

Road infrastructure and mobility of consumption in the Mexicali-Imperial Valley border area

Infraestructura vial y movilidad de consumo en el espacio transfronterizo de Mexicali y Valle Imperial

Alejandro Mungaray-Moctezuma* and Julio Alberto Calderón Ramírez*

Received: March 19, 2014. Approved: December 17, 2014.

Summary

The objective of this study is to analyze the mobility of consumption in the Mexicali-Imperial Valley border area. The study shows that the population in the Mexicali sections closer to border crossings generates the greatest amount of consumption dynamics with places located in Imperial Valley. Conversely, Imperial Valley sections that are more distant from the border concentrate a greater number of destination sites for these cross-border trips. It is concluded that a higher quality and more integrated road infrastructure allows the new consumption centers in Imperial Valley to be located farther away from the border and that the Mexicali population with visas can cross indiscriminately through any border crossing by taking longer journeys toward these centers.

Keywords: non-compulsory mobility, road infrastructure, cross-border urban spaces, consumption.

Resumen

El objetivo del presente estudio es analizar la movilidad de consumo en el espacio transfronterizo de Mexicali-Valle Imperial. El estudio arroja que la población de las secciones de Mexicali más cercanas a los puertos fronterizos genera mayor cantidad de dinámicas de consumo con sitios localizados en Valle Imperial. Mientras que, las secciones del Valle Imperial que están más alejadas de la frontera concentran fuertes cantidades de sitios de destino para esos viajes transfronterizos. Se concluye que una infraestructura vial más integrada y de mayor calidad permite que los nuevos centros de consumo de Valle Imperial se ubiquen más alejados de la línea fronteriza y que la población de Mexicali con visa pueda cruzar indistintamente por cualquiera de las dos garitas, para realizar recorridos más largos hacia dichos centros.

Palabras clave: movilidad no obligada, infraestructura vial, espacios urbanos transfronterizos, consumo.

[Original article language: Spanish]

* Universidad Autónoma de Baja California, Facultad de Ingeniería. Mexicali, Baja California, México. Address: Boulevard Benito Juárez s/n, C. P. 21280. E-mails: alejandro.mungaray@uabc.edu.mx, julio.calderon@uabc.edu.mx

Introduction

The Mexicali-Imperial Valley region is a border area located in the northwestern border of Baja California, Mexico-California, United States (see Figure 1). This area is made up of several urban nuclei of different levels of importance and has a population greater than 1.1 million inhabitants, of whom 936,826 live in Mexicali and 174,528 in Imperial Valley, according to the 2010 census. It covers approximately 26,432 square kilometers, 11,091 corresponding to the Imperial Valley and 15,336 to the municipality of Mexicali.

Figure 1. Geographical Location of the Mexicali-Imperial Valley border area



Source: Authors.

Mexicali was created in 1903 as a result of successive subdivisions of the land in the valley, after the Mexican government granted the first land concessions in the region (Padilla and Piñera, 1991). Because it was created as a product of foreign interests, during its early years, this area was developed in parallel with its North American counterpart, called Calexico. These names show a close connection and an ingenious wordplay: Calexico (*Cal* from California and *exico* from Mexico) and Mexicali (*Mexi* from Mexico and *Cali* from California) (Aguirre, 1983). There is mention that George Chaffey, a major investor in hydraulic works in the region, conceived of this concept (Alexander, 1928).

As in any bi-national region, the border of this transborder city results in discontinuities related to road networks and population mobility. In this study, first, the creation process of network channels between Mexicali and Imperial Valley is illustrated. Then, a brief review of the literature on mobility of consumption is presented along with a description of the study methodology for this type of mobility. The territorial patterns from the different Mexicali population sections toward the main consumer destinations in Imperial Valley are also analyzed. Finally, the characteristics of consumption are presented in the results in relation to the crossing conditions at the border crossings and the highway infrastructure in the Imperial Valley.

According to Gordon, Richardson, and Wong (1986), McDonald and Phrater (1994), Small and Song (1992), Clark and Kuijpers-Linde (1994), and Cervero and Wu (1997),

urban morphologies have been undergoing significant changes in recent decades; for instance, monocentric structures are being replaced by polycentric forms as a result of extensive suburbanization processes, and this transition is changing mobility patterns. The dispersion process has led to increased mobility in middle-distance journeys (Cervero, 1996; Massot and Roy, 2004) and expansive processes generate much more scattered, fragmented, and decentralized relationships (Monsoon and De la Hoz, 2009). The long distances and the lack of public transport cause a greater reliance on private transport (Monsoon and Sickle, 2006). For these reasons, there is a growing interest in investigating the relationship between urban structure and mobility patterns (Cervero, 1995; Giuliano and Small, 1993; Handy, 1996), foregrounding the need for a greater understanding of the phenomena of mobility. Given that the main type of cross-border mobility in Mexicali-Imperial Valley is associated with consumption, the aim of the present study is to present a first approach to this phenomenon in a case study. There is a special focus on the dynamics of cross-border mobility because there is no current information to further understand this topic.

To corroborate that borders undergo dispersion changes in population mobility that lead to increased travel distances, it has been hypothesized that a greater amount of consumption trips originating in the sections of the city on the Mexican side that are closer to the border do not pass through the closest border port within the section and arrive at destination points in the United States farther away from those border ports.

Background

In the latter half of the nineteenth century, the administrations of Mexico stimulated the development of the country through the use and exploitation of its natural resources. A major step was the construction of railways in the Mexicali Valley with American financing (Roeder, 1987), prompting the development of both Mexicali and the valley. Because the railways were built by an American company, the movement of passengers and goods between Calexico and Yuma was facilitated. The track layout began in 1904, and the first section that reached Hechicera was open to service in December 1907. Subsequently, the Burdick, Volcano, Bataques, Tecolote, Paredones, Cuervos, Dieguinos, and Algodones stations were added until Yuma was reached. In August 1909, the full journey from Calexico to Yuma was completed, with a duration of 1 hr 55 min (Kirchner, 1988). Most of these stations gave rise to towns in the Mexicali Valley that still remain (see Figure 2).

Similarly, border crossing I was built in 1904 between Mexicali and Calexico, creating a linear and disaggregated road network. In 1994, after 90 years, the "New Mexicali" crossing port was built, 12 km to the east of the first. The urban center of the city of Mexicali is located around the first border crossing, whereas the second border crossing has influenced urban, economic, and population growth toward the east of the city.

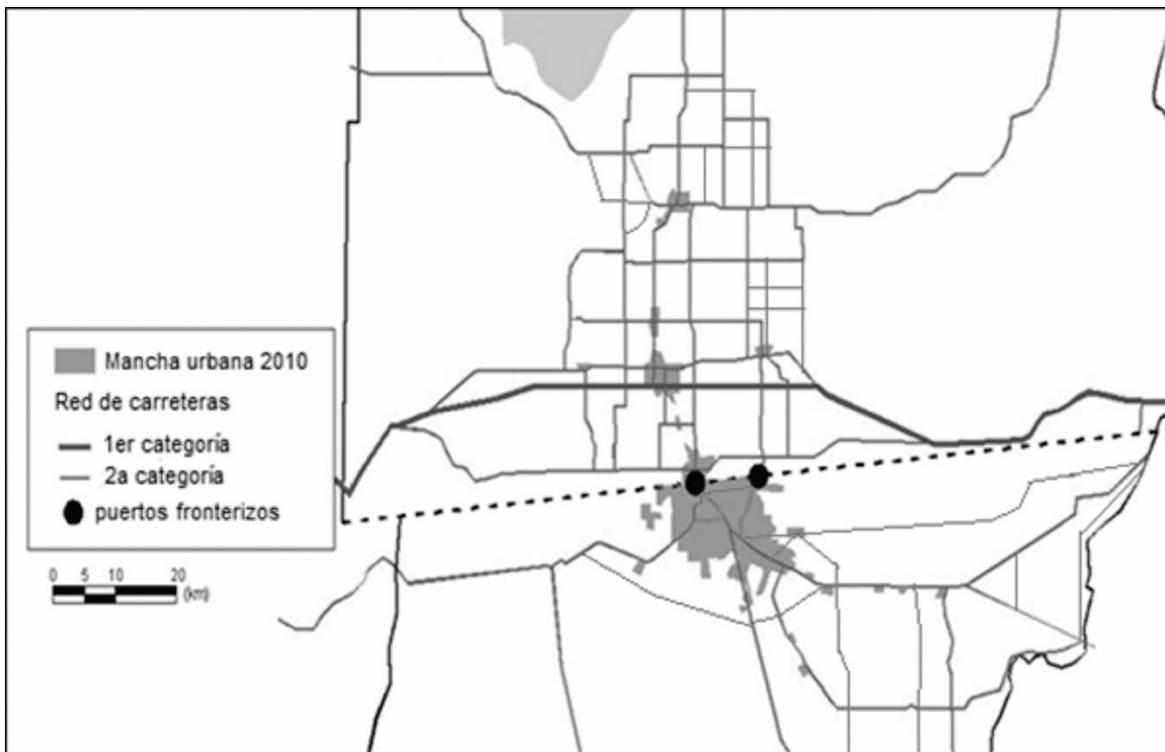
The first border crossing allows for pedestrian and passenger vehicle exchange 24 hours a day, while the second allows for pedestrian, vehicular, and cargo crossing during restricted hours. Both ports of entry connect Mexicali and the Imperial Valley area, giving shape to a mesh that interweaves almost the entire road network at various points, unlike the Mexican side where the network is much more disaggregated and linear (see Figure 3). However, these border ports have played a leading role in the configuration of urban cities on both sides.

Figure 2. The Inter-California railway, 1909



Source: Author's own, based on John A. Kirchner (1998, p.74).

Figure 3. Road Network of the Tijuana/San Imperial border space



Source: Updated from Mungaray-Moctezuma et al. (2010, p. 311).

Literature Review

The border can be considered a physical or administrative barrier that breaks up the flow of goods and people by regulating access, to a greater or lesser extent, in different ways, in one direction or the other, either facilitating, filtering, transforming, rerouting to other destination points, or even obstructing said flow.

The population mobility phenomenon originates in the human needs that necessitate traveling from one place to another to satisfy them. However, while all human mobility is caused by a specific motivation, it is limited to the transfer possibilities provided by the available road transport infrastructure.

Different purposes motivate the mobility of persons, and its impact on the structuring process may vary. On one hand, the type of mobility influences the selection of a residential location, which depends on the workplace location and the time it takes to get there (Cervero and Duncan, 2002). Increased mobility from the residence to the workplace (compulsory mobility or *working travels*) is associated with improvements in road infrastructure and in transportation technology (Rouwendel, 1996). On the other hand, there is also another type of mobility known as non-compulsory mobility (*non-working travels*) aimed at consumption, tourism, commerce, recreation, or medical service purposes.

In both cases, population mobility plays an important role in spatial and social organization. This is so because, first, its territorial location responds to the construction of infrastructure by government administrations regarding specific needs. Second, because mobility itself helps to create proposals that allow the identification of new spaces and new routes of transport infrastructure. Both types of mobility imply transfer times, distances, and costs that ultimately constitute different patterns depending on the size, quantity, and vocation of the transport infrastructure network in each urban space (Gordon, Kumar, and Richardson, 1989).

The relationship between spatial organization and urban compulsory mobility (work traveling) is typically studied by identifying employment centers, which often coincide with old city centers (Komei and Se-il, 1996; Van Ommeren, Rietveld, and Nijkamp, 1997). Additionally, analyzing consumption mobility (non-compulsory mobility) allows us to understand the emergence of other type of flow-attraction areas within urban centers. These areas generate the opportunity to increase their levels of development due to the improvement of the socio-economic conditions of the consumer population and its impact on the processes of urban-infrastructure structuring.

However, Duhau and Giglia (2007a) state that consumption is not in any way a solely utilitarian activity and that it is subject to material restrictions. Consumption must be analyzed taking into account its socio-spatial context, which often implies idiosyncratic practices (Williams, Hubbard, Clark, and Berkeley, 2001).

In addition, in the 2005 International Seminar on Urban Trade and Mobilities, it was noted that:

[...] consumer practices have become more complex. Demand has become more volatile because of increased mobility, the multiplication of individual choices, and the increasing complexity of supply. Purchase places mix in an increasingly systematic manner products and services that affect different sectors, both

formal and informal, industrial and handcrafted. The integration of supporting services to shopping places is a growing requirement for consumers because they are increasingly becoming accustomed to supermarket marketing techniques and strategies. Buying and consumption patterns are articulated at the territorial scale, from neighborhoods to metropolis and, in some cases, including extra-metropolitan scales. Trade and social exchanges have become de-territorialized in part due to information and communication technologies. In the city, purchases are linked to other urban practices (work, entertainment, etc.), generating combinations and itineraries with a logic increasingly difficult to understand. Finally, the reduction of working time and the growth of mobility have caused consumption space-time to expand and be reconfigured (Center of Mexican and Central American Studies [CEMCA], 2005, par. 4).

All these developments show that mobility of consumption is difficult to understand and that territorial scales are increasingly growing due to offer complexity. The hypothesis of the present study derives from this phenomenon because, despite the available local supply, in some cases, consumers choose cross-border supply, even that which is farther away from the border. In this sense, shopping becomes an activity that involves different travel modalities, from walking to the nearest store to traveling hundreds of kilometers in a vehicle to go to a shopping center.

Duhau and Giglia (2007b) claim that the great number of shops of various types and sizes has decreased the attractiveness of the city center as a regular place for obtaining supplies. Indeed, purchases in city centers are limited to certain products and daily consumption articles. These choices are conditioned simultaneously by closeness and socio-economic level. Large-scale shops (hypermarkets) offer such a wide range of products that attract consumers from the entire spectrum of society.

In the past, these shops used to be familiar places, and in some cases, they were even affectively charged, places where consumers knew the staff and where it was common to encounter an acquaintance or friend. Back then, the consumption dynamics in a family, a couple, or with the children were a ritual of expression of affection that reinforced family relationships and lifestyles (Millar, 1999). Now, however, globalization has led to a situation in which, within the household, each family member may have a different mobility of consumption; children in homes have less mobility than adults, and this fact tends to reduce per person mobility. Therefore, age clearly has an impact on mobility patterns (Gutiérrez and García, 2005).

Additionally, the disproportionate increase in the number of homes and its parallel decline in average size imply the need to make more trips to meet personal and home consumption needs, impacting the overall levels of motorization (Gutiérrez and García, 2005).

In terms of a metropolitan analysis, the growth of new consumption areas requires a reconceptualization of the role of the city center and reflection upon the need to analyze the new importance of peripheral areas to better understand the role of consumption as an urban practice detonator and to assess the weight of the peripheral areas in the mobility reconfiguration at the urban scale, whether local, metropolitan, or regional (Duhau and Giglia, 2007b): local, because accessing them is possible largely due to a tendency to function as quasi-proximity spaces; metropolitan, because its distribution responds to supply chain strategies organized on such a scale and because of its relationship with major intermodal transit nodes; or regional, because they

become poles of attraction by reaching the limits of conurbation (Duhau and Giglia, 2007a).

In this sense, Gutiérrez and García (2005) claim that metropolises today are characterized by increasing mobility, greater complexity, dispersion of network flows, increased traveled distances, and, above all, and in many cases as a consequence of the foregoing, by a steady increase in the use of private transport. The growth of general living standards and increased social polarization have a significant influence on people's everyday mobility, which means that an increased quality of life entails growing levels of motorization and consumption, thus improving general mobility.

In some cases, favorable shopping conditions are located in intermodal nodes along daily thoroughfares. Shopping areas in this case are traveled-through locations in everyday city trips. The massive presence of itinerant trading in these nodes and in automobile transit areas show the evident role of trade, particularly informal trade, as a service provided to transit customers. The role of trade has been observed in a systematic study conducted in four road crossings varying in size and importance with a large influx of people and cars (Monnet, Giglia, and Capron, 2005).

As a consequence of the dispersion phenomenon and these new consumer trends, people incur longer trips, both regarding time and distance, depending on the technological quality of the highway infrastructure and the new centers of consumption, assuming the costs of such mobility based on their socio-economic level. In sum, population-based activities and their compulsory or non-compulsory mobility transform the cultural models in border areas (Ojeda and López, 1994) and end up supporting the technological transition of urban infrastructures.

Methodology

In the border areas, the border emphasizes the cultural and developmental differences that exist between two countries, generating a strong and lasting spatial division. This is because relations between both sides of the border are administratively controlled or filtered, depending not on the requirements of the joint cross-border city but on the relations between two countries. However, the same border acts as a mechanism that allows a mixture of criteria and characteristics in each country and city (Mungaray-Moctezuma, Sánchez and Ureña, 2010).

Additionally, compulsory mobility is not a main factor in structuring border urban spaces; currently, non-compulsory mobility has become an indispensable tool for planning and structuring towns in these spaces.

This development reflects the importance of studying border spaces as unique spaces with different characteristics from any other border area in the world because each space offers particular characteristics regarding territorial dimensions, structuring processes, population importance, border dynamics, socio-economic aspects, territorial structuring, population mobility, and road network, according to the factors stated above. This uniqueness is why cities in these border areas have different organization models from each country; they are also influenced by flows between their counterparts, where each city brings a little of its own identity to its counterpart on the other side of the border. This exchange happens in the Mexicali-Imperial Valley border area, which is characterized by a greater population on the Mexican side and strong border mobility dynamics on the American side.

In general, the methodology used to analyze border consumption dynamics in this case study primarily consists of locating and selecting origins and destinations through the design and implementation of surveys. The collected data are included in a database, and the results obtained are analyzed and presented here.

First, road infrastructure is examined to identify roadways that facilitate population mobility and border ports where crossings take place. Subsequently, the main consumption and attraction centers in Imperial Valley are identified and cataloged as Mexicali residents' most frequent destinations. Then, accessibility is measured based on residents' level of connection with the rest of the road network. Simultaneously, the Mexicali area is divided into sections to identify where trips originate. After establishing origins and destinations, a survey is designed and conducted to associate origins and destinations from south to north, thus obtaining territorial patterns associated with the mobility of consumption.

To obtain a statistically representative sample, the sample size is calculated using the following formula:

$$n = \frac{(z^2 \cdot p \cdot q \cdot N)}{[(e^2 \cdot (N - 1)) + z^2 \cdot p \cdot q]}$$

where:

n = Sample size

N = Population

z = Confidence Level

$p \cdot q$ = Maximum variance assigned

e = sample error

In this case, a population (N) of 452,934 aged 18 or over in Mexicali (INEGI, 2010) is considered. This choice is in line with Gutiérrez and García (2005), who claim that age clearly has an effect on mobility patterns. In addition, a 95% confidence level ($z = 1.96$) is considered, with an assigned maximum variance ($p \cdot q$) of 0.5 and a sampling error (e) of 4.5%, resulting in a sample size of 474 surveys.

Because the aim is to analyze border consumption mobility, surveys are conducted in the main consumption centers in Imperial Valley. This practice ensures two fundamental points for research. First, 100% of the respondents were in the United States, which means that they had some type of US visa which allowed them to perform the dynamics of cross-border mobility. Second, 100% of the respondents were in a shopping area in Imperial Valley and therefore had already participated in cross-border consumer mobility dynamics.

According to the above, 500 surveys were equitably distributed between the major consumption centers in Imperial Valley. Given the geographical location of the consumption centers, Calexico was divided into two lateral sections (section A and section B), with a third section in El Centro, CA (section C). Section A is next to the border; section B is located in Calexico farther away from the border; and section C is in El Centro, CA. There are two important consumption areas in each section, where the same number of surveys were applied. In section A, 84 surveys were conducted in the main consumption areas on 1st and 2nd Streets and 83 in duty-free shops. In section B, 83 surveys were conducted in Walmart, 42 surveys in Tianguis Las Palmas, and 42 surveys in Tianguis Sto. Tomas. In section C, 83 surveys were conducted in the

Imperial Valley Mall and 83 surveys in Target. A total of 167 surveys were conducted in each section.

The origins of cross-border consumption mobility on the Mexican side were classified according to the division of Mexicali organized by the Municipal Institute of Research and Urban Planning of Mexicali (IMIP) in the Urban Development Program of the Center of Population of Mexicali in 2025, which consists of six sections. Section 1 corresponds to the west of the city; section 2 to the center; section 3 to the east; section 4 to the southeast; section 5 to the southwest; and section 6 to the south of the city (see Figure 4). The data related to border consumption in the survey were obtained through seven variables: trip origin, means of transportation, destination in the United States, border crossing point used, waiting time, consumer products, and monthly frequency of trips to the United States.

Finally, the sections in Mexicali (origins) and the sections in Imperial Valley (destinations) were correlated, as were the border crossing points used and the roadways in each main section, to finally obtain the territorial patterns of the dynamics of border consumption.

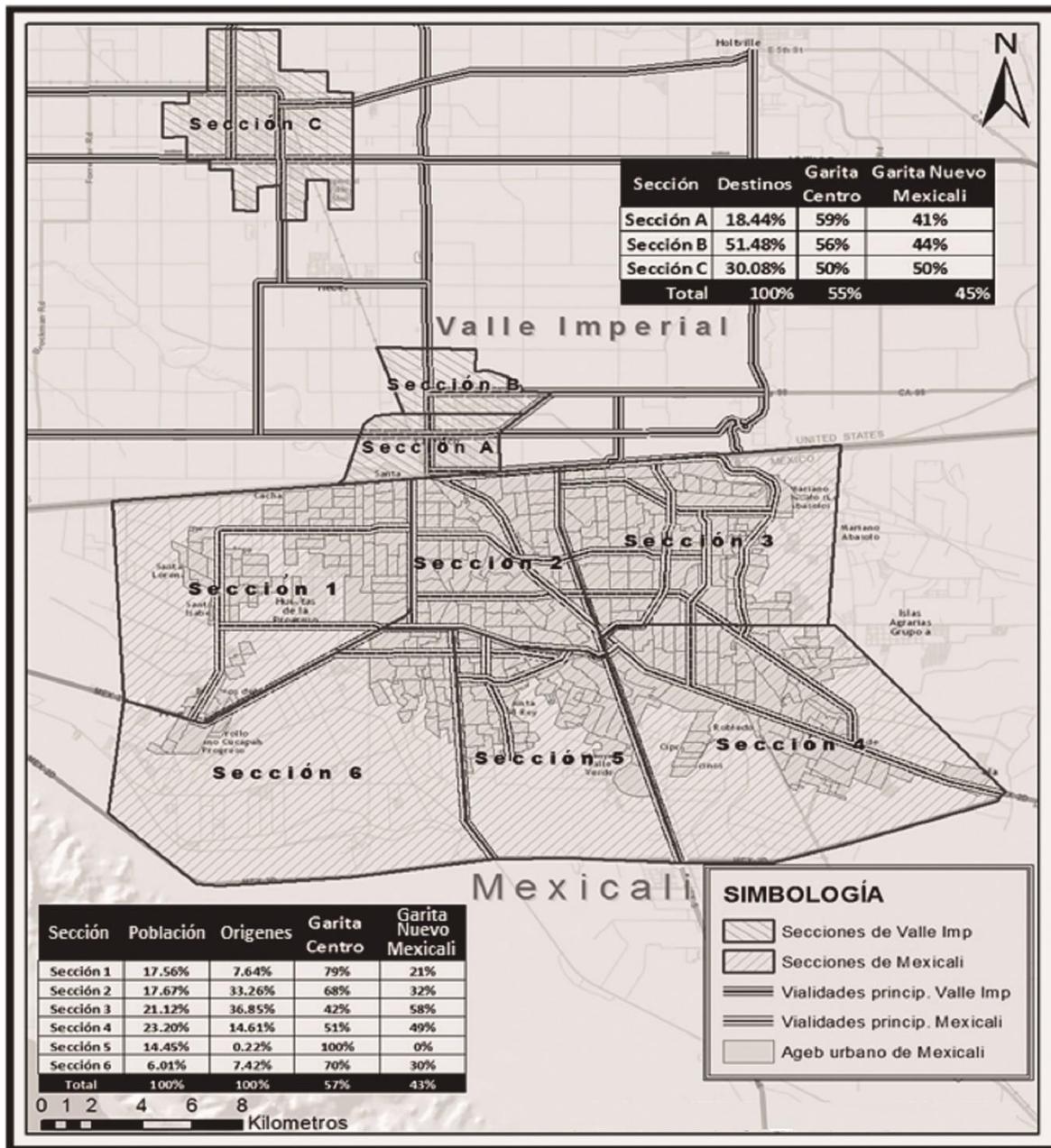
Results

In Mexicali, the majority of inhabitants who are capable of entering the US opt for acquiring products in this country based on quality and/or price. However, waiting times at border ports, exchange rates from pesos to dollars, the ever-increasing cost of fuel, and the ease of acquisition of new products in Mexico have modified border crossings, in some cases changing the modality of the crossing, redirecting, or simply decreasing them.

The information published by the Bureau of Transportation Statistics (2013) indicates that from 2009 to 2012, at both border crossing point I (Centro) and II (New Mexicali), the collective mode of crossing in buses is on the rise, whereas crossings in private vehicles is trending slightly downward. Pedestrian crossing is on the rise at border crossing point II and declining at border crossing point I, although this point concentrates 98% of total crossings. The origin of the trip is regarded as the beginning of the journey. It is located specifically in the home of the respondent and classified in the appropriate section in Mexicali. The results indicate that the sections with the most border interactions are adjacent to the border crossing points, specifically section 2 with border crossing point I and section 3 with border crossing point II. The largest concentration of origins was section 3, with 36.9%. It is noteworthy that these sections do not concentrate larger populations, which excludes the number of inhabitants as the reason for concentrating a greater number of origins. Section 4 has the highest percentage of population concentration, with 23.2%; nonetheless, its share of origins is 14.6%. It is concluded that proximity to border crossing points facilitates increased interaction with Imperial Valley. Additionally, the western zone, composed of sections 1 and 5, obtains low percentages of cross-border interactions, with 7.6% and 0.2%, respectively (see Figure 4).

Regarding respondents' socio-economic status, it should be noted that, regardless of the Mexican section of origin, they are middle class to upper class, given that 100% of them have a US visa, which is obtained after the subject undergoes a socio-economic check performed by US agents as a requirement for granting their visas.

Figure 4. Sections, origins and destinations in Mexicali/Valle Imperial



Source: Authors based on data provided by IMIP, Google Earth and ArcGIS.

In terms of means of transportation, vehicles were classified into private and public. It was found that 68% of the respondents performed their mobility of consumption in their own means of transportation. This result is confirmed in each section individually and becomes more evident in sections 2 and 3, with 70.3% and 73.4%, respectively (see Table 1). The above results show the importance of and/or preference for private means of transportation in comparison to public means, despite the fact that, as noted above, the latter has increased.

Table 1. Mode of transport used for mobility of consumption

	Private %	Public %
Section 1	65.38	34.62
Section 2	70.25	29.75
Section 3	73.44	26.56
Section 4	54.17	45.83
Section 5	100.00	0.00
Section 6	64.29	35.71

Source: Authors.

When analyzing mobility of consumption destinations, because consumers do not visit one consumption center but several in each journey, the survey considered nine centers of consumption in Imperial Valley. Thus, respondents had to prioritize which of these nine centers they visited with greater frequency. Therefore, the analysis of the results focused on the consumption centers most frequently attended.

In section A, duty-free, auto parts stores, and the shops on 1st and 2nd Streets (which concentrate great variety of shops) were integrated. Section B included Walmart Calexico, Tianguis (Las Palmas and Sto. Thomas), and Toys "R" Us; and section C included the Imperial Valley Mall, Target, and Walmart in El Centro. It was sought that each section with its respective centers of consumption included food products, electronics, clothing, household items, furniture, cleaning products, and fuel.

In this regard, the most frequented section was section B, located at the end of the Calexico urban section, with 51.5%, followed by section C, with 30%; section A had the lowest share, with 18.4% (see Figure 5). These results show that the quality and connectivity of the road infrastructure allow access to these destinations, minimizing the importance of the chosen border crossing. Indeed, there was no great variation in the selection of the border crossing points, as Border crossing point I (Centro) was the most frequented, concentrating 57% of crossings, whereas border crossing point II (Nuevo Mexicali) concentrated 43%. However, in all sections, a greater percentage of crossings entailed selecting the border crossing point closest to the destination.

Kilometers between the place of origin and destination were quantified for further analysis. To that end, a mid-point in each section in Mexicali was chosen across the main roads until reaching each border crossing point. The same exercise was performed from both border crossing points to an intermediate point of the sections in Imperial Valley. Table 2 shows that the choice of border crossing point affects the route and the distance traveled; for instance, when considering sections with the greatest concentration of origins and destinations, from section 3 to section C, there is a difference of approximately 7.5 kilometers. Similarly, the journey from section 2 to section A (adjacent sections separated by the border) shows that the difference is approximately 22.9 kilometers when one chooses to cross at border crossing point II instead of I (see Table 2). However, distance is not the only relevant factor because the waiting time at each border crossing is a determining factor when selecting which port to use.

Table 2. Distance in kilometers from the section of origin to the destination section

Section	Border crossing point I			Border crossing point II		
	Distance to Section A	Distance to Section B	Distance to Section C	Distance to Section A	Distance to Section B	Distance to Section C
Section 1	13.159	15.506	33.343	37.569	39.919	57.758
Section 2	7.216	9.563	27.4	30.142	32.492	50.331
Section 3	15.323	17.67	35.507	22.884	25.234	43.073
Section 4	18.904	21.251	39.088	30.128	32.478	50.317
Section 5	14.817	17.164	35.001	34.022	36.372	54.211
Section 6	12.25	14.597	32.434	35.178	37.528	55.367

Source: Authors.

In this regard, border crossing times vary by day and time, especially during peak work or school hours or due to the busy days of Tianguis in Calexico. Surveys were conducted on different days and at two different times (10 am and 3 pm). It was found that in most cases, delays took less than an hour in both border crossings. At the Centro border crossing and in Nuevo Mexicali, the average waiting time was 30 to 60 minutes (56% and 48%, respectively) (see Table 3). In addition, 87% of the 57% of the total respondents claimed to cross from 1 to 10 times a month through border crossing point I. Regarding the remaining 43% of total respondents, 92% claimed to cross from 1 to 10 times per month by border crossing point II (see Table 3). These results indicate that border consumption mobility is frequently exercised.

Table 3. Crossing frequency and waiting times for border crossing points

	Days	Monthly crossing frequency	Minutes	Waiting time
Centro border crossing point	1 to 10	87%	0 - 30	15%
	10 to 15	6%	30 - 60	56%
	15 to 20	2%	60 - 90	26%
	20 to 25	5%	More than 90	3%
	25 to 30	0%		
		100%		100%
Nuevo Mexicali border crossing point	1 to 10	92%	0 - 30	24%
	10 to 15	3%	30 - 60	48%
	15 to 20	1%	60 - 90	22%
	20 to 25	3%	More than 90	7%
	25 to 30	0%		
		100%		100%

Source: Authors.

Additionally, it is important to analyze and obtain knowledge on the products that motivate consumption mobility for Mexican population. It was found that the most widely consumed products were clothing, food, and electronics, totaling 64% of the products consumed. The remaining 36% consisted of household items, cleaning products, furniture, and fuel. Although there are differences in each section, the pattern of consumption is similar across most of them: food, clothing, and electronics predominate in section 1; clothing and food in sections 2 and 3; clothing, food, and household items in section 4; food, household items, and fuel in section 5; and clothing, food, and electronics in section 6 (see Table 4). In general, the product that generates the most mobility of consumption is clothing, with 26%, followed by food and electronics, with 22% and 16%, respectively.

Table 4. Products consumed by sections

	Food		Electronic		Clothing		Household items		Furniture		Cleaning		Fuel	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
Section 1	28	20.14%	28	20.14%	29	20.86%	19	13.67%	9	6.47%	17	12.23%	9	6.47%
Section 2	113	21.56%	83	15.84%	130	24.81%	66	12.60%	34	6.49%	51	9.73%	47	8.97%
Section 3	127	24.52%	76	14.67%	140	27.03%	73	14.09%	27	5.21%	45	8.69%	30	5.79%
Section 4	39	18.57%	32	15.24%	57	27.14%	36	17.14%	17	8.10%	12	5.71%	17	8.10%
Section 5	1	33.33%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	33.33%	1	33.33%
Section 6	20	21.98%	13	14.29%	29	31.87%	10	10.99%	4	4.40%	7	7.69%	8	8.79%
Total	328	22%	232	16%	385	26%	204	14%	91	6%	133	9%	112	7%

Source: Authors.

A map representing the territoriality of origins and destinations from south to north was created based on the data obtained. The number of journeys from sections in Mexicali (origins) to the sections in Imperial Valley (destinations) is expressed as percentages. In all cases, section B concentrates the greatest amount of destinations, followed by section C (with the exception of section 6); finally, the least attractive regarding consumption matters is section A (see Figure 5).

Section 3, which is located to the east of Mexicali, and has an immediate border crossing (border crossing point II), concentrates 21.1% of the total Mexicali population. This section presents the most mobility of consumption, with 36.85% of the total of origins. In 58% of cases, this border crossing is used, and there is greater interaction with section B in Imperial Valley, with 48% of the total number of destinations, followed by sections C and A, with 33% and 19%, respectively.

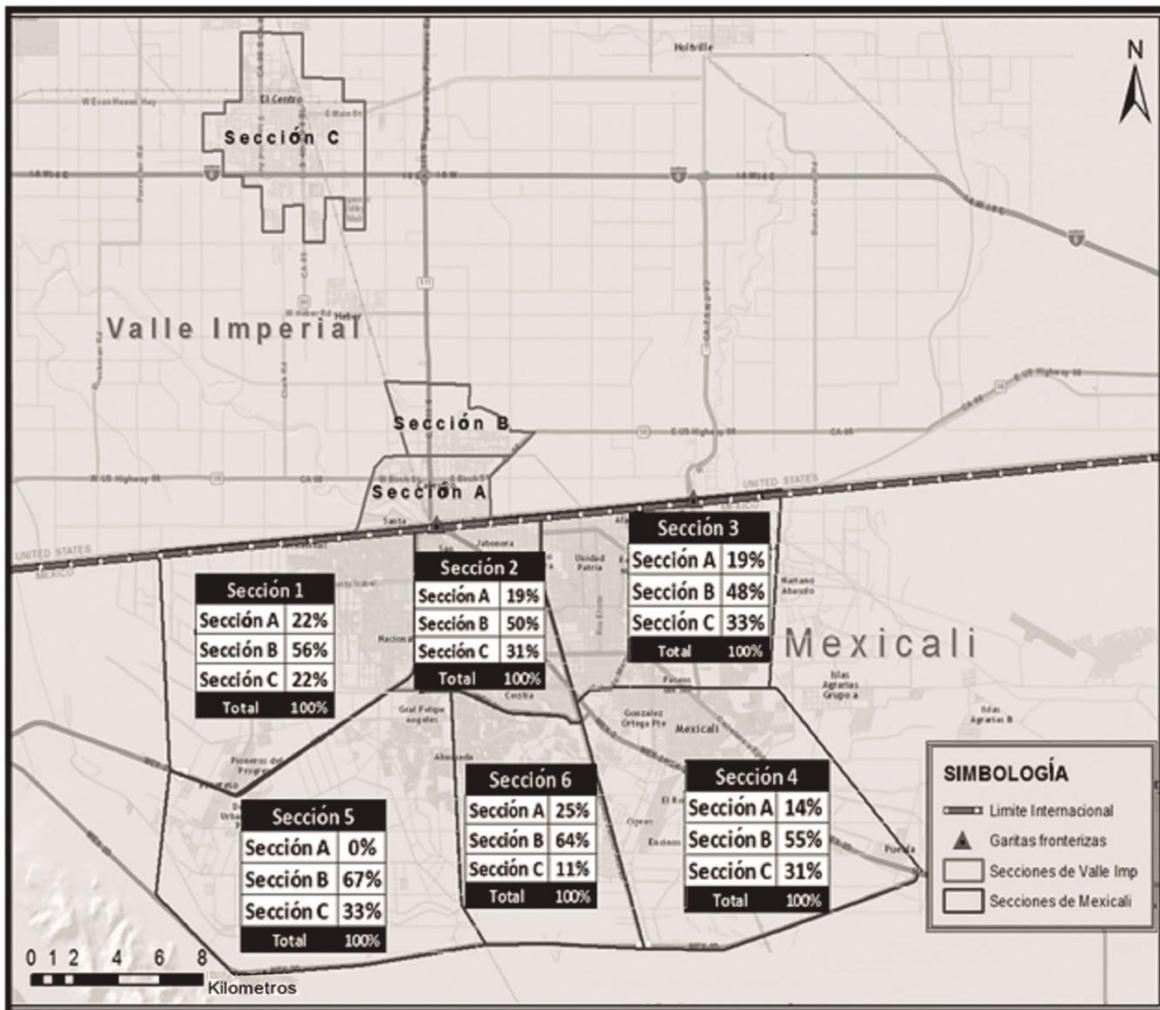
Section 2, which is located in the central area of Mexicali and also has a border crossing (border crossing point I), concentrates 17.7% of the total population of the town, with 68% using this border crossing to go to the US. The same pattern of destination concentration is observed. Section B is the most popular with 50% of the total number of destinations, followed by section C with 31% and section A with 19%.

In the remaining Mexicali sections, there is a similar pattern with higher concentrations of destinations in section B in Imperial Valley, indicating that it is not the North American section closest to the most frequented border.

By matching origins, destinations, border crossing points, and major roadways used, it was found that Mexicali presents roadways that enable connection with both crossing points, all of them being parallel to the border and allowing users to choose where they enter at any time.

Some of the main roads interconnecting Mexicali and border crossing point I are: Calzada Justo Sierra, De los Presidentes, Colegio Militar or Calle 11, Cristóbal Colón, Independencia, Lázaro Cárdenas, and Adolfo López Mateos; and border crossing point II: Calzada Independencia, de las Américas, Lázaro Cárdenas, and Calle Novena. In Imperial Valley, the Imperial Avenue (later Hwy 111) starts at border crossing point I and crosses Imperial Valley, connecting border crossing point II with Anza Road (later 2nd Street), Highways 7 and 98, and Interstate Highway 8.

Figure 5. Cross-border mobility of consumption population in Mexicali by section



Source: Authors.

Conclusions

The study of border urban spaces from the perspective of mobility of consumption (non-compulsory mobility) enables a better understanding of the process of territorialization occurring in these spaces. The analysis of the survey results in this study shows that the sections of the city closest to Mexican border ports present more consumer dynamics with their counterpart in the United States. However, in the American city, the section closest to the border does not attract greater Mexican mobility.

This finding indicates that new centers of consumption farther away from the border are more attractive to the Mexicali population, as though to compensate for higher costs and greater distances. This phenomenon is possibly due to the increasing sophistication and quality of the roadway infrastructure in Imperial Valley. This phenomenon of attraction between remote sections may be related to the creation of new centers of consumption that have emerged in recent years in these areas, which is in line with Duhau and Giglia (2007b), who claim that large-scale shops offer a wide variety of products to attract consumers belonging to a broad social spectrum.

In brief, consumption in more distant centers could be associated with private transportation's increasing importance as a means of transfer and the growth of public transport, whereas consumption in the border's immediate vicinity explains the growth of the pedestrian mode. The study results show that section B in Imperial Valley is the most frequented section for the dynamics of consumption, followed by section C and finally section A. In turn, it is noted that border crossing point I presents more crossings, with 57% and 68% using private vehicles; that in 71% of the cases, it takes less than an hour to cross the border; and that 89% of consumers cross the border less than 10 times a month. Additionally, it is shown that the products with the greatest demand among the Mexican population are clothing, food, and electronics.

Therefore, it is possible to conclude that the sections of the city on the Mexican side closer to the border concentrate a greater number of origins of journeys associated with consumption, while destinations in the US do not necessarily focus on sections immediate to the border. Regarding border crossing points, consumers seem to be indifferent to border crossing points. In all the sections, consumers used the closest border crossing point; in all Mexicali sections, there was a high percentage of crossings through the border crossing point farther from the point of origin. The above results reflect the importance of having an efficient road infrastructure network for border consumption mobility (pedestrian crossings, public transit, and private vehicles) and intermodal systems to propose solutions to problems associated with waiting time issues at international crossing points.

References

- Aguirre, C. (1983). *Compendio histórico-biográfico de Mexicali, 1539-1966* (tomo 2, pp. 55-56). Mexicali, México.
- Alexander, J. (1928). *The life of George Chaffey. A story of irrigation beginnings in California and Australia*. Melbourne, Australia: MacMillan.
- Centro de Estudios Mexicanos y Centroamericanos (CEMCA). (July, 2005). Documento de convocatoria al Seminario Internacional Comercio y moviidades urbanas en tiempos de metropolización. In E. Duhau and Á. Giglia, *Globalización e informalidad en la Ciudad de México* (28-43). Mexico: Universidad Iberoamericana.

- Cervero, R. (1995). Planned communities, self-containment and commuting: A cross-national perspective. *Urban Studies*, 32(7), 1135-1161.
- Cervero, R. (1996). Mixed land-uses and commuting: evidence from the american housing survey. *Transportation Research Part A*, 30(5), 361-377.
- Cervero, R. and Duncan, M. (2002). Transit's value-added effects light and commuter rail services and commercial land values. *Transportation Research Record*, 1805(1), 8-15.
- Cervero, R. and Wu, K. (1997). Polycentrism, commuting and residential location in the San Francisco bay area. *Environment and Planning A*, 29(5), 865-886.
- Clark, W. and Kuijpers-Linde, M. (1994). Commuting in restructuring urban regions. *Urban Studies*, 31(3), 465-483.
- Duhau, E. and Giglia, A. (2007a). Globalización e informalidad en la ciudad de México. Prácticas de consumo y movilidad. *Trace*, 51, 28-43.
- Duhau, E. and Giglia, A. (2007b). Nuevas centralidades y prácticas de consumo en la Ciudad de México: del micro comercio al hipermercado. *Revista Eure*, XXXIII(98), 77-95.
- Giuliano, G. and Small, K. (1993). Is the journey to work explained by urban structure? *Urban Studies*, 30(9), 1485-1500.
- Gordon, P., Kumar, A. and Richardson, H. (1989). The influence of metropolitan spatial structure on commuting time. *Journal of Urban Economics*, 26(1), 138-142.
- Gordon, P., Richardson, H. and Wong, H. (1986). The distribution of population and employment in a polycentric city: the case of Los Angeles. *Environment and Planning*, 18(2), 161-173.
- Gutiérrez, J. y García, J. (2005). Cambios en la movilidad en el área metropolitana de Madrid: el creciente uso del transporte privado. *Anales de geografía de la Universidad Complutense*, 25, 331-351.
- Handy, S. (1996). Methodologies for exploring the link between urban form and travel behavior. *Transportation Research D*, 1(2), 151-165.
- Instituto Nacional de Geografía y Estadística (INEGI). (2010). *Censo de población y vivienda*. México: Autor.
- Kirchner, J. (1988). *Baja California railways*. San Marino, California: Golden West Books.
- Komei, S. and Se-il, M. (1996). A dynamic analysis of multiple-center formation in a city. *Journal of Urban Economics*, 40(3), 257-278.
- Massot M. and Roy, E. (Mars, 2004). *Lieu de vie lieu de travail, 25ans d'évolution de la distance au travail* (rapport de Contrat INRETS pour l'ADEME). France.
- McDonald, J. and Prather, P. (1994). Suburban employment centers: the case of Chicago. *Urban Studies*, 31(2), 201-218.
- Millar, D. (1999). *Ir de compras: una teoría*. Mexico: Siglo XXI.
- Monnet, J., Giglia, A. and Capron, G. (July, 2005). *Cruces comerciales: ambulante y servicios a la movilidad en la Ciudad de México*. Paper presented at Seminario Científico Internacional Comercio y Movilidades Urbanas en Tiempos de Metropolitización, Centro

de Estudios Mexicanos y Centroamericanos, Universidad Autónoma Metropolitana-I, Universidad Iberoamericana, Mexico, Distrito Federal.

- Monzón, A. and De la Hoz, D. (2006). La movilidad y la eficiencia económica: especial aplicación a la ciudad de Madrid. *Revista del Instituto de Estudios Económicos*, 1-2(06), 31-63.
- Monzón, A. and De la Hoz, D. (2009). Efectos sobre la movilidad de la dinámica territorial de Madrid. *Revista del departamento de urbanismo y ordenamiento del territorio*, (14), 58-71.
- Mungaray-Moctezuma, A., Sánchez, J. and Ureña, J. (2010). Méthodologie pour l'analyse des réseaux routiers de la ville transfrontalière du Mexique et les Etats-Unis: Tijuana-San Diego et Mexicali-Imperial Valley. In *Frontiers et aménagements, Revue Mosella* (Tome XXXII, No. 14, pp. 303-324).
- Ojeda, N. and López, S. (1994). Familias transfronterizas en Tijuana: dos estudios complementarios. *Cuaderno El Colegio de la Frontera Norte*, 6, 80.
- Padilla, A. and Piñera, D. (1991). El surgimiento de Mexicali. En J. Martínez and L. Romero (Eds.), *Mexicali una historia* (volume 1, pp. 149-199). Mexicali, México: Universidad Autónoma de Baja California.
- Roeder, R. (1987). *Hacia el México moderno: Porfirio Díaz*. México: Fondo de Cultura Económica.
- Rouwendel, J. (1996). An economic analysis of fuel use per kilometer by private cars. *Journal of Transport Economics and Policy*, 30(1), 3-14.
- Small, K and Song, S. (1992). Wasteful commuting: A resolution. *The Journal of Political Economy*, 100(4), 888-898.
- Van Ommeren, J., Rietveld, P. and Nijkamp, M. (1997). Commuting: In search of jobs and residences. *Journal of urban economics*, 42(3), 402-421.
- Williams, P., Hubbard, P., Clark, D. and Berkeley, N. (2001). Consumption, exclusion and emotion: the social geographies of shopping. *Social & Cultural Geography*, 2(2), 203-220.