand Line 1 of the suburban train system with a branch to the airport terminal. This light rail expansion will have 7 stations in total at the end of the two construction phases. This kind of transport systems that link the city to the airport have played an important role in the economic and urban development of cities.

However, most of the existing transport networks connecting the airport to the city centre, as well as some under construction, respond more to economic interests based on traditional supply and demand perspective than to planning with a social vision in which aspects such as the right to the city and the right to mobility are relegated to second place. It is important to consider that all the decisions taken by the stakeholders correspond to a series of factors that were decisive in the execution of the project.

The preponderance of the economic aspect as the guiding axis of mobility policies where transport planning is derived leads to serious consequences in the integration or exclusion of urban areas. From a social point of view, aspects such as spatial segregation and marginalization are exacerbated by the failure to provide access to other services. From an environmental point of view, it generates a disorganized growth of urban areas as well as an increase in the preference of the automobile as a means of transportation, which involves the development of other problems such as increased pollutant emissions.

Therefore, the actors in the planning of public transport systems must consider the environmental and socioeconomic aspects equally for a better urban integration.

This research addresses the impacts on the Mexico City Metropolitan area crossed by the expansion of the transport rail networks that link the airport with the city centre by looking at spatial planning. In particular, I aim to focus on how spatial planning in the implementation of a mass rail transport system connecting airports and the city centre reconfigures the urban space it crosses. The research will study this impacts by looking into the Transport-Related Social Exclusion approach (TRSE), as well as the accessibility and the right to mobility to understand the relationship between space and transport for proposing improvement in spatial planning policies.

This research analyses 9 Municipalities of the Mexico City Metropolitan Area in order to demonstrate the impact and the degree of integration or exclusion of the new extension of the Suburban train with the metropolitan area located between the city centre and the airport. Both qualitative and quantitative methods will be adopted for this purpose. Quantitative method is used to measure certain TRSE indicators supported by cartographic tools, whilst qualitative method is used for the analysis of the integration of the concepts related with the new mobility paradigm and TRSE approach in the transport system projects and mobility public policies.

The text is made up of four chapters, each of which responds to the particular objectives of this research. The first one mentions the new perspectives in the study of mobility and the concepts related to the focus of this research. The second, through the TRSE approach, diagnoses the current state of the case study prior to the construction of the new suburban transport system. The third chapter evaluates urban policies and programmes in relation to mobility through the analysis of official documents. And the fourth and last chapter shows the future impacts of the implementation of the suburban train in the area. Finally, the conclusions develop a discussion of the general results of the research work, pointing out the favourable impacts on the space near the light rail stations as well as emphasising the areas that would need more intervention in order to be integrated into the new mobility pattern.

Chapter I. Theoretical-conceptual framework of the new mobility paradigm and Transport Related Social Exclusion approach.

This first chapter develops the mean concepts used in mobility and transport studies as well as it explains the approach about the relation between social exclusion and transportation based on a literature review of different case studies and authors who has used and developed this innovative approach. This chapter is divided in 4 sections.

The first section is about the new mobility paradigm which includes concepts as sustainable mobility, the right of mobility and how those concepts has been developed in transport geography, one of the mean social science that studies the mobility phenomenon. In the second chapters, the Transport Related Social Exclusion approach is explained followed by two mean concepts related to this scope: accessibility and social exclusion. For the third section, a literature review showed the different methods and case of studies related to transport and social exclusion in cities and rural areas from different parts of the world. And the last part of this chapter describe the methodology applied in this work in both, quantitative and qualitative methods.

This chapter aims to be basis of the theoretical-conceptual framework for the entire research work for a later application and development in the second and third chapter jointly with the results and discussion part.

1. New mobility paradigm

The new mobility paradigm has been the basis for the most recent research on the study of the way in which society moves today. It addresses different concepts that have been reflected in the urban development plans of large cities with a view to making mobility more friendly and respectful of the environment, as well as socially and economically inclusive. This new paradigm brings the concept of sustainable mobility that in some cases has legally become into the idea of the right to mobility. These concepts has been addressed by various disciplines, but in this section the emphasis is on the perspective of transport geography.

1.1. Sustainable mobility and spatial planning

The concept of mobility is understood as the quality of human beings to be mobile as well as the ability to physically move through space. (Berger, Freindt, Holden, & Rubik, 2014). Based on the above, the new paradigm of sustainable mobility has brought about a change in the way people think human being moves in space and the reasons why they do. The study of this new mobility phenomena has taken an important role nowadays with the aim of stablishing new policies that help to manage and plan the space according to the new needs.

This new way of thinking has led to face a complex transition from a traditional to a totally innovative system where different aspects are taken into consideration. This transition has brought about new challenges to overcome that are related to the traditional systemic perspective of mobility that encompasses: the current car dependency, the malleability of the term sustainable across the world, as well as the lack of understanding and connection between the needs of users and the policies implemented by the authorities (Berger, Freindt, Holden, & Rubik, 2014).

Sustainable mobility confronts the old system or idea of mobility where most transport projects are based on economic factors over social and environmental factors. A clear example is the Mobility-induced social exclusion phenomena that has developed with the car-dependency in peripheral and rural areas, since not having access to a car, they are automatically immobilised from their place of residence due to the lack of urban public transport (Berger, Freindt, Holden, & Rubik, 2014).

Similarly, this preponderance of the economic disciplines in mobility has led to the way projects are implemented being based on two principles: cost-benefit demand and the suppression of distance over time. So through a sustainable mobility approach these two principles are expanded and combined with the inclusion and understanding of physical aspects such as urban sprawl and vehicular traffic as well as social aspects such as people and the way they use space. (Banister, 2008).

The transition to sustainable mobility consequently brings with it a number of disputes or challenges among the actors involved in mobility along with purely cultural, political and economic issues. (Berger, Freindt, Holden, & Rubik, 2014; Urry, 2012). The search for sustainable mobility that is more socially just and environmentally friendly requires a fundamental intervention in human behaviour, habits, practices, the economic and political system as well as the landscape (Urry, 2012).

Despite the aforementioned challenges, 4 actions leading to sustainable mobility have been proposed: reducing the need to travel through trip substitution with the help of new technologies; encouraging a modal shift of mobility through cycling, walking or increased use of public transport in order to reduce car use; reducing distances through new mixed land use policies where the concentration of activities and population density in urban space is increased; and increasing the efficiency of new technologies in the engineering aspect such as improved fuels and renewable energies (Banister, 2008).

In order to bring these actions to reality through adequate spatial planning and urban policies, a number of key elements have been described. However, the main element is the participation of the various actors involved and interested in the improvement of mobility, since through dialogue and discussion it is possible to reach terms on which the majority can agree especially for achieving public acceptability of projects or policies. Through public acceptability the desired change will be easier and fairer to implement from the individual to the collective level (Banister, 2008). Otherwise, the result will be the imposition of a single idea against the wishes or interests of the majority. This lack of participation in policy and project development in the past has led to serious problems that cities are currently facing in terms of mobility.

1.2. Right to mobility

The right to mobility has been discussed in the literature dedicated to territorial planning in addition to sustainable mobility. It is a term derived from the concept of the right to the city. From a general point of view, the right to the city is understood as the right of the urban population to the appropriation of space and active participation in decision-making,

it looks for the construction of the city by all its inhabitants (Verlinghieri & Venturini, 2018; Lefebvre, 1968).

Related to the previous paragraph, the right to the city and the idea of sustainable mobility agree that they seek to integrate the participation of all the actors involved in this essential human activity with a special emphasis on those people who have historically been marginalised from decision-making (Verlinghieri & Venturini, 2018; Cresswell, 2006). It is also a concept that seeks the full integration of citizens into the urban space in an easy and safety way together with improving travel conditions within the city whilst reducing the negative impact on the environment.(Verlinghieri & Venturini, 2018; Hickman & Banister, 2014).

The right to mobility can be described as the right to access the city through free movement in the urban space. The main purpose of the movement of people is to fulfilling certain needs or having access to other rights such as education, health, culture, among others. Therefore, the right to mobility, especially in urban areas where it is more evident, is in itself a social process and at the same time an element that intervenes in other social processes (Verlinghieri & Venturini, 2018).

Due to the fundamental importance of mobility in people's daily lives, the concept has recently been integrated into the scientific literature and at the same time, thanks to social movements that fight to reduce mobility issues, the right to mobility has been recognised as a human right in local, federal and international legislations. Mobility in legal terms ranges from the basic need of human beings to move within the space they inhabit, to migration or tourism issues. (Cresswell, 2006). However, in terms of urban planning, the right to mobility focuses on the concepts of road safety, efficiency and quality, environmental friendliness, accessibility, inclusiveness and equality (Poder Legislativo Federal. Cámara de Diputados, 2020).

In addition to these changes in legislation where mobility is integrated as a right, it has brought the modification of the implementation and design of urban projects based on new spatial planning, land use planning along with the new needs of the population

(Miralles-Guasch, 2002). Therefore, both the concepts of sustainable mobility and the right to mobility can be applied immediately in the transformation of urban flows from an individual to a collective perspective, through policy implementation or a change in mobility culture and behaviour.

1.3. Geography of transports

One of the best ways to study the mobility of people in their different modes of travel is through the study of transport systems. The study of transport in cities has been taken as an object of study by different social sciences as well as engineering. Among the social sciences, sociology and geography stand out. For geography, the study of transport goes back to its interaction between the mobility of people and space-time. More specifically, transport geography examines the spatial impacts of transport systems and transport policies at different scales (Knowles, 2020).Therefore, the study of mobility and urban transport from a transport geography point of view is fundamental to be able to analyse and understand most of the elements involved in this activity.

Historically, for the 20th century, the great approaches to the geography of transport could be mentioned among the studies of model building, analytical-empirical, GIS behavioural, humanist-cultural and Marxist-social theory, but the weight of research was in the fields of engineering and neoclassical economics (Goetz, Vowles, & Tierney, 2009). In general terms, the study of the transport systems has always considered that a high connectivity public transport systems are those in which multiple routes provide for quick and efficient travel to a broad range of employment and service destinations with a minimum of waiting and interchanging between services (Dodson, Gleeson, Evans, & Sipe, 2007).

Among the studies in geography of transport with a merely quantitative/traditional approach, those related to the modelling of mobility patterns has been used in decision making for the implementation of projects (Shaw & Hesse, 2010). This framework is known as analytical approach originated in the 1960s. Spatial science or positivist approach has lost visibility in the field of urban studies as well as the use of quantitative

and analytical methods due to the emergence of new social and critical theories (Goetz, Vowles, & Tierney, 2009).

In recent years, this new sustainable point of view has attracted the attention of researchers. Some authors suggest that a better way to counteract the effects of climate change is to modify the habits developed in recent times, however these actions would lead to a struggle of interests between various actors in the global economy (Berger, Freindt, Holden, & Rubik, 2014; Schwanen, 2019; Urry, 2012). On the other hand, it has also been considered that in order to have sustainable mobility, methods and plans for a better integration of vulnerable groups or those that have been historically segregated from transport systems should be included in the studies (Lucas, 2019; Lucas & Musso, 2014).

The issue of the right to mobility has been poorly addressed by most studies of transport geography (Verlinghieri & Venturini, 2018). However, the new paradigm of mobility within the geography of transport encompasses issues of freedom, justice and inequality (Shaw & Hesse, 2010). In transport geography, critical theory has addressed social and environmental issues such as accessibility and equity for low-income people, minorities, and rural populations, as well as critical analysis of transport policy. It is also important to mention that critically focused studies in addition to relying on qualitative methods do not exclude the use of quantitative methods as a fundamental part in the understanding of social phenomena (Goetz, Vowles, & Tierney, 2009).

As observed in the previous paragraphs, transport geography has different approaches to address current mobility-related problems. For the purpose of this research, a special emphasis is placed on addressing the facts and phenomena derived from poor or lax planning of the metropolitan transport system with the help of the approach of transport related social exclusion, which will be developed with greater emphasis in the following section.

2. Transport Related Social Exclusion

The study of transport systems and the relationship between them and the territory has been done in different ways over time. The application of methodologies mostly from an economic perspective has resulted in the lack of consideration of some social aspects that cannot be quantified from an economic point of view. Therefore, the approach developed in this section describes an analysis based on social aspects and the impacts of transport on the inclusion of the population in the urban dynamics.

2.1. Transport Related Social Exclusion approach

Transport Related Social Exclusion (TRSE) approach addresses the inequality of transport and its consequences in space (Lucas, 2019). It is characterized by measuring different kind of issues. The three main issues are: the spatial, such as accessibility to transport; the temporal, such as availability; and the social, such as population characteristics and activity participation (Kamruzzaman, Tigitcanlar, Yang, & Mohamed, 2016). Moreover, this approach examines the impact of mobility projects, policies and new technologies on disadvantaged or marginalized groups or spaces (Lucas, 2019).

The term TRSE comes from the last decade of the 20th century and the beginning of the 21st century from the work carried out by various researchers in the United Kingdom related to the disadvantages of transport and its connection with the social exclusion of certain types of people or entire communities, which were set out in the document published by the Social Exclusion Unit of the UK. (Lucas, 2012; Social Exclusion Unit, 2003).

Over time, this new approach has been taken up by various disciplines such as sociology, psychology, political science and geography in order to understand the causes and consequences of social exclusion or the lack of accessibility to basic services. This type of approach has also been part of the basis of new policies that seek to reduce inequalities in certain cities in Europe and Australia (Lucas, 2012). However, there is no single methodology that follows this approach and there is a diversity of studies that use both quantitative and qualitative methods to study the relationship between lack of transport

and social exclusion, and also a combination of both methods (Lucas, Mattioli, Verlinghieri, & Guzmán, 2016).

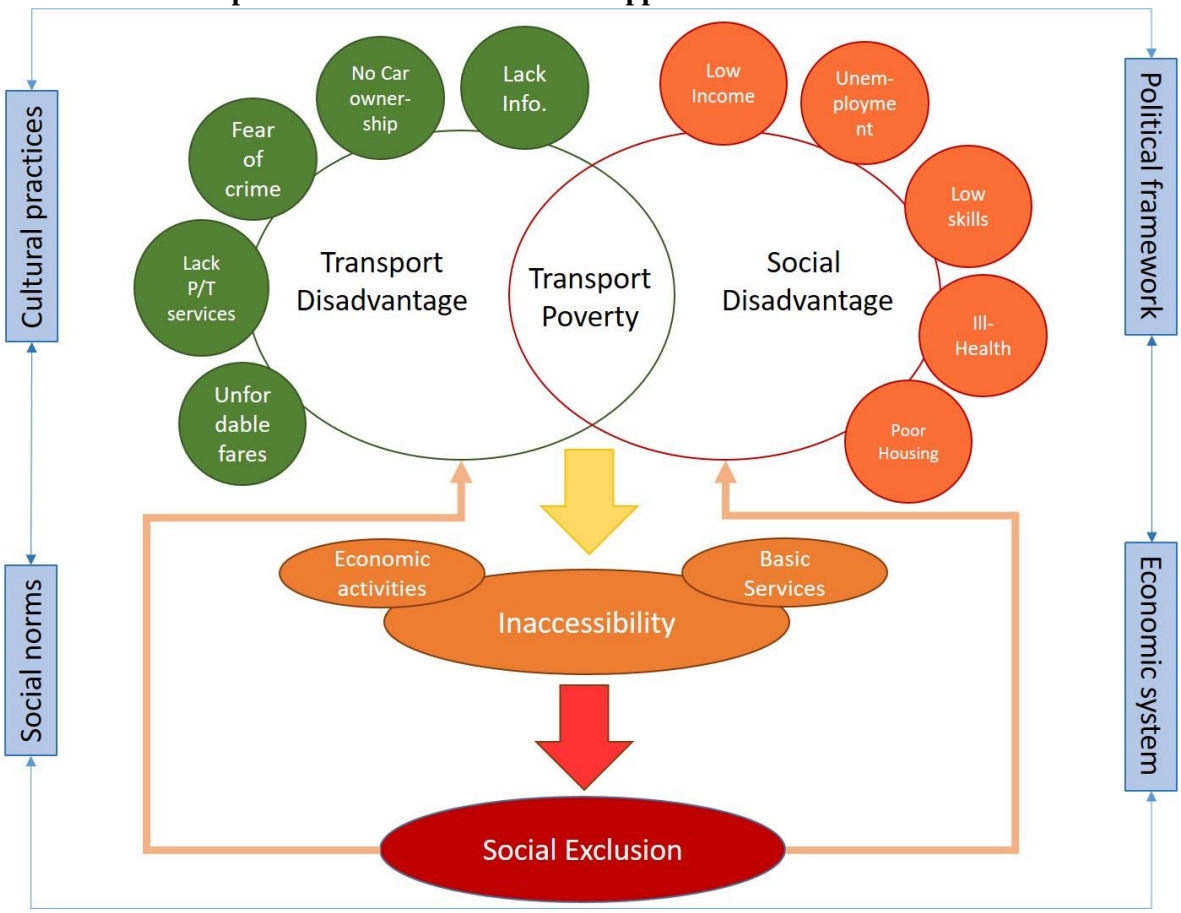
In order to better understand this type of approach, we must start from two basic terms related to transport: inequality which means lack or disadvantage in the use of transport or mobility; and social disadvantage of either the individual or the community. The first is about the lack of a physical mode of transport, such as non-existent transport or a disintegrated, unsafe and inefficient transport system. The second is about the socio-economic characteristics of the individual or community such as low income, lack of services, unemployment, precarious housing and social services such as education and health (Lucas, 2012).

The link between transport disadvantage and social disadvantage is the transport poverty which means a poverty in transport infrastructure, transport systems and transport modes, but some other authors agree on the difficulties of defining this concept because of the broad literature about this topic (Lucas, Mattioli, Verlinghieri, & Guzmán, 2016). Transport poverty leads to a lack of access to goods, services, employment, socio-cultural capital, community networking and decision making. This lack of access to basic services under this approach gives rise to social exclusion. It is important to emphasise that all of these elements have their origins in a number of factors depending on the characteristics of the space that includes the political framework, economic system, cultural practices and social norms (Lucas, 2012). Figure 1 shows the TRSE approach, all the elements above explained and how they are linked each other.

As it was mentioned above, to understand the causes of TRSE, it is also important to draw on the different scales of analysis. Spatially, Geography can study them at three scales: at the micro or local level ranging from the analysis of the individual; the meso level which encompasses the immediate environment of the individual such as the community, neighbourhood or locality; and the macro level which refers to a global systemic context (Lucas, 2019; Urry, 2000).

The TSRE approach involves the analysis of two other concepts: the concept of accessibility and the concept of social exclusion that will be explained in the following sections.

Figure 1. Relation between transport disadvantage, social disadvantage and social exclusion in Transport-Related Social Exclusion approach.



Source: Based on Lucas, 2012.

2.2. Accessibility

Accessibility can be understood as the physical availability of goods and services or the proximity of destinations (Atiullah Saif, Maghrour Zefreh, & Torok, 2018). However, it has been very malleable according to the discipline and the phenomenon to be analysed. From a general point of view, the concept of accessibility can be analysed in two ways. The first way to address accessibility is through applied studies, a practical domain where quantifiable information is generated. The other way to study accessibility is through the

analysis of the concept and the meanings attributed to it, known as definition-based conception (Levine, 2020).

The conception of accessibility within the practical domain is divided into positive and normative. The positive refers to the description, analysis or spatial prediction of accessibility-related phenomena, while the normative refers to its use and guidance within the legal framework as an axis in land use and transport policies, both of which aim to measure, explain or predict urban planning and policy models. On the other hand, the definition-based conception of accessibility refers to the use of mobility and proximity as the main axes for planning and evaluating urban environments while seeking to modify or adapt them to these principles (Levine, 2020).

In the context of transport studies and geography, accessibility refers to the ease of reach of certain spaces and services which, through measurement and comparison, helps to understand the dynamic of an area (Mavoa, Witten, McCreanor, & O'Sullivan, 2012; Atiullah Saif, Maghrour Zefreh, & Torok, 2018). Currently, the concept of accessibility, especially to public transport, has taken on a fundamental role in general studies of transport systems as well as in the design and implementation of urban policies along with concepts such as sustainable mobility, right to mobility, among others. Under this concept, two traditional ways of measuring the accessibility of a space to public transport emerge. These elements are commonly the analysis of the cost of travel and the quality and quantity of transport supply. (Páez, M. Scott, & Morency, 2012).

From the perspective of the TRSE approach, accessibility is seen in three dimensions, related to the geographical scales in which this type of studies can be analysed. The first one is based on the measurement of the opportunities and services to which the individual has immediate access according to his/her place of residence, we could call it a spatial dimension. The second dimension corresponds to social aspects of the community and necessities. Finally, the third dimension is about the characteristics of the individual, that means, the user profile according to the type of public transport and its needs (Lucas, 2012).

All accessibility dimensions are interrelated and for a better analysis, it is vital to take each of them always into account. Based on these dimensions, it is essential to bear in mind that when we are considering policies aimed at improving accessibility to public transport towards reducing social exclusion, we must situate ourselves in context where hypermobility is a characteristic of the global system (Urry, 2000; Lucas, 2012). Hypermobility continues to this day in both the movement of goods and people, so ways must be found to reduce this hypermobility to a minimum in order to have a greater impact on urban policies.

2.3. Social Exclusion

Most studies or analyses that measure the accessibility of a certain individual or community tell us about the degree to which they are included or excluded from the social group or territory to which they belong or in which they are located. Therefore, it is assumed that social exclusion is associated within the terms of accessibility and in some point with social justice (Hine & Kamruzzaman, 2020). Some definitions of social exclusion describe it as the situation in which a person or group of people are at risk of not being part of the society that hosts them (Stanley, Janet, Blabontin, & Hensher, 2019).

In issues of Transport Related Social Exclusion, the individual or group of people are not necessarily in a situation of general poverty, but have lost the ability to move around and access services, employment and/or goods offered by society. However, social exclusion is part of a process of impoverishment over time of the population while at the same time making them invisible in decision-making (Church, Frost, & Sullivan, 2000; Hine & Kamruzzaman, 2020).

As mentioned in the section on the TRSE approach, there are various ways of addressing the factors that cause TRSE. However, a number of typologies have been proposed according to different causes and phenomena as well as approaches. The main factors of exclusion have been categorized by Church, Frost, & Sullivan (2000) into 7 transport-related forms:

1) Physical or tangible exclusion: issues related to the composition of the transport system and the urban environment in which it operates that constrain users. These may be due to physical or psychological impairments.
2) Geographical exclusion: due to lack of coverage by a transport system resulting in the isolation of communities from the main urban centre.
3) Exclusion from services or basic needs: due to lack of time or income to use the transport system that connects to services, goods or rights.
4) Economic exclusion: the main reasons for this are income-related and difficulties in accessing the labour market linked to transport and commuting times.
5) Exclusion based on time: either in transfer or waiting times as well as adequate travel time.
6) Fear-based exclusion: linked to the lack of safe transport that affects different population groups in different ways.
7) Spatial exclusion: where the environment or design of the system does not encourage the use of public space.

In this work, emphasis will be placed on the territorial aspects of the study area without omitting that within these populations there are at the same time different degrees of exclusion depending on their socio-demographic characteristics. There are several publications linking the issue of TRSE and social inequality that exists in urban environments and its interaction with rural spaces. Although there are different types of social exclusion as developed here, it is important to note that this phenomenon is exacerbated in certain social groups such as low-income people, women, people belonging to ethnic minority groups, and people with disabilities. (Hine & Kamruzzaman, 2020), it is therefore essential to take them into account when studying the phenomenon and in the development of public policies.

3. Case studies in literature review

The concepts developed in the previous sections have been applied and analysed in various ways over the last few years. This section will mention some studies that serve as

a basis for the development of this research. Within this universe of transport studies, various methodologies have been used, which will be briefly described below.

3.1. Transport and (in)equality

Research addressing issues related to public transport and equality has a variety of perspectives and methodologies. However, most papers agree that the lack of public transport supply has shown the difficulty of access to employment and services if the population belongs to a vulnerable group. This lack of transportation generates a reduction in the ability to move around to get or cover basic needs and solve economic or social issues. This situation has led the population affected to search new ways of getting around, some examples could be as purchasing private vehicles or depending on the use of private services (Dodson, Gleeson, Evans, & Sipe, 2007).

In order to arrive at these results mentioned above and to be able to analyse the information, the Gold Cost City paper applied a quantitative analytical method called "community mapping" for the local analysis of the phenomenon. In addition, the use of GIS was used to represent socio-spatial and temporal phenomena with new techniques by combining socio-economic and transport service data through GIS in order to demonstrate the inclusion or exclusion of transport with the diversity of spatio-temporal patterns based on census and transport time tables (Dodson, Gleeson, Evans, & Sipe, 2007).

Other types of transports and inequalities studies that have been carried out with the help of maps and GIS are those associated with the correlation between transport and social exclusion focusing on issues such as deprivation, traffic impacts, air pollution, volume, transport access, car ownership, bus availability, and so on (Pennycook, Barrington-Craggs, Smith, & Bullock, 2010). Qualitatively, the use of surveys or interviews to determine the degree of exclusion in peripheral areas of cities has been used in studies in Germany to identify priority areas so as to comply with urban development plans on the creation and maintenance of equitable living conditions in the country (Blinder & Matern, 2020).

Some subjects of study have been pre-school children and their mobility in regions of Australia. This kind of study analyses the relationship of transport and equality in the creation or strengthening social capital among children. Government data, mobility surveys and in-depth interviews were used to confirm the importance of access and mobility capacity in avoiding exclusion and building social capital throughout statistical modelling (Stanley, Janet, Blabontin, & Hensher, 2019).

Moreover, transport disadvantage and inequality, in the case of private car use, have been analysed from an origin-destination distance point of view. This approach has also been studied for the impact on people's well-being through surveys of residents of areas adjacent to the city (Delbosc & Currie, 2011). Some other research about car dependency linked with transport inequalities are related with health conditions due to excessive car use or a polluting and poor public transport system that do not only affect people health but also do not allow an ease access to health services (Mindell, 2018).

3.2. Spatial planning in transport projects

Within spatial planning and urban policies, transport has been analysed, evaluated and projected by the measurement of accessibility. Some ways of measuring this concept throughout history have been, for example: through the distance to the nearest services such as schools and hospitals; by measuring a certain distance and travel time, the amount of services or opportunities that can be reached; or with mathematical models based on physical or economic theories, among others. However, accessibility can be measured in different ways according to the variables considered and the discipline selected (Miller, 2018).

For the evaluation of urban policies, various studies have also been carried out to analyse their impact on the territory. Some projects are known as ex ante and ex post assessments. For most projects, a study is applied prior to implementation, both to obtain funding and to assess feasibility. Most of the methods used in these types of studies are based on Cost-Benefit Analysis (CBA) and Multi Criteria (MCA).

In the case of CBAs, they have been highly criticised for the monetarisation of mobility as well as for the fact that people's mobility is based on mathematical models, so that social aspects are left out of the analysis. At the same time, it does not include externalities that may possibly occur during or after project implementation. Nevertheless, its strengths and why it is widely used are because of three elements: 1) the assessment of a large scale infrastructure projects, 2) the transparency of the assessment, and 3) easy to communicate (van Wee, 2012; Hüging, Glensor, & Lah, 2012). However, as in the case of the CBA analysis in the Netherlands, the pros and cons of the methods should be considered, and a balance should be sought in their implementation according to ethical principles of decision-makers to avoid inconsistencies (van Wee, 2012).

On the other hand, the MCA may be a better way to cover aspects that the other method leaves out, however this method tends to be less rigorous than the previous one as it is considered subjective, not very comparable with other analyses, and it takes more time to obtain it. But users of this method endorse it as being more malleable in data collection and management by combining qualitative and quantitative criteria based on scoring, ranking and weighting impacts (Hüging, Glensor, & Lah, 2012). An example could be the analysis of the problems of the city of Vilnius in relation to transport through MCA together with geoprocessing in a GIS with the aim of obtaining a comprehensive system in urban transportation sustainability (Jakimavičius & Burinskienė, 2009).

Despite the strengths and weaknesses of the most common methods of transport project and policy evaluation, some papers have contribute to straighten them in terms of social justice, fairness or equity. In order to create a project evaluation that promotes welfare and justice, based in a case study, the decision maker must make arbitrary decisions. There are 3 mean decisions: 1) between the components of utility; 2) between the interests of people of different spaces and time; and 3) between the different ethical principles for a fair or just distribution of welfare over society. This will serve as a basis for recognising the role of the decision-maker and the interests at stake when the project is drawn up (te Boveldt, Keseru, & Macharis, 2020).

The analysis of the study of transport projects has also been done from the perspective of the impact of neoliberal policies on transport design and implementation. Neoliberal urbanisation has been studied as one of the main actors in the transformation of public transport in the city of Chicago. This approach is based on examining transport-related infrastructure projects as a form of capital attraction and accumulation that benefits a certain group of people. It also studies their possible consequences that would exacerbate unequal spaces within the city (Farmer, 2011).

For Latin American cases, it is important to highlight that the concept of accessibility has had an important weight with the aim of reducing social inequalities that predominate in most urban areas of this region. Latin American studies stand out for ethical principles such as equity and justice, through the analysis of accessibility according to time, space, the characteristics of the individual, and the type of means of transport. For a good development of policies, it is essential that academia and the political sector work together to develop easy and comprehensive tools to measure accessibility (Vecchio, Tiznado-Aitken, & Hurtubia, 2020).

Lastly, another way of approaching the issue of evaluating the impacts of transport policies or projects with a comprehensive vision that seeks to reduce inequalities is through the socio-economic consideration of the population, where the review of the different travel costs or the purchasing capacity of specific social groups has an impact on the degree of accessibility. The approach based on the economic limitations of the population as a fundamental aspect in the generation of accessibility policies has been carried out in the city of Bogotá (Bocarejo S. & Oviedo H., 2012).

3.3. Perspectives on studies related of City-airport transport lines

Among the issues and approaches related to Airport City connections, studies address the accessibility and spatial planning to reduce travel times between the two points. Articles talking about transportation planning take into consideration the passengers and their mobility patterns, for example the type of passenger according to the type of airline they will travel on (Castillo-Manzano, 2010), as well as studies promoting the implementation

of mass transport projects linking the city to the airport to counteract the use of private vehicles (Mandle, Mansel, & Coogan, 2000) or the management of intermodal systems to avoid problems between flight connections (Milbredt, Florian, Grunewald, & Christ, 2017).

According to Tloczynka and Hebel (2020) the best transportation system connecting economic centres to the airport is the one involving rail systems. These systems come across the economic requirements of a means of transport: they meet the demand for travel, are comfortable, reliable, fast, and exceed vehicle traffic (Tloczynska & Hebel, 2020). Likewise, studies show that the development of light rails together with other infrastructures has positive economic impacts on cities, stimulating economic growth in areas where there was difficult access to means of transport (Knowles & Ferbrache, 2016).

However, from a critical perspective, it has been argued that the development of light rail projects or express transit systems are a reflection of the neoliberal urban economic development strategy lagging social aspects behind (Olesen, 2020; Farmer, 2011). Light rail infrastructure projects are characterised by political agendas with the aim of increasing the economic development of the area and therefore having an impact on the urban landscape (Olesen, 2019).

In general terms, most of the texts about transportation and cities seek to contribute to a new way of seeing mobility from a sustainable point of view, some mainly focus on environmental problems and therefore seek to break with the current lifestyle in which mobility is reduced, while other authors focus more on sustainability from a social point of view, which seeks the inclusion of vulnerable or segregated populations with the aim of integrating them into the city and improving their quality of life. Finally, within the literature reviewed so far in the research, the specific studies on the city airport connection lines concentrate on supply and demand studies, leaving the spaces adjacent to these projects out of the analysis.

4. Methods

This research will analyse a case study in order to show the impact in the degree of integration or exclusion of public transport on the metropolitan area located between the city centre and the airport. Both qualitative and quantitative methods will be adopted for this purpose. Quantitative methods will be used to measure certain accessibility indicators whilst qualitative methods for the analysis of the transport projects and public policy of mobility and transport systems. The data collection methods are essentially record-based and policy documents combining multiple sources from the official website.

4.1. Quantitative method.

This work comprises a direct interpretation and quantitative analysis throughout cartographic tools. The table presented in Figure 1 will be taken as a model and the data will be based on the 2020 National Population and Housing Census, the survey on perception of security in the last quarter of 2020, public transport routes and the price of travel according to the Ministry of Mobility of the State of Mexico, as well as the National Statistical Directory of Economic Units. Based on Figure 1, the aspects that make up transport disadvantage and social disadvantage will be taken into consideration to visualise spatially the transport poverty that also generates inaccessibility to certain services based on isochrones that exemplify social exclusion in a spatio-temporal manner.

Therefore, five maps will be developed: the first one that summarises transport disadvantage; the second about social disadvantage; the third one of transport poverty; the forth one about accessibility to basic services as a consequence of transport poverty; and the last one which encompasses the last four maps is about the transport related social exclusion of the area. This provides an overview of the current situation in the study area, which will be compared with the planning project of the extension of the suburban railway to the new airport of Mexico City (AIFA).

The route of the new line and possible stations will be projected according to official documents and its possible impact on the study areas described in the previous paragraph. So in summary this method is divided into two sections: the description of the current

situation of the study area and the analysis of the impact on public transport in the area with the implementation of the new project. This part of the research will employ GIS (ArcGIS or QGIS). There are studies that use these tools to evaluate TRSE such as the one carried out by Wu and Hine (2003) on the bus network system in Belfast.

4.2. Qualitative method

This research analyses the project for trains connecting international airports with the economic centres of the cities and the incorporation of the metropolitan area through which the system passes. I take as an example the analysis of transport plans in North America and the integration of social equity (Manaugh, Badami, & El-Geneidy, 2015) the importance of the stakeholders for the decision making on policies (te Boveldt, Keseru, & Macharis, 2020) and the evaluation of transport policy instruments in the case of study the rural areas in Ireland (McDonagh, 2006).

In this case, the documents that support this project will be analysed, those include the development programmes, plans and political discourse about implementation and design of the project in relation to the impact that the New Mexico City Airport will have. In this work, it will be analysed the use of the concepts of the right to mobility, sustainable moility, TRSE concepts and the extent to which they seek to reduce the inequality gap in terms of urban transport in this area of the Mexico City metropolitan area.

For the above, the documents of the comprehensive AIFA programme and its relation to the conurbations municipalities, the state mobility programme and the municipal development plans will be used. The comprehensive urban development programme of the New Airport of Mexico City (AIFA) is a federal programme which collaborate with municipal and state levels. The state mobility programme corresponds to the regional document developed for the State of Mexico. The municipal development plans are from the next municipalities: Zumpango, Tecámac, Tizayuca, Jaltenco, Tultitlán, Tultepec, Nextlalpan y Tonanitla. The suburban train infrastructure project and press articles, will be further analysed.

4.3. Case study

The Northern part of the metropolitan area of Mexico City which will be directly crossed by the new branch of the suburban railway line connecting the new international airport and city center, will be taken as case of study. The Secretariat of Communications and Transport of the Federal Government of Mexico presented this mobility project to connect the new airport of Mexico City with the historic centre of the metropolis. It aims to move between 70,000 and 90,000 passengers a day. The project is part of the territorial planning of the metropolitan area that will be affected by the construction of the new international airport (Government of Mexico, 2020).

For the purpose of this research, the unit of analysis is the territorial demarcations affected by the implementation of this metropolitan mobility project will be taken into account. The municipalities are Zumpango, Tecámac, Jaltenco, Tultitlán, Tultepec, Nextlalpan y Tonanitla from the State of Mexico, and Tizayuca from the State of Hidalgo. These municipalities are part of the Northern Metropolitan area of Mexico City directly affected by the transport system project that will connect the international airport and the city center since the implementation of the new branch of the line 1 of the suburban railway (SEDATU, 2020).

The extension of the new brand of the suburban railway line 1 will connect the new international airport of Mexico City with the city center. It is design to be constructed in two phases: the first one will include 1 terminals and two intermediate stop for June 2023 and the second phase will develop other 4 intermediate stations without date of construction (SEDATU, 2020).

In the following chapters, each of the selected methodologies will be developed in greater detail along with processed and analysed database. It is fundamental to mention that this work is mostly based on open date of the Mexican government, as well as official documents. Both methods chosen are an innovative proposal to analyse this type of passenger transport infrastructure projects with the aim of improving people's living conditions and reducing inequalities.

Chapter II. Quantitative analysis of the current situation in the study area according to the Transport Related Social Exclusion approach.

This chapter will present the current situation of the study area under the TRSE approach analysis. The aspects that make up transport disadvantage and social disadvantage will be taken into consideration to visualise spatially the transport poverty that also generates inaccessibility to certain services and confirms a socio-spatial exclusion status. The chapter is divided into two main sections. The first section covers the general description of the study area and its historical development. The second section deals with the current situation as outlined by the TRSE approach.

1. Study area

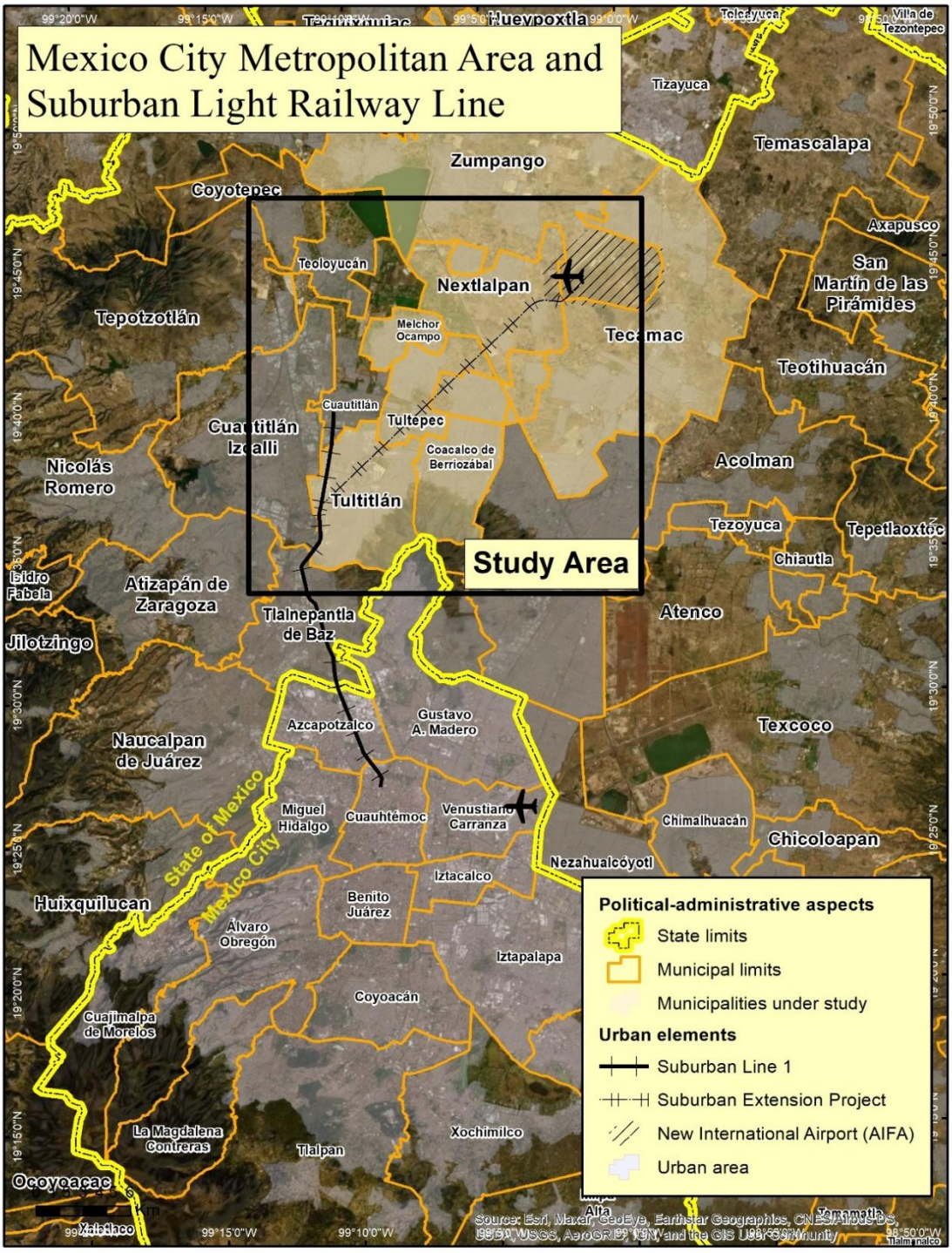
This section describes the geographical and historical aspects of the study area. Before applying the TRSE approach on this area, it is important to know the general characteristics of the territory to better adapt the concepts to the local reality.

1.1. Geographical location

The study area is located in the northern part of the Mexico City Metropolitan Area. The territorial demarcations studied belong to 9 of the 59 municipalities of the State of Mexico within the Mexico City metropolitan area. Each of the municipalities is free and sovereign in decision-making regarding public services, management of public resources, as well as urban and rural planning and development. In Mexico, the municipality is the smallest administrative and political entity in the country and belongs to a one of the 32 federative entities.

Geographically, these municipalities are far away for the historical and business centre of Mexico City, within a distance of 40 – 60 km from the Mexico City downtown to the new housing developments and historical municipality centres. The estimated population for the year 2020 of the study area is around 1,907,547 inhabitants distributed among the 9 municipalities of the study area which are: Tonanitla, Tultitlán, Coacalco, Melchor Ocampo, Jaltenco, Nextlalpan, Tecámac Tultepec and Zumpango. Figure 2 shows the geographical location of the study area on the Mexico City Metropolitan Area. The study

Figure 2. Geographical location of the study area.



Source: INEGI, 2020; SEDATU, 2020; Government of Mexico, 2020.

area comprises the municipalities in the State of Mexico that are close to the New Mexico City Airport (AIFA) and that will be served by the expansion of a branch of the suburban train that departs from the centre of Mexico City.

1.2. A brief history of the urbanisation of the Mexico City metropolitan area

At present, Mexico's urban system is made up of around 358 cities with more than 15,000 inhabitants, with a population of around 80 million people. From the total population, almost half resided in cities with more than one million inhabitants, concentrated in the cities of Mexico City, Guadalajara, Monterrey, Puebla-Tlaxcala, Toluca, Tijuana, León, Juárez and La Laguna. The growth of Mexican cities to cover the right to housing today has generated a physical expansion of these metropolises causing problems such as: water scarcity, availability of land suitable for urban development, increasing poverty, housing requirements, provision of public services, preservation of the natural environment, governance and lack of public transport systems (Aguilar & Escamilla, 2011).

Historically, the central region of Mexico has been the preferred place for the settlement of people from pre-Columbian times to the present day. The Valley of Mexico and the settlements near this physiogeographic region have been closely related in the social, economic and political spheres. The main entity of the Metropolitan Area is Mexico City; however, urban growth was rapid and disorganised that today the urban sprawl includes localities in three states: Mexico City itself, the State of Mexico and Hidalgo.

The 4 characteristics of the conurbation area (Nivón Bolán, 2008) that can currently be defined for what is now known as the Metropolitan Area of Mexico City are:

Firstly, the role it has played as the seat of political, economic and social power by representing the capital of the country. In addition, its central location facilitates the relationship with other nearby cities in what has been named by some authors as the "Regional Crown of Central Mexico" (Bataillon, 2008). This constant relationship with nearby cities has marked the expansion of the city along the main transport routes connecting the urban centres, generally highways and freight railways.

Secondly, the characteristic of a diffuse city as the production of an expansion of the urban sprawl in a disorganised manner and at a high rate of growth, where the new physical, administrative and social boundaries are not well defined. Some areas in the periphery retain their social and cultural characteristics related to the Mexican rural environment, but in economic aspects they are closely subordinated to the dynamics of the centre of Mexico City. Due to this situation, several authors have studied the terminology of ruruban spaces, rural-urban regions, among others (Linck, 2001; Nivón Bolán, 2008; Cruz Rodríguez, 2001).

A third characteristic is the weakening of the public sector with the entry of the neoliberal model reinforced in the 1990s and implemented in its entirety during the first decade of the 21st century. The private sector had a greater intervention in urban development and expansion with the modification of article 27 of Mexico's political constitution, which gave way to the privatisation of communal and ejido lands. This modification generated a struggle for land between the ejidal and municipal administration against federal or state intervention as mediator of the private sector (Cruz Rodríguez, 2001).

The fourth point, and closely related to the previous one, is the construction of social segregation environments for both high and low-income sectors, together with the privatisation of land in urban areas. The creation of these types of spaces was carried out by large real estate companies that, under the management of the Mexican state, built large low-cost housing residential areas far from workplaces, where there was no prior urban planning such as public transport. Collective transport of the area were also left in hands of the private sector through concessioner transport (Nivón Bolán, 2008; Janoschka & Salinas Arreortua, 2017)

Since 2000, peripheral urbanisation in the Metropolitan Area of Mexico City has concentrated in some municipalities (Janoschka & Salinas Arreortua, 2017). Only between 2000 and 2015, an overall number of 686,926 housing units were authorised in 409 different residential developments across municipalities in the Metropolitan Area of Mexico City, with roughly 90 per cent of these units targeting populations on lower income scales, which were classified by public administrations in three categories:

progressive social housing; social interest housing; and popular housing (Janoschka & Salinas Arreortua, 2017).

The proposal was to establish sources of employment close to the new housing developments, as well as the creation of a structured suburban transport system. In fact, this proposal was not well executed which meant that the people who moved to the area continued working in Mexico City and made daily commutes trips of two and a half hours each way on bad transport services (Gómez Mena, 2019). Therefore, it is important to analyse in the next section, the current situation of this study area in relation to its social exclusion and its relationship with the lack of a transport system.

2. Spatial analysis of the current situation of the study area according to the TRSE approach

As mentioned in the first chapter, this work comprises two methodological parts to understand the impacts of the new light rail transport project that will connect the New Mexico City airport and the centre of the capital. This section will describe the quantitative methodological part, based on a basic spatial and statistical analysis with the help of databases from different sources, analysed in Excel as well as through cartographic tools such as ArcGis and QGIS.

This section will evaluate the current situation in the study area prior to the implementation of the transport project that will cross the 9 municipalities studied. This analysis is based on Figure 1 presented in Chapter 1, which provides a series of fundamental concepts for understanding social exclusion related to transport, in this case public transport. Therefore, this section will be divided into the 5 concepts of the TRSE approach.

2.1. Transport Disadvantage

Transport disadvantage is understood as the set of characteristics of transport or mobility systems in a space that does not meet the mobility needs of the population either due to monetary, design, or frequency issues (Currie & Delbosq 2010).

2.1.1. Methodology

For this research, based on the data obtained and Figure 1, Transport disadvantage is built on five elements of the transport system of the study area. Depending on the characteristics of the Basic Geostatistical Area (BGA), it is given a number value from 1 to 5. After analysing the five elements, all the number values per BGA are added. The higher the sum value per BGA, the higher degree of Transport disadvantage. Those value were obtained from various sources and compiled in an Excel database for subsequent management, analysis and weighting. Each of the variables and their characteristics are described below:

2.1.1.1. Lack of information

This variable includes the lack of knowledge of public transport user on the start and end of the transport service operations, the signposted stops, and the frequency of the runs per hour and day of the week.

This variable was obtained according to the BGAs that were close to a public transport station or stop with established infrastructure within 850 metres, which is the maximum walking comfort distance (Singh, Lukman, Flacke, Zuidgeest, & Van Maarseveen, 2017). This infrastructure provides the route, origin-destination, schedule and useful information to the user. The main source of data was obtained from the mobility page of the State of Mexico and the Suburban Transport System. With the help of GIS, the BGA close to 850m of transport stops with fixed infrastructure were indicated.

The rating is given from 5 to 1, with a value of 5 being the most lack of knowledge or existence of a transport route and a value of 1 being an integrated system with user information. The values are shown in Table 1 below:

Table 1. Lack of Information values

Value	**Type**
5	Without transport
4	Concessioner transport
3	Mexibús (BRT)

2	Suburbano
1	Concessioner transport, Mexibús and Surburbano

Source: Secretaría de Movilidad, 2021.

2.1.1.2. No car ownership

This variable indicates the absence of a car per household that serves or does not serve as the main means of transport. This variable helps to determine to some extent the degree of dependence of certain geographical areas on the car, which has various causes.

This variable was obtained from the 2020 Population and Housing Census in the basic questionnaire section (INEGI, 2021). The data shown by the census is the number of households per BGA that have a car. Therefore, a subtraction was made between the total number of inhabited dwellings and the number of dwellings with a car in order to know the number of dwellings without a car.

The subtraction was converted to a percentage which was weighted between values from 1 to 5. The highest value represents the BGA with the highest number of households without a car, while 1 represents the lowest number of households without a car. The values are represented on Table 2.

Table 2. No Car Ownership values

Value	**Household without car (%)**
5	81 – 100
4	61 – 80
3	41 – 60
2	21 – 40
1	0 – 20

Source: Economic Census, 2020.

2.1.1.3. Fear of crime

Fear of crime represents the variable of the perception of public transport and crime rates in the area where it is used, as well as the lack of use of public transport for fear of being a victim of a criminal act.

This variable was taken from the National Survey on the Perception of Security in Mexico (INEGI, 2021). The data were based on the section Population aged 18 and over by state

and public or private space, according to perception of safety in March 2020, specifically Public Transport (INEGI, 2021). As this is an indicator measured at national and state level, the same value was used for all BGA. Therefore, the single value is 4.5, where the maximum value would be 5, which represents 100 of the population with a perception of insecurity in public transport.

2.1.1.4. Lack of public transport services

This variable indicates the proximity to a stop of an integrated or multimodal transport system. Different types of public transport converge in the study area, which are not necessarily integrated.

It was given a value according to the number of types of public transport that have stops or routes within or near each BGA. The data were obtained from municipal development plans, the institutional page of mobility of the State of Mexico and the suburban train system. A GIS was also used to determine the BGA close to the Mexibús and Suburban train stops.

The values are on a scale of 1 to 5 where the highest number corresponds to a lack of a transport service either concessioner, suburban or Mexibús, while the lowest corresponds to a BGA that has all types of transport service in the study area (Table 3).

Table 3. Lack of Public Transport Services values

Value	**Type of transport service**
5	Without transport
4	Few concessioner transport
3	High number of concessioner transport
2	Suburbano or Mexibús
1	All type of transport services.

Source: Municipal Urban Development Plans and Ministry of Mobility, 2020.

2.1.1.5. Unfordable fares

This variable shows the prices of public transport and its affordability or not for the population that needs these services to move around the territory. For the case study, the current fares of the modes of transport in the area were taken into consideration. The

prices were obtained from the official website of the Ministry of Mobility of the State of Mexico, which shows the cost of the cheapest journey for concessioner transport based on a mileage system. The single price of Mexibús and the lowest price of the suburban train system were also obtained.

The valuation is based on the lowest price and the number of options according to service and price (Table 4). It is important to note that when there was only one concessioner transport service, a value of 5 was assigned depending on the distance travelled.

Table 4. Unfordable fares values

Value	**Price ($MXN)**	**Options**
5	12	Most expensive fare and only option
4	9 – 12	Cheap and expensive fare with 2 or many options
3	9	Only one option between all types of public transport
2	9	Cheapest fare. Mexibús or Suburbano short trip
1	< 9	Mexico City public transport price

Source: Secretaría de Movilidad, 2021.

2.1.2. Results and Interpretation

As a result of the sum of the 5 variables described above, a choropleth map (Figure 3) was obtained. The map shows the transport disadvantage per BGA. From a general point of view three main patterns are found according to the visual spatial information.

The first pattern is that most of the BGA with a low degree of transport disadvantage are located close to some major roads on which articulated public transport lines pass. These means of transport correspond to the route of the suburban train as well as the route of the Mexibús route.

The second pattern corresponds to the medium and high values that are located further away from the access roads to the centre of the Mexican capital in the central and northern part of the map. These areas correspond to most of the localities in the municipalities of Zumpango, Jaltenco, Nextlapan and Melchor Ocampo. These municipalities have been integrated into the urban stain and dynamics in recent years.

The third pattern is located to the east of the map, which corresponds to the municipality of Tecámac, where a different dynamic to the rest of the BGA is observed, as it is connected to a main road where several concessioner transport routes pass through.

Finally, it is important to highlight that some BGAs with high values of transport disadvantage are located in the South and Southwest of the study area corresponding to the urban spaces located in the mountainous areas of the Sierra de Guadalupe, where transport is scarce, with high prices, high indexes of perception of crime and low frequency.

This map shows that within the same study area there are varying degrees of transport disadvantage related to distance, proximity to articulated means of transport, car ownership and proximity to the centre of Mexico City.

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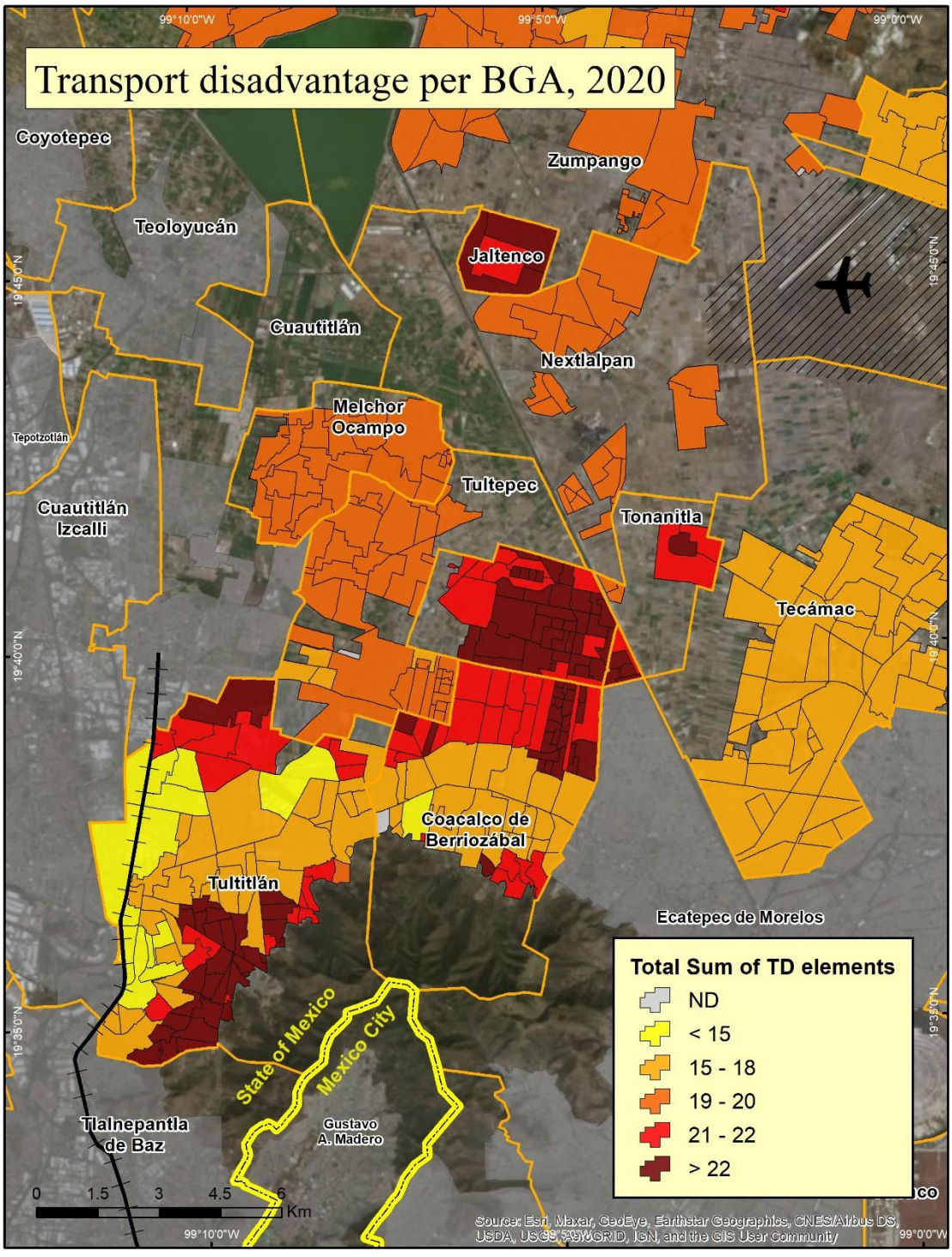
. **Figure 3. Transport Disadvantage of the study area, 2020**



Source: based on Economic Census, 2020; National Survey on the Perception of Security in Mexico, 2020; Secretaría de Movilidad, 2021.

2.2.Social Disadvantage

Social disadvantage has been widely described by various disciplines and governments over time to measure part of the social inequality of a space. In this section, it will be described the main points taken into account for this research, the methodology and cartographic result.

2.2.1. Methodology

There are many different ways of measuring social disadvantage. For the purpose of this study, the five elements shown in Lucas' (2012) diagram are considered. As the previous indicator, Social disadvantage is the addition of 5 main elements. The higher number value the higher social disadvantage per BGD. The elements that make up social disadvantage are as follows:

2.2.1.1. Low Income

This variable indicates the economic income from a wage for carrying out an economic activity, whether formal or informal. For this research, it was selected the extended questionnaire of the Population and Housing Census 2020, specifically the section on average household income by size of locality.

Since this variable is not disaggregated by BGA, each one was categorised by size of locality to which it belongs in order to give a value of average monthly income per household in minimum wages. With this categorisation, income was classified by socio-economic level to determine whether it was high, medium or low income. Although there were different income averages per BGA, all fall into the D+ category with an income between 7,000 and 11,000 pesos per month. The values given are shown in the table below:

Table 5. Low Income values

Value	Socieconomic level
5	D/E
4	D+

3	C
2	C+
1	A/B

Source: INEGI, 2020; AMAI, 2020.

2.2.1.2. Unemployment

This indicator shows the economically active population that is not in paid employment. This variable represents the number of people who are looking for work and have no income, which impacts on the well-being of the urban population.

For this indicator, it was chosen the percentages of the unemployed population with respect to the total economically active population. The economically active population is considered to be 15 years old or older according to the 2020 Population and Housing Census.

The values assigned for this indicator are from 1 to 5, where 1 is the lowest percentage of unemployed population and 5 with a high percentage of unemployment close to 7.8 per cent of the population. This value is based on the state-wide unemployment rate. The values are the shown on Table 6.

Table 6. Unemployment values

Value	**Unemployment Rate**
5	Very high
4	High
3	Medium
2	Low
1	Very low

Source: INEGI, 2020.

2.2.1.3. Low Skills

This value shows the average level of schooling of the inhabitants per BGA. This indicator is useful to know the type of workers in each area, for example whether the population works in skilled trades or professions according to the average number of years of schooling of people over 12 years old. This value was obtained from the 2020 Population and Housing Census, in the section on average years of schooling by BGA. In

this work, the years of basic, middle and higher education were taken as a base, so this variable was left as the values shown in Table 7.

Table 7. Low Skills values

Value	Average year of education	Educational level
5	< 6	Unfinished elementary school
4	6 a 8	Completed elementary school or unfinished secondary school.
3	9 a 11	Completed secondary school or Unfinished High School
2	12	High School
1	> 12	University or more

Source: INEGI, 2020.

2.2.1.4. Health Insurance

The indicator related to the health of the population is based on the population's access to the health system. For this work it was considered the percentage of people who are not entitled to any public or private health service related to the total population by BGA. This indicator was obtained from the Population and Housing Census 2020, in the section on persons not entitled to any public or private health institution. The lowest values, or values equal to 1, correspond to BGAs with almost all entitled persons, while with a value of 5, the majority, or close to 100 per cent, are not affiliated to a health system. The values are represented in Table 8.

Table 8. Health insurance values

Value	Population not entitled to health services (%)
5	81 – 100
4	61 – 80
3	41 – 60
2	21 – 40
1	0 – 20

Source: INEGI, 2020.

2.2.1.5. Poor Housing

This variable shows the housing situation of the study area according to the socio-economic level prevailing in the territorial demarcation. The housing poverty variable includes the type of materials, basic services such as water, gas, electricity and drainage.

This indicator was obtained from the Population and Housing Census 2020, as well as from the characteristic of the predominant socio-economic level of the metropolitan area of Mexico City. The result was based on the type of houses prevailing in the region and was assigned the characteristic of D+. The values range from 1 to 5 as shown in the Table 9.

Table 9. Poor Housing values.

Value	**Household socioeconomic level**
5	E
4	D
3	D+
2	C
1	A/B C+

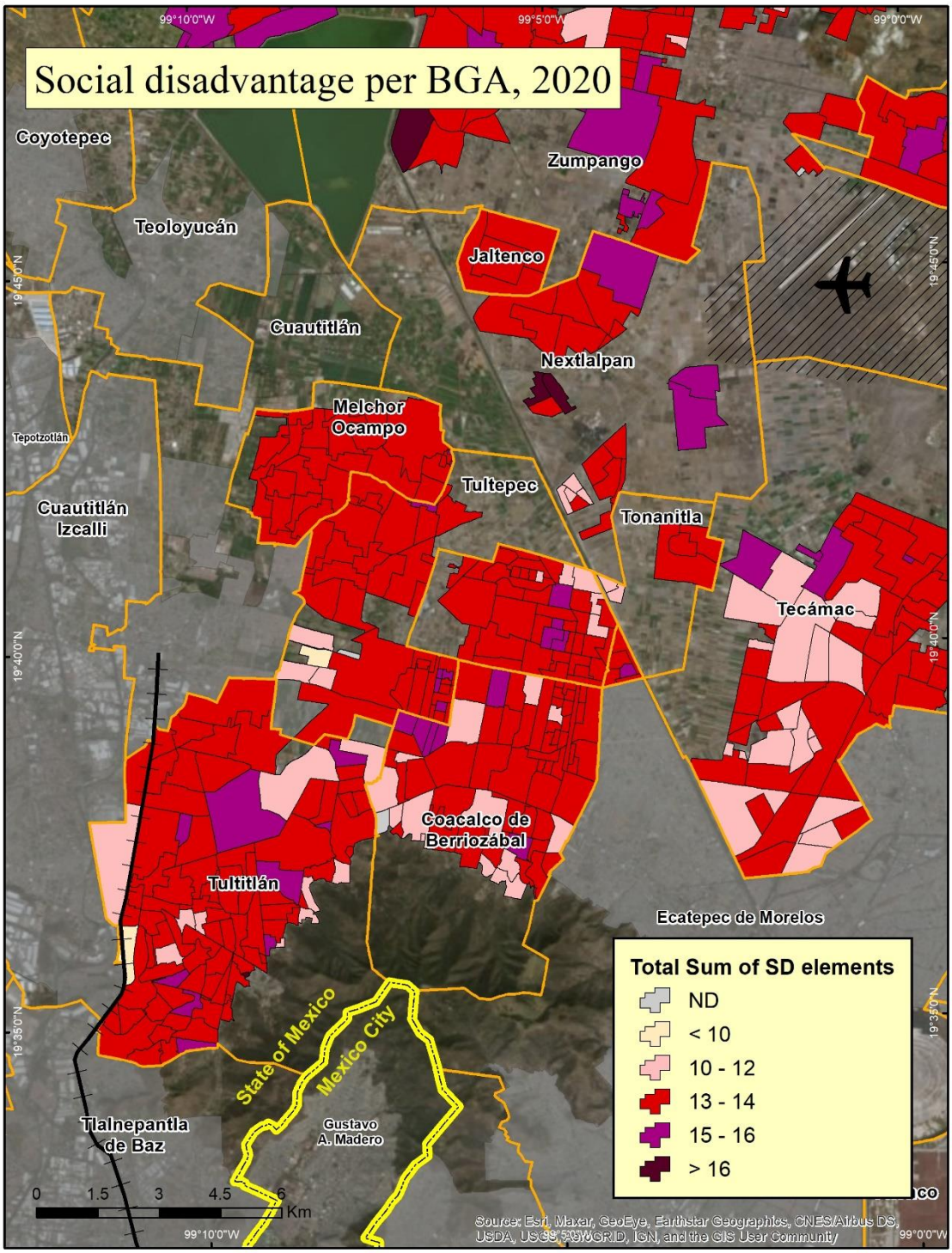
Source: INEGI, 2020; AMAI, 2020.

2.2.2. Results and interpretation

Based on the results of the sum of the five indicators previously described, the map of social disadvantages (Figure 4) was obtained. This map shows graphically the distribution of social disadvantages of the population living in the study area by BGA. From a general point of view, three important characteristics can be identified.

The first is that within each municipality there are different degrees of social disadvantage, ranging from high to low with respect to the study area. This indicates that social disadvantage in the study area is dispersed at the BGA level. Although the map shows a dispersion of values in space, it is important to note that most of the values are close to each other between 10 and 14 points.

Figure 4. Social disadvantage of the study area, 2020



Source: based on INEGI, 2020; AMAI, 2020.

However, a second important feature of this map is that in the north of the study area, the area furthest away from the centre of Mexico City, there is a larger number of BGAs with high values. These localities belong mostly to the municipalities of Zumpango, Tecámac, Nextlalpan and Jaltenco. Finally, the third important characteristic is that the BGAs that are isolated from the urban area have the highest values of social disadvantage, as they are not in the spatial contiguity of the urban sprawl.

2.3.Transport Poverty

The Transport Poverty variable is a dependent variable of Transport Disadvantage and Social Disadvantage. For this research, this indicator shows the interaction of problems related to the lack of social aspects and problems related to the transport system and forms of mobility at the spatial level. The methodology to obtain this value and the graphical result is shown below.

2.3.1. Methodology

After obtaining the value of each of the elements that make up Transport Disadvantage and Social Disadvantage, a sum was made between the two indicators to visualise in which BGAs the highest scores were obtained in order to know the degree of interaction between these indicators. Through the GIS, the SUM() formula was applied to get the total score of the two indicators mentioned above. The higher the value of this indicator, the greater the set of transport and social problems within the BGA. The result is mapped in order to better visualise the results and show spatial patterns.

2.3.2. Results and Interpretation

The results of this addition show that the scores of more than 90% of the BGAS exceed the value of 25 points, indicating that transport and social problems exacerbate poverty or lack of an efficient public transport or mobility system. The highest score is close to 40 points, which indicates that within the same study area there are different degrees of transport poverty, which makes the spatial distribution of this indicator clearer through

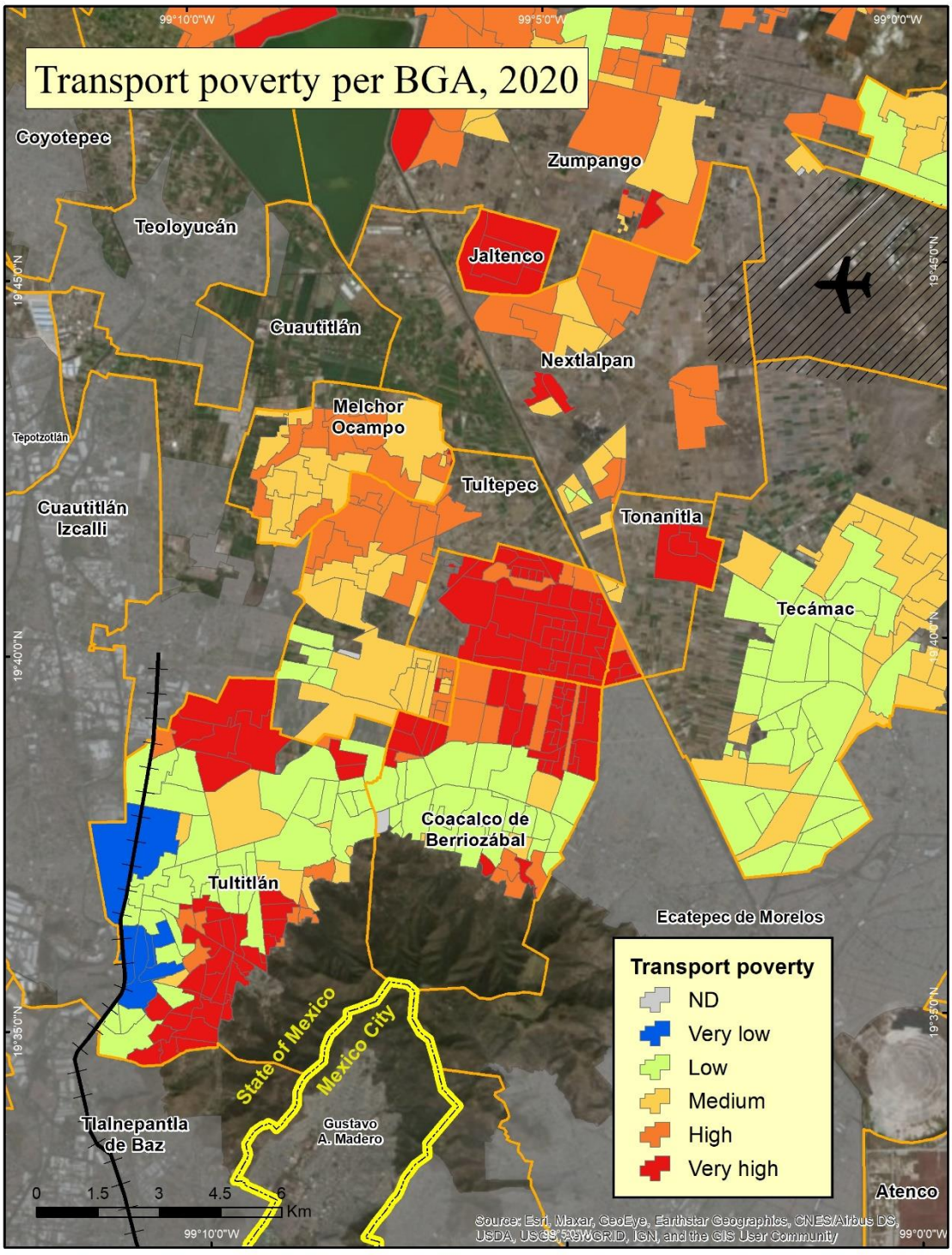
mapping. The transport poverty map (Figure 5) shows that there are clear spatial patterns in the study area.

The main pattern of high values is the one observed in the centre of the map, which corresponds to the BGAS of the municipality of Coacalco, Tultitlán, Tonanitla and the southern enclave of the municipality of Jaltenco. This zone is characterised by its remoteness from articulated transport systems or main roads that connect with other annexed municipalities, despite the fact that it borders a recently built highway, which functions as a spatial delimiter since the inhabitants do not have direct access to this transportation route. This area is characterised by former ejidos with self-built housing as well as large housing developments where there was no planning for an integrated transport system and where private concessioner services prevail.

On the other hand, high transport poverty is observed in the south of the municipality of Tultitlán, which corresponds to residential areas located on the slopes of the Guadalupe mountain range that were populated without orderly planning and responded more to the sale and speculation of land at low prices. In the northern part of the same municipality, another high degree of transport poverty can be observed in the BGAs that correspond to industrial zones. The lowest values of this indicator correspond to those located near important transportation routes where the main concessioner transport, Mexibús and suburban train, provide service. This can be observed in the centre of the municipalities of Tultitlán, Coacalco and the municipality of Tecámac, which also have important roads and a large number of concessioner transport routes.

Finally, the northern part of the study area has medium to high values due to its remoteness from transport systems and unfavourable socio-economic characteristics, as well as its isolation from the continuity of the urban sprawl. Transport poverty in the study area is present in different magnitudes within the study area, however, its distribution responds to the proximity to important transport system such as the Mexibús or Suburban Train, and is exacerbated when these areas also present important socio-economic problems.

Figure 5. Transport poverty of the study area, 2020



Source: based on AMAI, 2020; INEGI, 2020; National Survey on the Perception of Security in Mexico, 2020; Secretaría de Movilidad, 2021

2.4.Inaccessibility

This indicator is essential, together with transport poverty, to determine the degree of social exclusion that exists in the study area. Inaccessibility derives from the difficulty of the population to make use of certain services or to be able to fully enjoy the rights granted by society. This work takes into consideration the inaccessibility of public services as well as sources of employment for the population. The following is a description of how this indicator was obtained and the results.

2.4.1. Methodology

For the Inaccessibility indicator, it was decided to take as a database the National Statistical Directory of Economic Units (DENUE) which is composed of the economic activities of the whole country classified by sectors of the economy. This database is public and free for use in research, consultancy and other areas. The point files were downloaded in .shp format to be used and processed in ArcGIS. Table 10 presents the economic units that were taken into consideration:

Table 10. Economic units by DENUE code

DENUE code	Name of economic activity
31 – 33	Manufacturing industry
46	Retail trade
52	Financial services
61	Educational services
62	Health and social work services
71	Recreational, cultural and sporting services

Source: DENUE, 2021.

These types of economic activity were chosen because they represent basic services for the well-being of people, as well as being the main sources of work for the inhabitants of the Metropolitan area. Economic units with more than 30 employees were taken into account as these types of units generate a greater number of daily commutes in the Metropolitan area compared to small units that are related to family businesses or small franchises.

In order to have a better cartographic visualisation of this indicator of accessibility to basic services, "Kernel Density" geoprocessing was carried out, which analyses the number of points close to each other to give as a result a heat map showing the areas with the highest density of economic units.

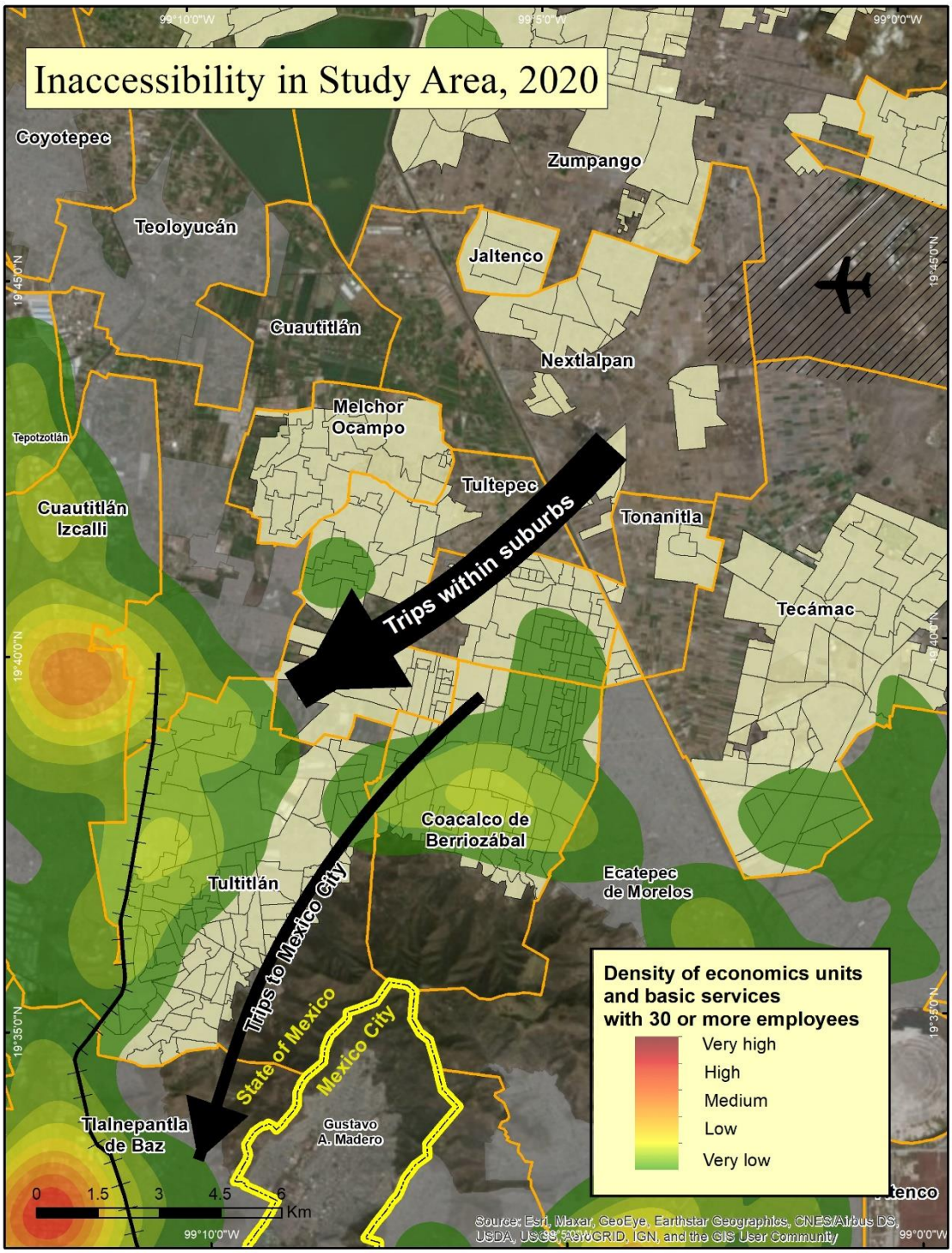
2.4.2. Results and Interpretation

Figure 6 shows a high density located specifically to the West of the study are, particularly in the municipality of Cuautitlán Izcalli, South of Cuatitlán and Northwest of Tultitlán, followed to a lesser extent by the central zone in the Municipality of Coacalco. The densest zone of economic units corresponds to the main industrial zone of the Mexico City Metropolitan Area, where there are sources of work in maquiladoras and assembly plants, as well as commercial centres and other types of health and education services. In the case of Coacalco, it corresponds to the commercial area of the municipality located on José López Portillo Avenue.

From the above, it can be observed that the rest of the study area has few important economic units, however the higher concentration of these in a specific area of the Metropolitan Zone generates a significant amount of travel flows. According to the 2017 Origin-Destination Survey, 87.4% of trips in the Mexico City Metropolitan Area are within the municipalities of the State of Mexico, which is equivalent to 14.68 billion trips per day. This high number of daily trips translates into a need to travel by some means of transport to the main sources of employment, so that means of transport play a fundamental role for people living in remote municipalities, in this case, for the study area, it corresponds to the municipalities of Zumpango, Jaltenco, Nextlalpan, Melchor Ocampo, Tultepec, Tonanitla and Tecamac.

In general, this map shows the spatial inequality of important services and sources of work concentrated in a specific part of the metropolitan area. For the study area only two municipalities have a concentration of important economic units while the rest move to these areas to cover and satisfy these needs.

Figure 6. Inaccessibility in the study area, 2020



Source: based on DENUE, 2020; EOD, 2017; INEGI, 2020.

2.5. Social Exclusion

As well as the concept of accessibility, the concept of social exclusion has been widely analysed. This research is based on social exclusion as the phenomenon where the individual or group of people have lost the ability to move around and access services, employment and/or goods in the surrounding space (Hine & Kamruzzaman, 2020).

2.5.1. Methodology

In order to create this last map and present the relationship between public transport and social exclusion, the previous indicators are combined into a single map that includes the main articulated transport systems. The articulated systems taken into consideration are the current Suburban train line and line 2 of the Mexibús. This map is the final result of the scheme that explains social exclusion related to transport and therefore depends on the results of the previous sections.

2.5.2. Results and Interpretation

Figure 7 resulting from the integration of the variables of inaccessibility and transport poverty together with the main structured transport systems of the study area shows the spaces that are related to exclusion caused by the public transport situation. This exclusion can be represented in several ways (Lucas, 2012).

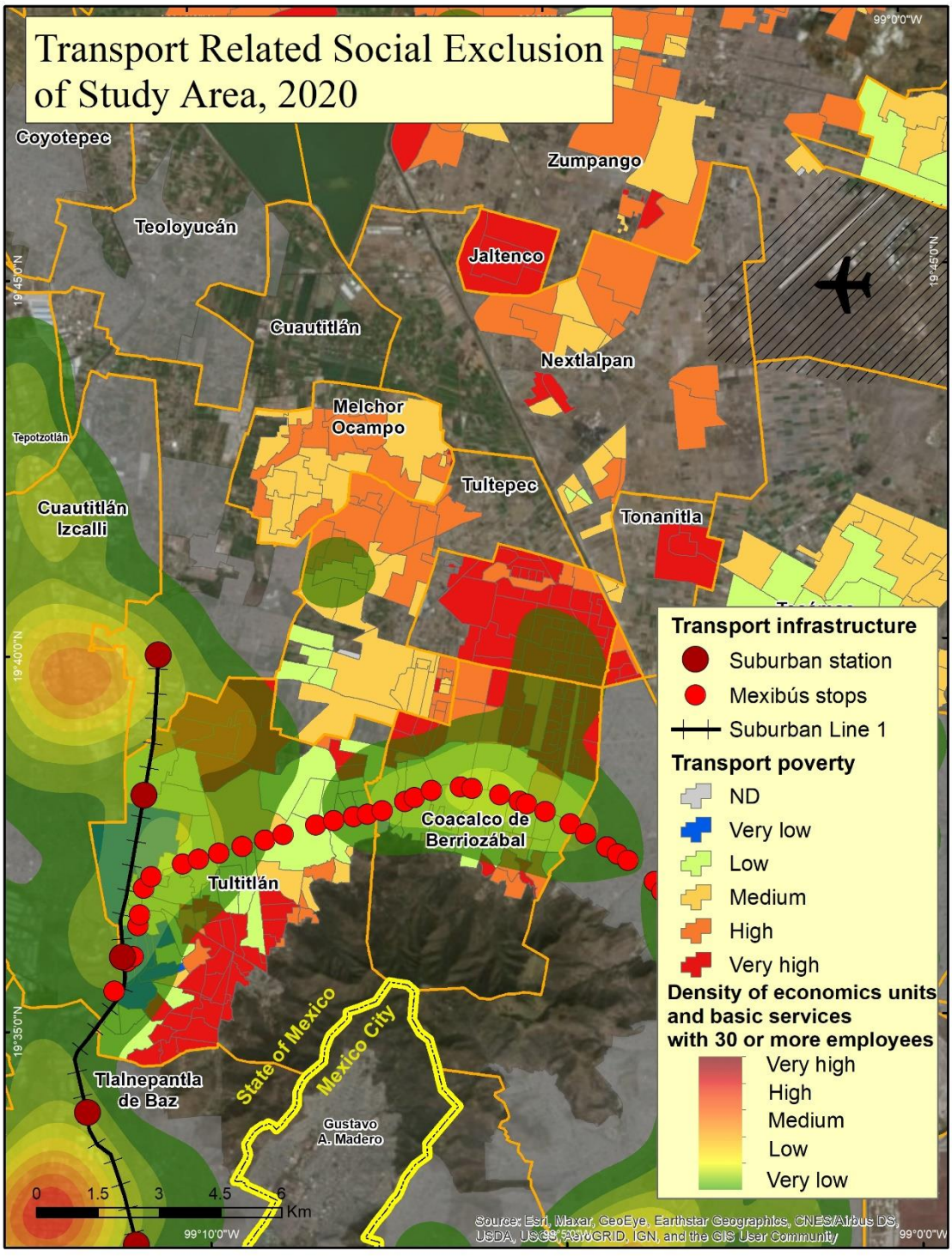
Social exclusion starts from those BGAs that have a high degree of transport poverty and are located far from the main sources of employment and services. Therefore, physical distance is an important factor in this exclusion that could be reduced through integration with a transport system that connects these remote areas. In addition, another aspect highlighted by this final map is that structured public transport is scarce in this area of the city. Although there is concessioner transport at a more local and municipal level, the precariousness of its operation limits the improvement of people's mobility because it does not meet the needs of the inhabitants.

Public transport in this study area coincides fully with the majority of economic units that are a source of employment and services for the population and play an important role in the generation of development poles. The map on Figure 7 shows that the highest density of medium and large economic units is found adjacent to the Mexibús and suburban lines.

The social and spatial exclusion observed in Figure 7 of the localities in the centre and north of the study area is related to the lack of development of integrated public transport systems that connect with the south-west of the map, in this case, the sources of work and basic services in Cuautitlán, Tultitlán and Coacalco. However, within these municipalities there is a social exclusion that is related to the difficult access to these parts of the municipality due to their historical background of construction and urban development.

Finally, based on the socio-spatial exclusion of the study area, the possible impacts of the development of the new transport infrastructure project on the area can be analysed in the following chapters.

Figure 7. TRSE of the study area, 2020



Source: based on DENUE, 2020; EOD, 2017; INEGI, 2020. AMAI, 2020; National Survey on the Perception of Security in Mexico, 2020; Secretaría de Movilidad, 2021.

Chapter III. Qualitative analysis of the spatial planning of the study area and the extension of the Mexico City-International Airport suburban light railway project.

This chapter addresses the idea of how the concepts envisaged in Chapter 1 and 2 are connected in territorial or urban development plans at the different governmental levels related with the planning and design of public transport development systems in Mexico. The second part of this chapter is focused on the impact of those urban development plan based on the construction of the New Mexico City Airport and on the design of the extension of the suburban light railway project.

1. Urban development plans

In order to understand the way the territory is structured and ordered, the following methodology of a purely qualitative nature was proposed, which combines the concepts studied in chapter 1 into official documents.

1.1. Methodology

The methodology was based on an analysis of official documents dedicated to territorial and urban development plans at the three levels of government in Mexico, specifically on issues dedicated to urban mobility such as public and private transport infrastructure, integrated mobility systems, concessions and routes.

First, the general structure of the territorial, urban and rural planning system in Mexico and the main institutions responsible for the design and execution of urban development are studied, including the legal bases of territorial and urban planning at the three level of government. Subsequently, the qualitative analysis of urban and territorial development plans is based on the study of the content and application of the concepts studied in chapter 1 according to the main planning instruments elaborated by each government level: the federal, the state and the municipal levels.

The content analysis was based on how they make use of certain terms, either exactly or with some other similar terms used on the strategy to implement them in urban policies

and territorial actions. The concepts taken into consideration are based on the Transport Related Social Exclusion approach listed below:

- Sustainable mobility
- Spatial planning
- Right to the city
- Right to mobility
- Transport disadvantage
- Social disadvantage
- Transport poverty
- Accessibility
- Social Exclusion

At the federal level this analysis was based on the documents: *"Estrategia Nacional de Ordenamiento Territorial"* (National Spatial Planning Strategy- NSPS) and "*Estrategia 4M"* (4M Strategy), both elaborated in 2020, as well as the Political Constitution of the United Mexican States. At the state level, it was based on the document: *"Plan Estatal de Desarrollo Urbano"* (State Urban Development Plan-SUDP) from 2019. And at the municipal level, the Municipal Urban Development Plans (MUDP) of 6 of the 9 municipalities in the study area. The results are presented in the next section.

1.2. Results and interpretation

The research showed that Mexico has a broad legal framework for urban planning and development at all three levels of government, which is specified in several constitutional articles. This is due to the fact that nearly 80% of the Mexican population lives in urban areas (INEGI, 2021).

The organic composition of the federal public administration is highly developed in terms of planning, which seeks to diagnose the population and develop possible strategies to reduce urban problems. The Political Constitution of the United Mexican States, based on Article 27, declares the national property of the land and the extension of the national

territory. A series of laws serve as a basis for urban and territorial planning. Table 11 explains the structure of the legal framework of urban planning in Mexico.

Table 11. Legal framework of urban development and planning in Mexico

Political Constitution of the United Mexican States	
International framework on urban planning	
Human settlements management	
General Law on Human Settlements, Land Use Planning and Urban Development	
Federal	National Programme for Spatial Planning and Urban Development
	National Spatial Planning Strategy
	National Housing Programme
	National Land Policy
	Metropolitan Area Management Programmes
State	Laws, codes and state programmes for urban development, land use planning, housing, registry, cadastral and other sectoral programmes.
Municipalities	Municipal regulations and programmes for urban development and land-use planning of municipalities
	Partial programmes, sectoral programmes, simplified planning schemes and rural service centres

Source: based on ENOT, 2019, pp. 109.

Mexican Constitution considers the territorial and urban planning as part of the signing of international agreements and treaties such as the New Urban Agenda Habitat III, Agenda 2030 with the Sustainable Development Goals (SDGs), The Paris Agreement, among other. From the above, the General Law on Human Settlements, Land Management and Urban Development is responsible for structuring the general, state and municipal urban development plans throughout the country. In the same way, depending on the political administration level, other laws and regulations are derived including the way of conceptualising, defining and structuring urban mobility in the territory.

The issues associated with urban mobility are developed within urban development plans and institutions linked to mobility and transport systems. The mobility of goods and people issues are also discussed. Likewise, the issue of mobility has been understood in some texts as being related to migratory movements within and outside the territory. The

results of the analyses of the urban development plans of the three levels of government are shown below.

1.2.1. Federal level

Urban and territorial planning stems from Mexican political constitution, as well as from a series of laws aimed at territorial planning. Therefore, the analysis shows that the National Spatial Planning Strategy (NSPS) document reflects the most important points of national spatial planning, including issues related to mobility of people and public transport (SEDATU, 2020).

At the constitutional level, the right to mobility has been recognised since last year when the Congress approved the modification of Article 6 in which it proclaims that everyone has the right to mobility. For Mexican law, the right to mobility is based on the concepts of road safety, efficient and quality, environmentally friendly, accessible, inclusive and egalitarian, terms that are replicated in the laws derived from this article and in urban development plans (Poder Legislativo Federal. Cámara de Diputados, 2020).

Mobility in the General Law of Human Settlements, Territorial Planning and Urban Development speaks of the capacity, ease and efficiency in the movement of people and goods, where universal accessibility and sustainable development of this activity are the main objectives. For NSPS, mobility is understood as a cross-cutting aspect of all public policy and for that reason, it should be considered at all levels of government and should include gender issues, road safety, climate change and fundamental rights. Mobility is based on 4 main points: land-use planning, transport, transit and environment (SEDATU, 2020).

These points are fundamental to avoid the development of social problems because NSPS considers that mobility is a fundamental aspect to generate well-being and avoid phenomenon of social, spatial, economic, gender and environmental exclusion. It also diagnoses how the lack of public transport has led to private transport and cars

dependency. This dependency has generated other road and environmental problems (SEDATU, 2020).

The document divides the country into strategic regions called "Urban-Regional Systems" for a better diagnosis, coordination and space management. The Urban-Regional System which corresponds to the study area mentions that in the case of mobility and transportation it is a priority in the short term to integrate a transport network. This transport network system generates new mobility patterns through a rail transport mode. This new mode of transport is part of the idea of a sustainable mobility for the region. A special emphasis is placed on creating an inter-city and suburban rail system for a better socio-economic impact and a metropolitan mobility system (SEDATU, 2020).

Within the goals in the implementation of these strategies, the document emphasises the well-being of society. The mobility aspect is based on sustainable mobility and access to safe and affordable transport systems available to all through the integration and expansion of transport systems. At the same time, the strategies seek the design of compact cities by avoiding the expansion of the urban sprawl (SEDATU, 2020).

On the other hand, a document that reinforces the NSPS and published last year as way to counteract the effects of the pandemic in the country is the 4M Strategy. This strategy seeks to emphasise the importance of mobility for both social and economic growth throughout the country. It takes up the concept of sustainable mobility, as well as a right to mobility for all people through access to safe, affordable, quality and sustainable transport systems. In addition, it addresses mobility as the phenomenon that brings employment, education, health, culture, basic services, coexistence, recreation and the full exercise of right without any exclusion of the people (SEDATU, 2020). Therefore, the concepts analysed in Chapter 1 are reinforced in this document.

Concepts such as transport disadvantage and social disadvantage are addressed in different ways throughout the documents, which shows that they are recognised in the territorial diagnosis and that the aim is to reduce inequalities. However, the concept of transport poverty is not used in either of the two documents analysed and no similar term

is found to describe this phenomenon. Table 12 shows the terms used by the official documents to refer the concepts described on chapter 1 and those related with TRSE approach.

1.2.2. State level

The State of Mexico will host the New Mexico City Airport (AIFA), as well as the suburban line 1 branch. The official document that includes the way in which it will act at the territorial and urban level is called “Plan Estatal de Desarrollo Urbano” (State Urban Development Plan –SUDP). Like the federal level, the state plan is based on Mexican Constitutional articles as well as the State Constitution itself. Another important characteristic is that the document is aligned with the 17 Sustainable Development Goals and the 2030 Agenda of the United Nations (Secretaría de Desarrollo Urbano y Metropolitano, 2019).

Despite the structure of the plan according to federal and local laws, a distinctive characteristic of the development plans analysed above can be observed. This mean difference is its focus and importance on economic issues, mainly the attraction of whether national or foreign productive capital to the state’s territory.

However, after mentioning economic aspects for the attraction of capital, SUDP points out the importance of strengthening territorial planning for better governance, social inclusion and environmental sustainability. Based on federal policy, the previous characteristics seek a cross-cutting approach to the application of this document. As the development plan was published a year before the change of federal government, it seeks to homologate the criteria and regulations to the current structural territorial context. Likewise, although these types of plans should be legally binding, in reality they tend to become discretionary planning, since they are not laws but documents derived from laws.

Table 12. Use of the concepts of the new mobility paradigms and TRSE approach in official documents

Concept	Political Constitution of the USM		NSPS		4M Strategy	
	Included or not	*Term used*	*Included or not*	*Term used*	*Included or not*	*Term used*
Sustainable mobility	Yes	Sustainable displacement	Yes	Sustainable mobility	Yes	Sustainable mobility
Spatial planning	Yes	Land-use plans	Yes	Land-use plans	Yes	Urban Development Planning
Right to the city	Partially	Fundamental rights	Partially	Universal accessibility	Partially	Universal accessibility
Right to mobility	Yes	Right to mobility	Yes	Universal accessibility	Yes	Right to mobility
Transport disadvantage	No		Yes	Lack of Modal Transfer Centres	Yes	Lack of Modal Transfer Centres
Social disadvantage	Yes	Vulnerable groups	Yes	Degree of Marginalisation	Yes	Poverty
Transport poverty	No		No		No	
Accessibility	Yes	Universal accessibility	Yes	Road accessibility	Yes	Accessibility
Social Exclusion	Yes	Degree of Marginalisation	Yes	Degree of Marginalisation	Yes	Social backwardness

Source: based on SEDATU, 2020.

In the topics related to mobility and the concepts analysed, it is observed that from 2018 local reforms were made to integrate the issue of sustainable mobility within urban planning through certain criteria such as: age, gender, economic investment for the development of sustainable, safe and accessible transport in the urban environment. It addressed issued such as resilience, densification through economic concepts that seek to

generate investments such as the concept of urban renewal and the provision of infrastructure and services.

Thus, under the idea of generating infrastructure project, the SUDP seeks to maximise economic development, improve mobility in the metropolitan area and consolidate an integral urban mobility system helped by the project proposal of the Surburban light rail (Secretaría de Desarrollo Urbano y Metropolitano, 2019). The creation of these projects would also serve to diminish the problems that the entity presents due to the lack of mobility, such as social exclusion and inequalities in the territory. This lack of mobility translates into an institutional fragmentation of mobility systems, the abandonment of infrastructure and public transport services.

Finally, despite the use of concepts such as social exclusion, lack of transport and territorial inequalities, in general the document has a legal and regulatory discourse that differs from the federal system in the way it tries to find solutions as it does not seek in itself a more socially and just urban planning. SUDP includes in its update, the right to mobility concept and universal accessibility as fundamental parts of the composition of the new sustainable mobility programmes for urban and conurbation areas (Table 13).

Table 13. Concepts used in the State Urban Development Plan, 2019

Concept	State Urban Development Programme	
	Included or not	*Term used*
Sustainable mobility	Yes	Sustainable mobility
Spatial planning	Yes	State Urban Development Plan
Right to the city	Partially	Universal accessibility
Right to mobility	Yes	Right to mobility
Transport disadvantage	Partially	Lack of public transport
Social disadvantage	Yes	Social inequality
Transport poverty	No	
Accessibility	Yes	Universal accessibility
Social Exclusion	Yes	Social exclusion

Source: State Urban Development Plan, 2019.

1.2.3. Municipal level

The Municipal Urban Development Plan (MUDP) is a document required by law that every municipal government must submit to the State congress in order to know the

spatial strategy that will be carried out during the three years of government in the territorial, urban and rural aspect. However, just 7 of the 9 municipalities studied in this research have their MUDP updated to 2019-2021 current government period.

The 7 MUDPs elaborated by each municipality have a similar structure as they are based on the State Development Plan and the federal urban settlement laws as well as the Sustainable Development Goals by Habitat III. The format is similar among the 7 municipalities despite being governed by 3 different political parties. In general, they use SWOT analysis to assess the characteristics and possible strategies to reduce the problems on the territory.

The 7 available plans (Table 14) divide their approach to the territory under 4 main pillars: Social, Economic, Territorial and Security. Among the 4 pillars, mobility is located within pillar 3. The main objective of pillar 3, called Territorial, is to improve the urban aspect of the municipality through land use and road planning. It also seeks to make the municipality and mobility within and in the metropolitan area sustainable and resilient. Issues such as a more egalitarian and inclusive society are mentioned in Pillar 1, however there is no close link to the lack of public transport.

On the other hand, the mobility aspect for each of the municipalities is reduced to a list of the main public transport routes that operate in the municipality as well as the types of units that circulate and have a concession from the State or Municipality. In general, the mobility sub-themes as well as other sections of each of the documents are reduced to simple inventories. In addition, there is some emphasis on roads for automobiles, since due to lack of integrated public transport, the automobile has taken on a fundamental role for mobilisation of people and goods.

Few references about the lack of transport and the problems it causes. Nevertheless, only the MUDP of Nextlalpan, speaks of the importance of the new suburban light train project for the mobility and connectivity of the municipality, as it will be essential for accessibility to sources of employment and other basic services that the area does not have (Gobierno Municipal de Nextlalpan, 2019).

Table 14. Analysis of Municipal Urban Development Plans, 2019.

Concept	Coacalco		Melchor Ocampo		Nextlalpan	
	Included or not	*Term used*	*Included or not*	*Term used*	*Included or not*	*Term used*
Sustainable mobility	Partially	Sustainable cities and communities	Partially	Sustainable city	Yes	Sustainable mobility
Spatial planning	Yes	Urban Development Plan	Yes	Territorial planning	Yes	Land-use plans
Right to the city	No		No		No	
Right to mobility	No		Partially	Universal accessibility	Yes	Universal accessibility
Transport disadvantage	Yes	Urban mobility issues	No		Yes	Lack of Modal Transfer Centres
Social disadvantage	No		No		Yes	Degree of Marginalisation
Transport poverty	No		No		No	
Accessibility	No		No		Yes	Road Accessibility
Social Exclusion	No		No		Yes	Degree of Marginalisation

Concept	Tecámac		Tultepec		Tultitlán	
	Included or not	*Term used*	*Included or not*	*Term used*	*Included or not*	*Term used*
Sustainable mobility	Yes	Sustainable mobility	Partially	Sustainable mobility	Yes	Sustainable mobility
Spatial planning	Yes	Urban planning	Partially	Strategic planning	Yes	Urban Development Planning
Right to the city	No		No		No	
Right to mobility	No		No		No	

Transport disadvantage	Partially	Improving public transport	No		Partially	Access to land transport systems
Social disadvantage	Partially	Social backwardness	No		Yes	Poverty
Transport poverty	No		No		No	
Accessibility	Yes	Access to roads	No		Yes	Access to land transport systems
Social Exclusion	Partially	Social backwardness	No		Yes	Social backwardness

Concept	**Zumpango**	
	Included or not	*Term used*
Sustainable mobility	Yes	Sustainable displacement
Spatial planning	Yes	Urban planning
Right to the city	No	
Right to mobility	Partially	Improving mobility for better quality of life
Transport disadvantage	Partially	Poor road safety
Social disadvantage	No	
Transport poverty	No	
Accessibility	No	
Social Exclusion	Yes	Degree of Marginalisation

Source: Municipal Urban Development Plans, 2019.

Finally, after revisiting the results for each government level, the main characteristic in common is the use in almost all documents the concept of sustainable mobility and the importance of spatial planning for that. Moreover, other common aspect that pops up from the data collected is the lack of using or referring of Transport poverty as the concept that

take into account transport and social disadvantage. This last point could be essential for the development of new strategies for attaching the problem.

2. Mexico City-International Airport suburban light railway project

This section, in comparison to the previous one, will be based on the analysis of the plans and project dedicated to the construction, design and planning of the Suburban train line 1 branch that will connect the New Airport with the centre of Mexico City, which will cross several municipalities whose urban development plans were analysed in the previous section. Therefore, this section is divided into 2 parts. The methodology will be described and then the results and their interpretation will be developed.

2.1. Methodology

Two qualitative methodologies were used for this section. The first section analyse how the concepts studied in chapter one related to sustainable mobility and the TRSE approach are included in the planning discourse of the light train project as well as the strategies that will be developed to create a more accessible space for public transport and the connection with sources of employment and basic services in the Mexico City Metropolitan Area.

On the other hand, a journalistic review is made in the second section to the articles that deal with the suburban train project, as well as the official conferences in which the project was presented. It is important to mention that the official document "Cost Benefit Analysis" done by a private company is not available on the official website, so this research took into account the last journal literature which had access to the document. This journalistic review shows the main characteristic of the project and the construction time.

2.2. Results and interpretations

This section is divided into 2 parts. The first one is the analysis of the Territorial operational Programme linked to the construction of the New Airport, and the second one which talks about the project itself.

2.2.1. Operational Territorial Programme for the Northern Zone of the Valley of Mexico

The document entitled “Programa Territorial Operativo de la Zona Norte del Valle de México” (Operational Territorial Programme for the Northern Zona of the Valley of Mexico- OTP) emphasises the construction and development of the area directly impactedd by the New Mexico City Airport Felipe Ángeles located in the municipality of Zumpango. It is closely linked to federal regulations and the New Urban Agenda for sustainable urban development (Habitat III) (SEDATU, 2020).

Therefore, and linked to what was discussed in chapter one, this programme has a broader approach in the way it develops and plans high-impact projects in the territory with well-defined objectives related to sustainability: social, economic and environmental. It also stresses the importance of inter-institutional work as well as the democratisation of decision-making among all sectors.

This programme covers 8 municipalities of which only 7 are among the 9 municipalities studied in this research. The programme considers 8 municipalities that will be directly affected by the implementation of the airport, while the 9 municipalities selected in this study are focused on the potential municipalities impacted by the extension of the suburban train.

OTP describes the strategies for developing sustainable mobility within the area. It looks for the design of an integrated transport system that is safe, inclusive, resilient and environmentally friendly. Spatial planning would develop land and public space policies as well as road and rail infrastructure to promote more sustainable mobility (SEDATU, 2020). Thus, the concept of sustainable mobility and spatial planning go hand in hand from the point of view of this urban development programme.

However, the document refers to the concept of the right to the city as a main axis of the new urban policies to be undertaken at all levels of government. The right to the city described in the document includes to a certain extent the right to mobility of people. The right to the city is fulfilled on the basis of guarantee access to housing, infrastructure,

equipment and basic services to all inhabitants of a human settlement or population centre, based on the right recognised by Mexico (SEDATU, 2020, p. 6).

The concepts of universal accessibility and mobility are based on the right to the city and include the adaptation of existing road infrastructure to favour public transport, pedestrian and non-motorised systems. Universal accessibility seeks connectivity of road networks that facilitate the connection between the so-called "urban rural subsystems and metropolitan spaces" (SEDATU, 2020). Some concepts that were not extensively developed in chapter one but which are a fundamental part of the TRSE approach are the terms equity, inclusion and social justice, which are mentioned in the document as essential concepts to guarantee the full exercise of human rights such as equality and social cohesion in the territory. These concepts have the goal of avoiding discrimination, segregation or marginalisation of the most vulnerable individuals or groups.

The concepts of social disadvantage and transport disadvantage are not exactly described in this way, but instead terms such as lack of public transport and social backwardness and marginalisation are used. However, theoretically they have the same essence and are widely described in the document as part of the objectives to reduce the inequalities that these spaces present. Thus, Mobility Subsystem section, a diagnosis of the transport systems in the area is developed. This section concluded that the mobility model is inefficient.

Therefore, the implementation of planning instruments for the extension of the suburban train and the Mexibús system to the area are fundamental to change the future outlook of this historically marginalised area. Not only with these two transport systems, the aim is to reduce transport problems, but also with the development of Modal Transfer Centres with other feeder systems for a better articulation of the territory and mobility.

An important aspect is that the new modal centres that will be the suburban train stations are planned under the concept of Transit Oriented Development, another approach closely related to the TRSE to reduce territorial inequalities and avoid the phenomenon of social

exclusion. With the implementation of TOD, the aim is to reduce social exclusion in these municipalities by managing the space impacted by transport infrastructure projects.

Finally, it is important to mention that, as in the urban development plans studied above, the concept of transport poverty does not appear literally in the official documents. However, the diagnoses resulting from the study of the territory reflect that the concept is present in study area, with areas of high social and transport disadvantage. The Table 15 represents the summary table of the concepts analysed and the strategies proposed in the document with the implementation of the railway project.

Table 15. Mean mobility concepts used and strategies in the Operational Territorial Programme, 2020.

Concept	Operational Territorial Programme	
	Included or not	*Strategy*
Sustainable mobility	Yes	Generation of a safe, inclusive, resilient and sustainable integrated transport system in the metropolitan area.
Spatial planning	Yes	Land-use plans at various scales of government.
Right to the city	Yes	Ensure access to fundamental rights, basic services and facilities.
Right to mobility	Partially	Linked to the concept of the right to the city and access to fundamental rights.
Transport disadvantage	Partially	Planning instruments for the expansion of transport systems, Modal Transfer Centre.
Social disadvantage	Partially	Ensure that vulnerable groups, gender perspectives and all inhabitants can choose from a diverse supply of land, housing, services, facilities, infrastructure and economic activities according to their preferences, needs and capacities.
Transport poverty	No	
Accessibility	Yes	Adequacy of transport infrastructure.
Social Exclusion	Yes	Planning through the Transport Oriented Development approach.

Source: SEDATU, 2020.

2.2.2. Suburban light railway extension project

The project of the extension of Line 1 from the current suburban train that runs from Buenavista station to Cuautitlán was proposed by the Minister of Communications and Transport of the Government of Mexico to solve the challenges of mobility and

connectivity with the New Mexico City airport (AIFA) located in the municipality of Zumpango, approximately 45 km from the centre of Mexico City.

This new extension line, known as Lechería-Xaltocan, would be 23 km long from the existing Lechería station to the new air terminal (García, 2020). Each station would have Modal Transfer Centre to organise local public transport and the feeder routes that will complement the suburban transport system, while at the same time it will be a space for leisure, commerce and parking (Zavala, 2021).

The main responsible for it construction will be the concessionaire of Line 1, CAF, a Spanish company already settled in Mexico 2005. In addition, a public investment by federal government through the armed forces (SEDENA), the ministry of Communications and Transport (SCT), and the bank specialising in infrastructure projects (BANOBRAS) will be part of the construction process. Moreover, the Cost-Benefit Analysis of the project was carried out by Adhoc Consultores, a multidisciplinary group of experts in economics, finance, infrastructure, transport and energy specialised in transport projects (De La Rosa, 2020).

At a press conference on 19 March 2020, the SCT informed that the Surburban train project would be executed in 2 phases. The first one with the construction of 3 stations: a terminal and 2 intermediate stops. The stations of the first phase would be Teyahualco, Jaltocan and the AIFA terminal. It would have an investment of around 13.5 billion pesos. For phase two the stations would be added: Cueyamil, Los Gavaes, Prados Sur and Nextlalpan. The route is based on existing railway rights of way. The first phase would be completed by June 2022 (Government of Mexico, 2020).

However, in the latest press reports that had access to the CBA elaborated by Adhoc Consultores, it was found that the completion date was extended to 2023 due to delays caused by COVID-19 pandemic, although the Ministry of National Defence has already started the construction of the terminal station at the airport and the tracks that will connect it with the rest of the existing route.

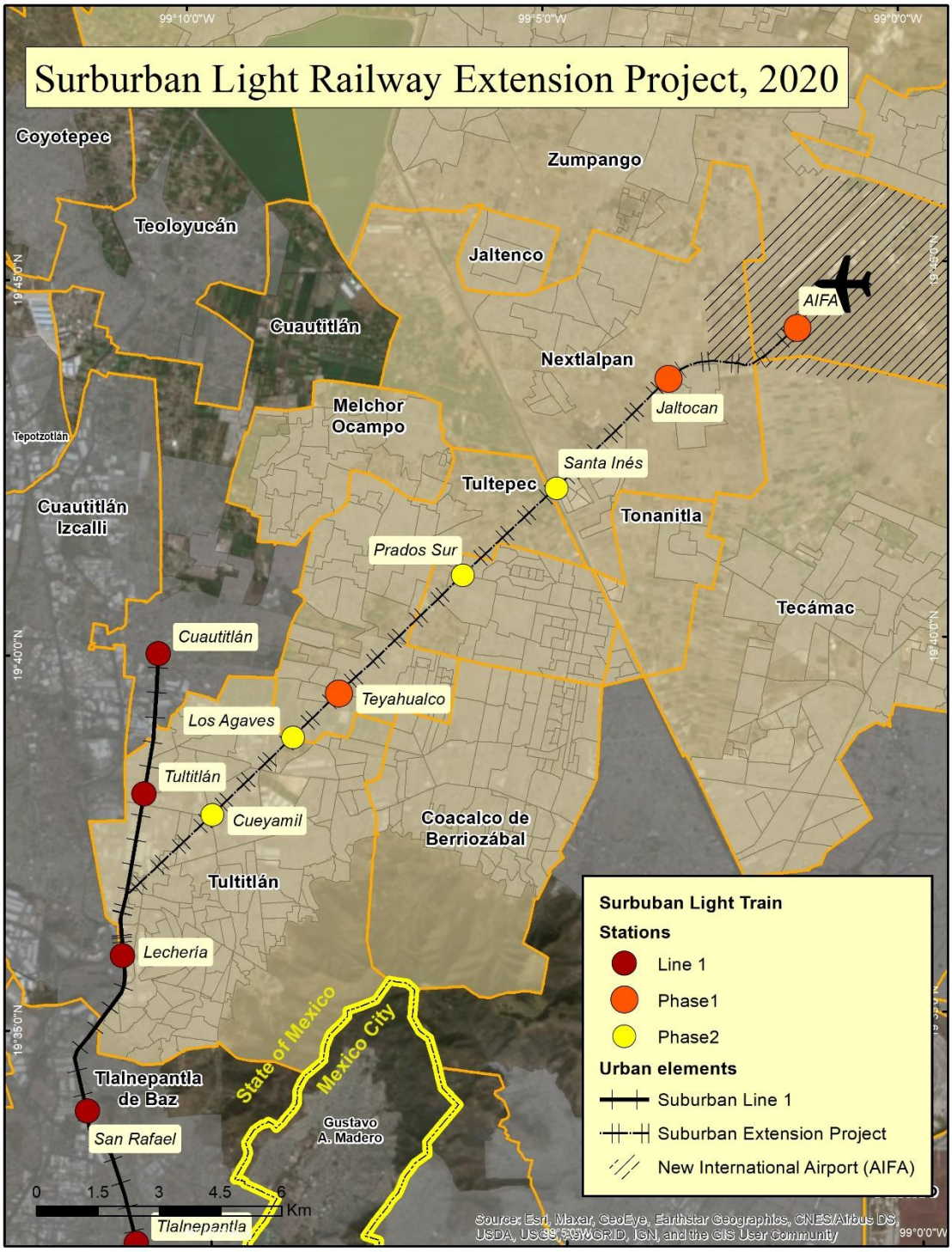
According to the interview with the director of the CAF company by the newspaper “El Economista” (March, 2021) a slight modification in the number and name of the stations is mentioned, although it is not fully specified. The stations mentioned are Cueyamil, Los Agaves, Nextlalpan and Jaltocan. It also gives an approximate cost of the trip which is around 60 Mexican pesos from Buenavista station in Mexico City centre to the airport (De La Rosa, 2021).

Centro Urbano article (2020) mention that the CBA presented by the Ministry of Finance and Public Credit comments that the project is viable technically, legally and environmentally feasible and socio-economically profitable solution (García, 2020). The project would be 80% finances by the federal government and the operation concessioner to the current company CAF that manage Line 1 of the Suburban System.

Based on the official information presented in March last year, the proposal for the suburban train is shown in Figure 8, which shows the stations that would be ready in phase 1 and those that would be built in phase 2. Although newspaper articles speak of only 4 intermediate stations, there is no official document confirming this modification to the original plan.

In general, based on the information obtained on the newspapers is that the economic issue in the implementation of this type of project, both technical and monetary, continues to be predominant, while the socio-environmental aspects remain on the margins of the results of the CBA. The institutions in charge of planning and carrying out the project are public agencies in charge of the administration of public resources, banks and technical engineering, but which must work hand in hand with the agencies in charge of social welfare and the environment.

Figure 8. Suburban Light Railway Extension project, 2020



Source: Government of Mexico, 2020.

Chapter IV. Impact of the spatial planning project of the New Mexico City-Airport Suburban Light Railway extension in the study area.

This chapter answers the research question that governs this document based on what has been developed in the previous sections. Therefore, the following chapter describes how the spatial planning project of the new Mexico City-Airport Suburban Light Railway Extension reconfigures the integration of the towns it passes through.

Thus, through the spatial modifications related to the construction of the light rail project, the variables used in Chapter 2 will be modified based on the TRSE approach to observe the impacts at the studied space level as well as the influence of the development plans and the mobility programme to be implemented in the region.

The chapter is divided according to the impacts on the concepts related on the new mobility paradigm and the TRSE approach. Those impacts will be supported by cartographic tools based on information obtained from official documents and data base.

1. Transport Disadvantage

The effects that the implementation of the suburban train to the new Mexico City-Airport would have in terms of transport disadvantage is remarkable since it would reconfigure mobility flows and the composition of public transport in Northern part of the Mexico City Metropolitan Area under study. And it would reach a high impact, if other project proposal are met, such as the development of Modal Transfer Centres (MTCs) at each of the proposed stations.

The area of influence of the stations would expand due to the arrangement of the space adjacent to the suburban train, as well as modifying the values of the variables that make up the transport disadvantage according to the TRSE approach. The way in which each of the variables will be directly or indirectly affected by each Basic Geostatistical Area will be described below.

In the Lack of Information, this project would give certainty to the population with established times for daily train runs at each station, i.e., there would be established opening hours, number of journeys per hour, approximate waiting time and approximate

duration of the journey. This would not only be limited to the suburban train service, but MTCs would also publicise the feeder routes with three respective timetables fares and routes.

The No Car Ownership variable would be the most difficult variable to measure in the short term, as it will depend on the acceptance of the population of the area to change from private transport to public transport. Therefore, this variable would remain unchanged for the time being.

With regard to the variable on Fear of Crime, it could be drastically reduced after the implementation of this mode of mass transport since, according to what was said by the director of CAF, the suburban train is widely accepted by users who rate it as safe and reliable means of transport. Therefore, this variable, which currently has a very high value due to the poor perception of the population, could drop to very low values.

Another variables strongly impacted by the development of this project is the Lack of Public Transport Services, since the implementation of this branch would connect with a more articulated public transport system in the area, as well as the reorganisation of local and intermunicipal public transport in each of the MTCs. This extension of the transport system would be the new backbone of this metropolitan area.

Finally, the Unfordable Fares variable would be moderately reduce, since due to the distance between this part of the city and the main destinations in the area, the trip could have a high cost. According to an interview conducted by the newspaper "El Economista" with the director of the CAF Company, the full trip from the city centre to the airport would cost around 60 pesos. The same rule could be applied on fare depending on distance that currently governs this transport. However, the cost of this transport might not be a problem as it would bring more benefits such as reduction in travel times (De La Rosa, 2021).

2. Social Disadvantage

This indicator is complicated to measure through the information obtained from the literature review and analysis of development plans, as these are aspects of the population

that its measurement is not directly related to the suburban rail transport project. However, some possible impacts will be mentioned.

The low income variable could be impacted through the development of new economic activities with higher remuneration close to the project. The main sources of employment could be developed on the land adjacent to the new airport. The land use near the airport has already been evaluated and planned as mentioned in the OTP document for the establishment of new industries that together with the start of the airport operation will increase the average income of the inhabitants of the area.

Closely related to the previous variable, the Unemployment variable would be directly impacted by the creation of new sources of employment both at the airport and at each of the stations where the TOD approach is developed. The main jobs would be related to tertiary activities such as service providers or within secondary activities such as transport, courier and cargo. The construction of the airport is designed to generate around 250,000 jobs between 2022 and 2052 (Usla, 2020). However, it all depends whether the population living in this area will be formally integrated into the offer jobs once the project is up and running.

The Low Skills variable impact will be reflected through facilitating access to educational centres at all levels. The impact could be through the reduction of commuting times for students from one municipality to another, which will help to raise he long-term schooling average of the population of these municipalities. This impact is relative since other factors that determine the continuity of students in the educational system must be fulfilled. The improvement of mobility with the suburban train, although it plays an important role, is not determinant.

Likewise, the health insurance variable not only depends on improving the population's mobility to health services, but is also a key element for access to the population's right to health, including the main heath centres located in Mexico City.

Finally, the Poor Housing variable would be reconfigured through the implementation of Transit-Oriented Development approach mentioned in the OTP for the new airport. Within the programme, affordable and decent housing is planned adjacent to the main suburban train stations in order to generate a compact urban development close to mass transit to densify the area best connected to the rest of the Metropolitan area and thus reduce travel times on the first and last miles of the trip journey.

Social disadvantage would be the indicator that will take the longest time to show the degree to which the area will be affected by the implementation of the transport system, since most of the measurements are based on data from the census carried out every 10 years. However, when this indicator is added to the transport disadvantage indicator, there are notable changes in what is defined as transport poverty.

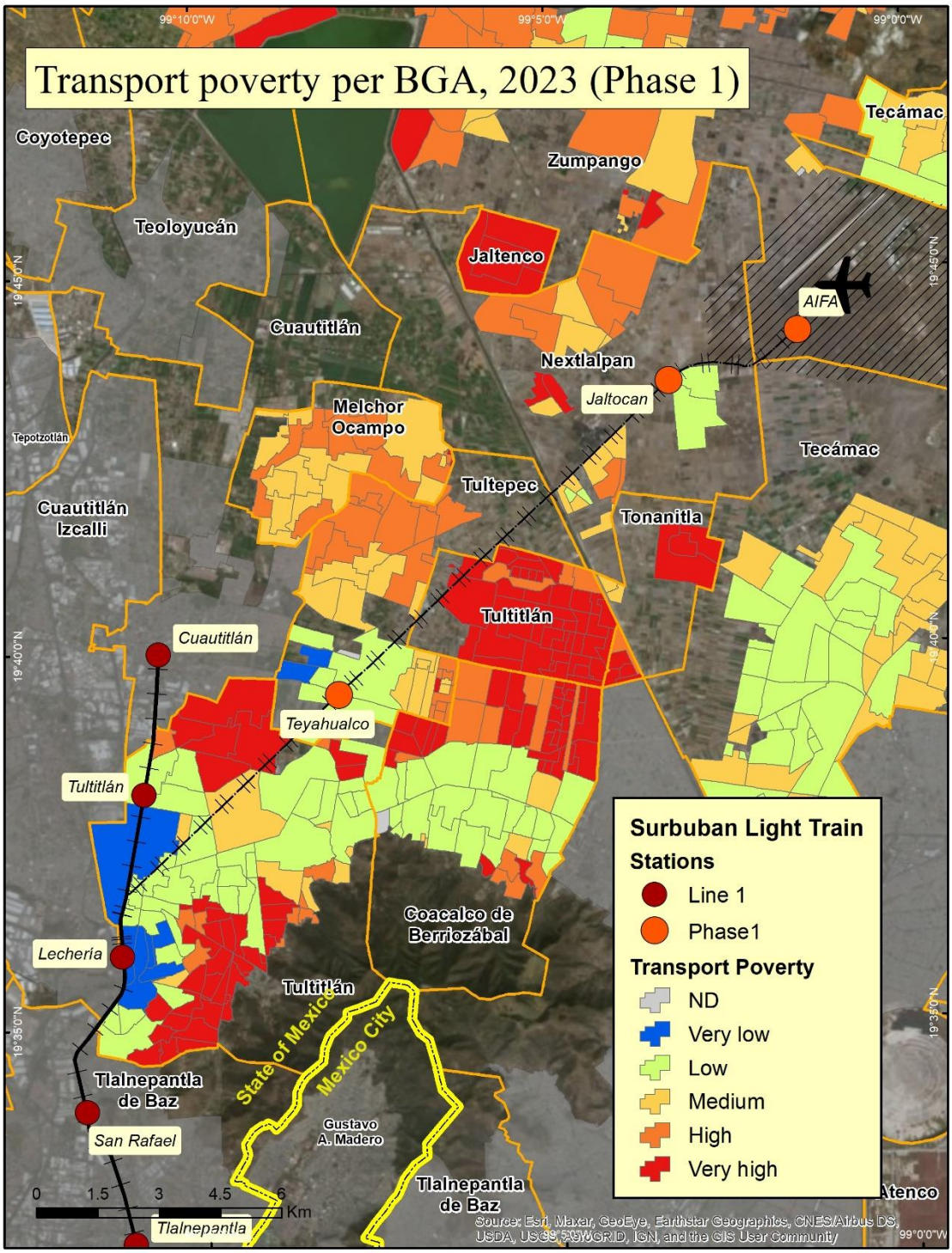
3. Transport Poverty

Transport Poverty indicator is the result of the sum of the transport and social disadvantage. Thus, Those BGAs with concise modifications in the values of the above variables that will host or be close to the suburban train stations will have a new outlook and reduce the degree of transport poverty.

The BGAs that will contain the new transport project will have a similar configuration to what currently occurs in the BGAs near the existing Cuautitlán, Tultitlán and Lechería stations. The implementation of a commuter rail stop is reflected in Figure 9 where the degree of transport poverty drops markedly from a high or medium level to a low or very low level. It is important to mention that the most noticeable effects would be until the second phase of the implementation of the official project where there would be a total of 7 new stations of the suburban railway system, covering a much larger area of influence than the first three stations of the first phase.

According to the Figure 9 representing the changes in the study area in 2023 with the completion of the first phase of construction. These localities would go from high to low transport poverty, which in general terms is a very marked change that would benefit the population of these municipalities and neighbouring localities. The construction of MTCs

Figure 9. Transport Poverty after Phase 1



Source: based on National Census, 2020; SEDATU, 2020.

will extend the influence of train stations to neighbouring municipalities such as Melchor Ocampo and Jaltenco with the help of the configuration of concessioner transport in those areas.

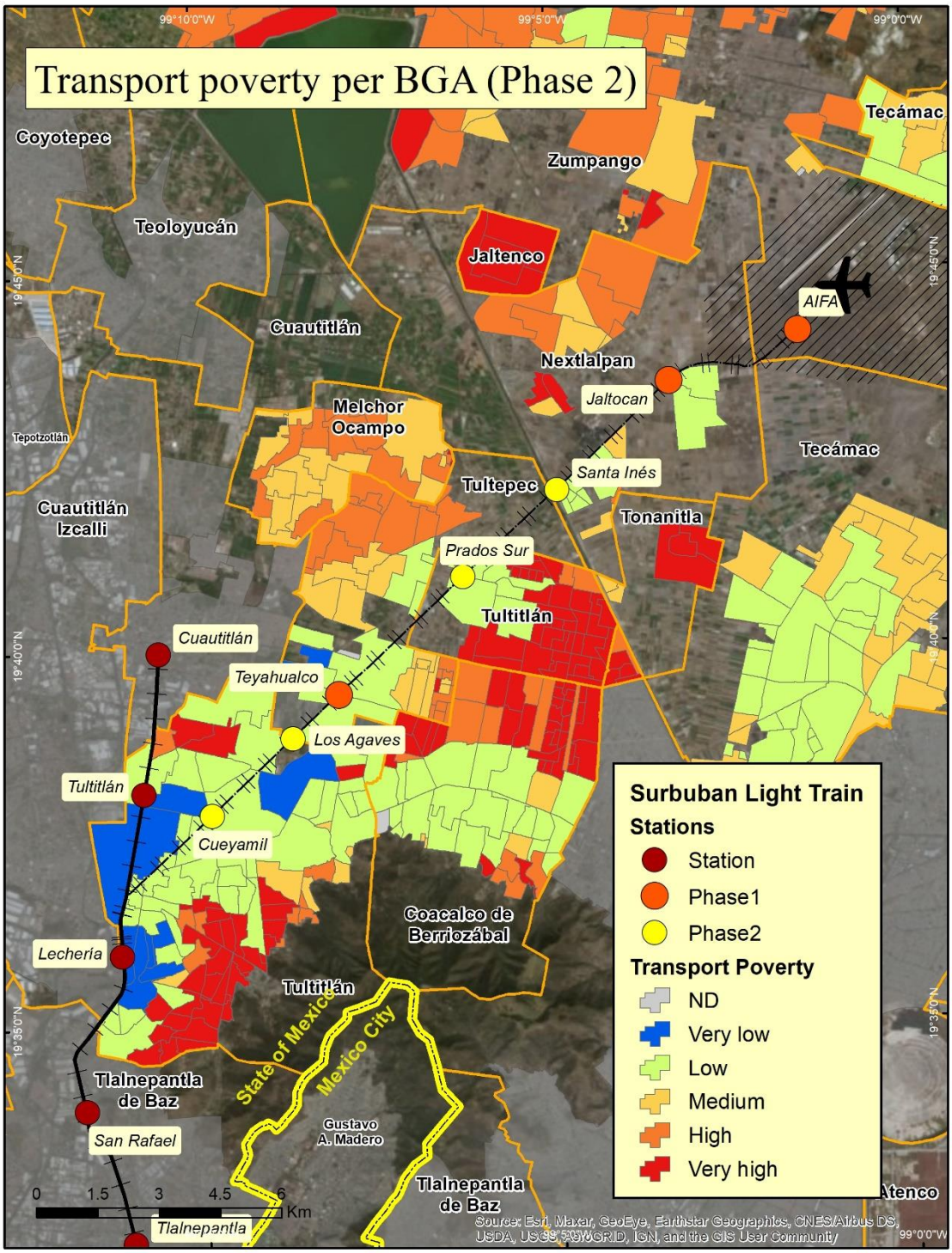
However, despite the implementation of the first phase of the train, the map still shows areas with a very high degree of transport poverty, which translates into a lack of integrated transport to help the population meet basic needs and basic rights. The map shows that most of the BGA of Jaltenco, the northern zone of Tultitlán, Tonanitla, the North and centre of Nextlalpan and the northern zone of Coacalco still have very high levels of transport poverty. Only with the organisation of the concessioner transport routes in the area could the values shown in the map be counteracted, which implies the coordination of the 3 levels of government and the transport companies.

Figure 10 shows the spatial modifications of the transport poverty at the end of the second phase of the construction, which includes 4 new intermediate stations between AIFA terminal and the Lechería station. The four new stations are: Cueyamil, located in the Southern part of the municipality of Tultitlán; Los Agaves, located in the limits of the municipalities of Tultepec and Tultitlán; Prado Sur, located in the northern section of the municipality of Tultitlán; and Santa Inés, located in the border zone between the municipalities of Tultepec and Nextlalpan.

The implementation of phase 2 would cover a larger area, compared to the map showing the impacts on the territory of phase 1 (Figure 9). This larger extension will benefit most of the municipalities in the study area. It would change the degree of transport poverty from very high and high to low and very low. Likewise, other municipalities could have a significant reduction after the implementation of the suburban train and the feeder bus lines that will connect to the MTCs. That is the case of the municipalities of Melchor Ocampo, Zumpango and Coacalco.

Despite the construction of 4 more stations in phase 2, there are still a considerable number of BGAs with a very high degree of transport poverty, such as half of the BGAs in the North and South zone of Tultitlán, the NorthWest of Coacalco, the whole of the

Figure 10. Transport Poverty after Phase 2



Source: based on National Census, 2020; SEDATU, 2020.

municipalities of Tonanitla and Jaltenco, and partially the municipality of Zumpango. The best option to improve change in the degree of transport poverty of this area is through the articulation and design of local public transport that converge in the MTCs of the Suburban stations for a better connectivity with the transport system network of the area. In addition, Local authorities need to improve public services that impact directly on the variables of this indicator to observe a high effect.

4. Accessibility and Social Exclusion

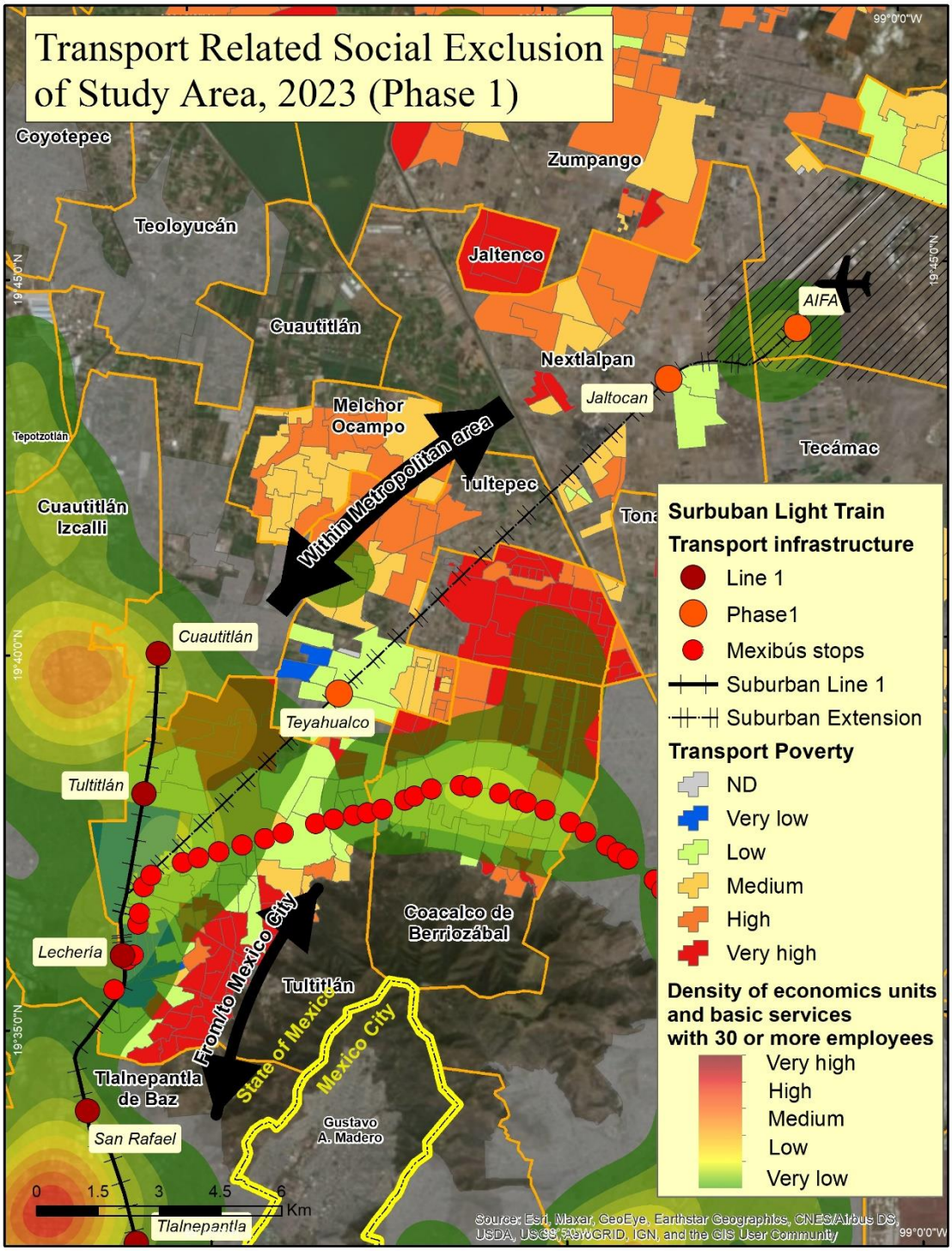
In terms of accessibility and social inclusion modified by the operation of the light railway branch, the Figure 11 shows that mobility in the area through public transport will be strongly modified as the stations will act as poles of development and will organise the local transport. However, the effects will be seen in the long term and will be more visible after the construction of the second phase with the 7 station in total.

According to the OTP for the area and the suburban railway project, each station will contain certain economic units that will generate employment; however, it is not specified whether a creation of basic public services will cause a reduction in flows to the West of the Metropolitan are or to the centre of Mexico City where most of the educational centres and specialised hospitals are located.

However, the commuter rail transport system will serve to reduce travel times, and although it is not precise whether new educational or health services will be built near the stations, the train will help to connect the population with existing public services. However, the following two maps represent the effects of the first and second phases of transport project construction.

In addition to the changes already mentioned above, the new Mexico City airport by 2023 appears as a new development pole with the presence of a density of economic units that will generate jobs and people movement flows, however most of the population living in the study area would continue travelling towards those that currently are the main attraction poles of the area: the West and Southwest.

Figure 11. Accessibility and Transport Related Social Exclusion of the study area after Phase 1.



Source: based on INEGI, 2020; SEDATU, 2020; Government of Mexico, 2020.

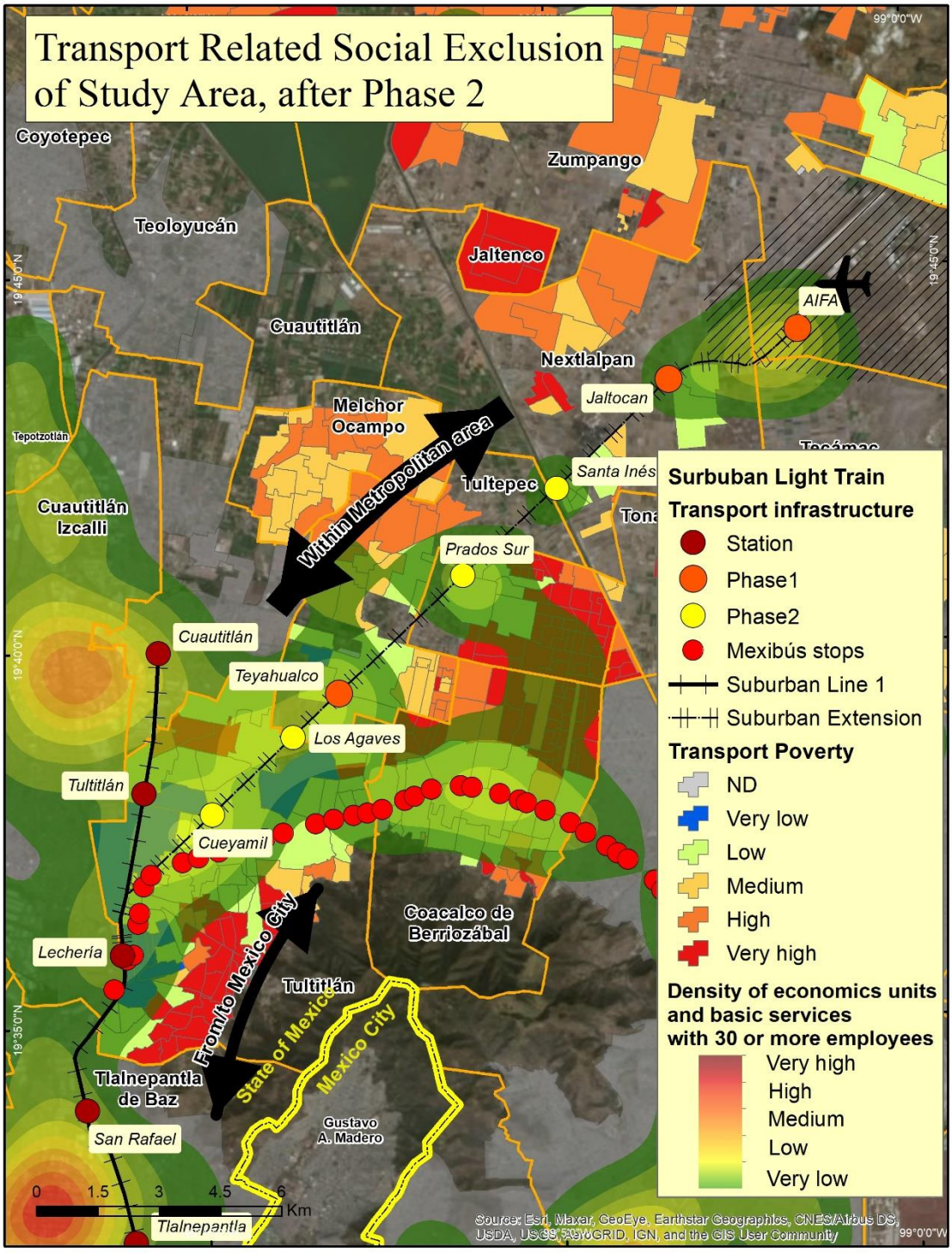
Figure 11 also shows that the location of suburban line 1 and Mexibús stops contains the highest density of economic units. For that reason, the other two intermediate stations in Phase 1 will start to become real development centres for the area as planned in the urban development programmes of regional and federal level. However, the areas far from the transport modes will continue to lag behind, resulting on a social and spatial exclusion related to the integrated transport of the suburban train.

The Figure 12 shows a greater extension of the density of economic units by the end of the construction of phase 2. The new Mexico City Airport (AIFA) will be positioned as a main pole of economic development with the settlement of large companies from different economic activities that will generate employment for people in the area, making it a main destination for mobility patterns in the Northern part of the Mexico City Metropolitan Area.

Similarly, the four new intermediate stations will act as a centre of urban development by organising local transport routes, housing economic units and employment. Compared to the Phase 1 map (Figure 11), Phase 2 map (Figure 12) shows a significant increase in the density of economic units near the Suburban train stations, which indicates a possible reduction in travel times and a change in the dynamics of local mobility in the area towards the suburban train stations.

Based on the development programmes and the TRSE maps of the study area, the municipalities of Tultitlán, Tultepec and Nextlalpan will be the main long-term beneficiaries of the implementation of this transport project. This project will reduce historical inequalities both in the social sphere and in terms of mobility and accessibility. Nevertheless, as shown in the map, the northern part of the study area will continue to be excluded from the new dynamics generated by the suburban train. This continuity results in a deepening of the social exclusion phenomenon which could be reversed if the local transport system is reformed and integrated it into the suburban train, becoming the backbone of transport in the northern part of the Valley of Mexico.

Figure 12. Accessibility and Transport Related Social Exclusion of the study area after Phase 2.



Source: based on INEGI, 2020; SEDATU, 2020; Government of Mexico, 2020.

5. Sustainable mobility

According to the Operational Territorial Programme (OTP) for the Northern Zone of the Valley of Mexico, it mentions that the development of the suburban train extension project will improve mobility in the area by making it safer, more comfortable and less polluting. Characteristics included in the concept of the sustainable mobility.

On the other side, official documents and reports emphasis that the light railway project takes part of the sustainable mobility by developing and applying to the stations the Transit-Oriented Development Approach. This approach seeks to produce an important economic and social nodes, and a more sustainable urban centres by reducing long journeys for people to meet basic needs such as going to school, work, recreation and health. Therefore, it seeks to make a compact city through the densification of strategic spaces (Singh, Lukman, Flacke, Zuidgeest, & Van Maarseveen, 2017).

The 7 stations of the suburban train at the end of the two phases will become important mobility centres within each municipality that will connect with an electric transport with zero polluting emissions in situ, which will bring the population closer to a more environmentally friendly mobility that can move a large number of people compared to the number of units that currently exist in local public transport to meet the demand. At the same time, this project seek to attract new urban transport passengers to reduce the car dependency that has grown in recent years due to the disadvantage of public transport in the area.

In general, sustainable mobility cover not only environmental aspects but will also seek a balance with the economic and social pillars and for this case study, the Federal authorities look for this balance through the implementation of the spatial planning and programmes in the study area together with the light railway project, municipalities and other stakeholders. However, as observed in the analysis of the maps in previous paragraphs, some area will not be covered in their entirety, so new programmes must be allocated for the incorporation of that areas into a metropolitan mobility system.

6. Right to the city and right to mobility

In addition to the previous analysis, the right to the city as well as the right to mobility will be fulfilled in the study territory in an unequal manner. The localities and municipalities that will be close to the Suburban train will increase the availability of quality public transport which helps population to travel to the main urban economic centres or the region and to the Mexico City centre. While localities further away from the transport project will continue to be excluded if the area of influence is not expanded with feeder transport routes.

It is important to mention that at the federal level, the discourse of the right to the city to sustainable mobility is present in urban programmes and plans; nevertheless, the state and municipal level have a long way to go and integrate these concepts and strategies, so the implementation of this transport project may not have the best impact if it does not work together with the different levels of government and stakeholders.

It should also be noted, as it was mentioned before in this work, that the studied project itself, despite having a strong economic basis for its implementation and justification to the institutions that finance the project, has sought through urban development programmes and plans to create a more comprehensive vision of what the development of transport infrastructure entails. This comprehensive vision of projects goes hand in hand with the concept of the right to the city, which seeks universal access to basic services for population linked with the right to mobility.

Discussion and conclusions

This research work obtained the impacts in the 9 municipalities of the northern zone of the Mexico City Metropolitan Area due to the implementation of the suburban light railway extension project towards the New Mexico City airport from the Transport Related Social Exclusion approach. This scope showed that benefits for the localities near the stations of the system according to the construction phases will stand out by reducing the indicators of transport poverty as well as the accessibility of the population to employment and basic services sources. This territorial impact is due to the fact that currently, transport-related social exclusion is mostly prevalent in the study area as a result of the lack of a comprehensive public transport system connecting to the main socio-economic centres of the area.

The spatial modifications that will be observed in the study area are confirmed by analysing the two scenarios based on the two phases of construction of the suburban train. In phase one, with the construction of 2 intermediate stations and the terminal at the airport, they will have a direct impact in the municipalities of Tultitlán and Nextlalpan. In the second phase of the project, a substantial improvement is observed in the areas surrounding the 7 stations, as well as the consolidation of the new airport as an important socio-economic nucleus that will modify the mobility patterns of the northern zone of the Valley of Mexico.

However, it was noted that even with the implementation of this transport system, some municipalities will continue to have similar values to the current ones in terms of transport poverty and inaccessibility, which could be compensated with the integration of local transport into the suburban train system. The slightly impacted municipalities would be those that will not physically contain a station of the system, such as the municipalities of Zumpango, Melchor Ocampo, Tecámac and Jaltenco.

The results were obtained thanks to the Transport Related Social Exclusion approach which proposes a series of concepts that are analysed in this work through a mixed methodology. The quantitative method employed, through the use of official data, basic

statistics and cartographic analysis, showed the current situation of the study area. The qualitative method employed was based on the analysis of the development plans of the three levels of government on urban issues with emphasis on the sections dedicated to urban mobility. The use of both methods facilitated a better understanding of the impacts of a transport infrastructure project connecting the New Mexico City airport (AIFA).

This work reinforce the idea of light rails together with other infrastructures has positive economic impacts on urban spaces since they stimulate economic growth in areas where there was difficult access to means of transport (Knowles & Ferbrache, 2016). But compared to other studies dedicated to the analysis of light rail connecting the city to the airport, this work focuses on the social and territorial impacts. On the other hand, the use of this methodology based on the TRSE approach and mapping had only been done in bus transport systems by Wu and Hine (2003). While the analysis of rural development programmes and plans based on TRSE approach complements previous studies done by Manaugh, Badami & El-Geneidy (2015) that assesses social equity.

At the same time as obtaining the short and long term impact of the transport project, the methods applied made it possible to understand the current situation in the study area with regard to transport, social and economic aspects, as well as to outline the legal structure that prevails in the application of laws and programmes on urban development and planning. In addition, this research contributes to defining and measuring the Transport Poverty described by Lucas, Mattioli, Verlinghieri, & Guzmán (2016).

The results obtained are fundamental for studies of sustainable urban mobility and the relationship with social exclusion, as they contribute to the new mobility paradigm in Geography of transports and its impacts on the territory under the Transport Related Social Exclusion approach developed extensively by Lucas (2012). Although Lucas outlines the conformation of the approach and its concepts, had not been elaborated under a mixed methodology as proposed in this research work focused on the Mexico City-Airport suburban light train project.

The evolution in urban transport studies has led to the expansion of the mobility concept as a right and part of the right to the city, as well as the new paradigms within transport geography. This research takes into consideration qualitative and quantitative data that allow us to understand the spatial planning of transport projects and their development within certain urban spaces from a sustainable mobility perspective that emphasises the social aspects. The use of mixed methodologies, such as quantitative and qualitative methodologies shared by the social sciences, is becoming increasingly common in order to provide other interpretations of socio-spatial phenomena.

In addition, chapter two helped to show the current situation in the northern zone of the Valley of Mexico in terms of the relationship between public transport and social exclusion before the implementation of the suburban train project, which served as a basis for comparison with the possible impacts of the project. Moreover, chapter three provided information on the main lines of action available under the legislation and programming of the various levels of government to improve mobility in the area in accordance with the development of the airport and urban transport derived from this public work. Furthermore, the suburban rail project is based on purely economic issues that are complemented by government programmes to have a beneficial impact on society.

Finally, both previous stages were key to obtain the results on the impact of the suburban train in the study area. The scenarios show that both quantitative and qualitative analysis are complementary in the study of transport projects and the importance they have for understanding spatial and social issues, while at the same time generating visual material such as maps and tables that facilitate the interpretation of the results. Two phases of implementation are distinguished according to the number of stations planned, with the second phase being the one in which there will be the greatest benefit for the population living or working close by the stations.

However, the limitation of this research correspond to the time frame and the availability of some data that needs to be measured in field work. There are various social factors that can both improve or deteriorate the impact of this transport project, so this research provides a guideline for further work on other modes of transport in the area that can

contribute to their implementation which can be combined with the Transit Oriented Development approach and its impact on space. Moreover, a field work and the elaboration of travel survey can expand the scope of this research by adding new data of the mobility patterns of the study area.

In general, the development of the research has shown that based on the principles of sustainable mobility, new concepts such as the right to mobility have become important and seek to reduce inequalities linked to the lack of comprehensive transport. The Transport Related Social Exclusion approach is useful to understand the current and future situation of the Northern part of Mexico City Metropolitan Area directly impacted by the extension of the Suburban train. This approach helps to analyse the implementation of a transport project from a socio-spatial and innovative perspective. The analysis of official data and documents through a mixed methodology resulted in short and long term impacts of the infrastructure project such as the reduction of transport poverty and inaccessibility of the study area, which translates into the decrease of social exclusion linked to public transport. This type of methodology could be used to complement economic studies such as CBAs often used to evaluate transport infrastructure projects as well as to justify the implementation or design of a transport system for socially excluded communities.

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Appendix

Appendix 1.

List of Figures

List of Tables