II-6

Land Use Changes in the Paso del Norte Region: A Brief History

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Abstract

An objective of the Border Plus Twenty Years (B+20) Project is to construct a system dynamics model of the processes of urban growth and urban sprawl. This chapter provides an historical background that describes urban growth in the El Paso, Tex.-Ciudad Juárez, Chih., twin city region, also known as Paso del Norte, and explains the land use sector of the model.

The Paso del Norte land use model begins with some basic assumptions that take into account how economic and demographic processes trigger the demand for urban land in the form of residential and non-residential uses such as industrial, commercial, and roads, among others. The process can be described as a negative sum game where the gains of land in one sector are the losses of land in another. In this particular case in the model, the gains in urban land have been at the expense of dry land and farming land capture; the variables have been denominated as conversion rate to urban land.

Cambios del Uso del Suelo en la Región Paso del Norte: Una Historia Breve

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Resumen

Un objetivo del Proyecto Frontera Más Veinte Años (F+20) es construir un modelo de sistema de dinámicas del proceso del crecimiento urbano y de la desorganización urbana. Este capítulo proporciona un antecedente histórico que describe el crecimiento urbano en la región de ciudad gemela de El Paso, Tex.-Ciudad Juárez, Chih., también conocida como Paso del Norte, y explica el sector del uso del suelo del modelo.

El modelo del uso del suelo del Paso del Norte comienza con suposiciones básicas que toman en cuenta cómo el proceso económico y demográfico provoca la demanda por tierra urbana en la forma de usos residenciales y no-residenciales como industriales, comerciales y carreteras, entre otras. El proceso puede ser descrito como un juego total negativo en el cual las ganancias de suelo en un sector son las pérdidas de suelo en otro. En este modelo particular, las ganancias en suelo urbano han sido a expensas de suelo seco y captura de suelo ganadero; las variables han sido denominadas como ritmo de conversión a suelo urbano.

The Twin Cities of El Paso and Ciudad Juárez

The binational conurbation of El Paso, Tex., and Ciudad Juárez, Chih., currently extends for 134,029 acres (209 square miles, or approximately 541 square kilometers). It is home to nearly 1.9 million people; 637,859 live in El Paso and 1,217,818 in Ciudad Juárez. El Paso accounts for 59.5% of the developed land but only 34.4% of the population living in Paso del Norte. El Paso has a density of 0.799 people per acre; Ciudad Juárez's density is 22.4 people per acre[1].

El Paso and Ciudad Juárez have experienced not only different rates of growth, but different patterns of growth that have had an impact on their form, density, and the rate at which they have expanded their urban boundaries. The urban boundary of Ciudad Juárez between 1990 and 2000 increased its size 1.5 times, whereas the urban boundary of El Paso in the same 10 years grew by a factor of .855—nearly half the rate of Ciudad Juárez (City of El Paso 1999).

Economics and demographics are the driving forces of urban growth. An important economic force in the region has been the exponential growth of the maquiladora industry on the Mexican side of the border. This industry has had a substantial impact on population growth, urban growth, and land use in both El Paso and Ciudad Juárez.

At the peak of the economic boom in 2000 in the United States, the number of maquiladora plants in Mexico reached 3,703 and they employed more than 1.3 million people. Nearly one in two plants were located in cities along the Mexican side of the border. Tijuana, B.C., and Ciudad Juárez contained about one-third of the plants and their employees (INEGI 2000). This economic boom also became associated with an important wave of migration. Demographic trends show that on the Mexican side, the population of the border cities has increased greatly since 1970. For example, Ciudad Juárez tripled its population in 30 years from 407,370 in 1970 to 1,217,818 in 2000.[2] On the other hand, El Paso has decreased its rate of population growth to the point of almost stagnating. However, this does not mean that the urban spatial growth

has stopped. It is important to point out that El Paso has seen increased demand for land to accommodate international trade and the maquila industries; the amount of land used for warehousing, transportation, commercial, and industrial use has increased.

Population Growth Rates and Urban Growth in Ciudad Juárez

Historically, Ciudad Juárez has experienced one of the fastest rates of population growth in the country. From 1856 to 1960 the city remained relatively compact. It was characterized by a higher population density and less vacant land than cities north of the border (Arreola and Curtis 1993). In 1856, Ciudad Juárez's population density was high for the small city (482 inhabitants per hectare[3]). After the Mexican Revolution, the city began to experience population pressures as a product of immigration flows from central Mexico. In 1921, the Ciudad Juárez population was growing at a rate of 5.5%, reaching 19,457 inhabitants. In the 1930s its population reached nearly 40,000, and the urban area had grown to 471 hectares. During the 1940s these indicators slowed their pace. Ciudad Juárez's population growth rate was only 2.0% and the urban area increased by only 92 hectares over the decade (Fuentes 2000).

Beginning in the 1950s, the city embarked on another phase of spatial expansion. Ciudad Juárez experienced the highest rate of population growth in its history in 1950 (9.2%) and its urban area grew to 800 hectares. As a result of immigration flows, the city became relatively densely inhabited (164 inhabitants per hectare, up from 85 persons/hectare in 1930). The city's population continued to grow at a high rate of 7.2% in 1960 and its urban area reached 1,894 hectares.

Ciudad Juárez experienced two periods of expansion during this era. The first, from 1856 to 1930, is characterized by a high population growth rate and physical expansion. The second, from 1931 to 1960, began with a decrease in population growth rate and population density. Throughout this period, however, Ciudad Juárez could be characterized as a relatively compact city.

In the 1970s, the city's urban growth was affected by intense immigration flows and the location of industrial parks. The great supply of jobs generated by the maquiladora industry attracted a large number of workers who eventually became integrated into the city. The number of inhabitants grew from 276,995 in 1960 to 424,135 in 1970. The urban area increased from 1,894 hectares in 1960 to 5,608 hectares in 1970, a growth rate of 10.8%. Due to spatial expansion, the population density decreased from 146 inhabitants per hectare in 1960 to 75 inhabitants per hectare in 1970.

During the next decades the city continued to experience high population growth. Because the urban area grew more quickly than the population, the population density of the city continued to decline. The city population passed 567,365 inhabitants in 1980 to reach 798,499 inhabitants in 1990. The urban land reached 9,395 hectares in 1990 and the population density continued declining to 57 inhabitants per hectare. In 2000, the population growth rate was similar to the urban area growth rate. Thus, population density has stabilized. During the period from 1970 to 2000 the city grew in an unstructured pattern of urban sprawl, as Table 1 shows.

Land Use in Ciudad Juárez

In the case of Ciudad Juárez, recent land use changes are related primarily to the effects of the industrialization process. The first industrial park was established in 1967 on the northeast side of the city; it has an extension of 174.2 hectares (Fuentes 1992). Previously, this land had been used for irrigated agriculture[4] purposes, primarily to grow alfalfa and cotton. In the early 1970s, two new industrial parks were opened and occupied 125.8 hectares, but only 81.8 hectares had previous agricultural use. The commercial land use represented 305 hectares; all of them were located in the central business district and on the main arterial network.

In 1980, the city limits had an extension of 15,227 hectares, of which 9,385 hectares were urban land. Residential use occupied 6,061 hectares, industrial use 378, commerce and service 688, open spaces 401, and internal roads 1,857. Four years later, the urban area reached 13,170 hectares, consisting of 6,452 hectares for resi-

Table 1. Population and Urban Growth in Ciudad Juárez: 1856–2000

Year	Population	Population Rate of Growth (%)	Urban (ha)	Population Density (Pop./ha)
1856	4342	Base	9	482
1894	7582	1.4	60	126
1900	8,218	3.5	61	134
1910	10,621	2.5	119	89
1921	19,457	5.5	N.D.	N.D.
1930	39,669	7.9	471	84
1940	48,881	2.0	563	87
1950	131,308	9.1	800	164
1960	276,995	7.2	1,894	146
1970	424,135	5.2	5,608	75
1980	567,365	4.4	9,395	60
1990	798,499	3.4	14,049	57
2000	1,217,818	4.2	21,572	56

Note: N.D. = no data
Source: Fuentes 2000

dential use, 681 for industrial use, 380 for commerce and service, 461 for open space, 1,529 for urban vacant land, 2,150 for internal roads, and 656.5 for other uses (Table 2).

Industrial growth toward the northeast and southeast also demanded the establishment of residential and commercial areas. From 1984 to 1988, land with residential and industrial uses increased 337.49 hectares and 159.13 hectares, respectively. In 1995, urban land totaled 18,767 hectares and was distributed as follows: residential use reached 8,416 hectares, industrial use 1,209 hectares, commerce and services 1,075, mixed use 617, open spaces 446, internal roads 4,785, and urban vacant land 2,219.

Table 2. Land Use in Ciudad Juárez (1985, 1995, and 2001)

Land Use/Year	1984		1995		2001	
	Surface	%	Surface	%	Surface	%
Residential	6,452	48.9	8,416	44.8	9,992	45.1
Industrial	681	5.7	1,209	6.4	1,844	8.3
Commerce and service	380	2.9	1,075	5.7	1,638	7.4
Mixed use	656	4.9	617	3.2	503	2.2
Open space	461	3.5	446	2.3	605	2.7
Internal road	2,150	16.3	4,785	25.5	5,040	22.7
Urban land vacant	1,529	11.6	2,219	11.8	2,500	11.3
Total	13,170	100	18,767	100	22,122	100

Source: City of Juárez 1985; 2001

The land use of the city has not been modified substantially since 1995. Residential use totals 45.17% of the urban area, the roads system has reduced its area by three percentage points and totals 22.78%, the industrial land use has increased its portion from 6.44% in 1995 to 8.34% in 2001, and the commerce and service surface increased to 7.40%.

Table 2 shows that in relative terms, the residential use of land has constituted a constant portion of total land use since 1984. However, industrial use has increased from 5.7% in 1984 to 8.3% in 2001. Since 1995 nine industrial parks have been added, for a total of 23 parks. The last nine industrial parks are located near working-class neighborhoods and main roads.

The traditional pattern of urban growth that consists of the centralization of commercial and service land use has not occurred in Ciudad Juárez; instead, the pattern of growth can be described as suburban sprawl. Four factors appear to account for this growth pattern: the southward location of warehouses adjacent to residential areas, deficient public transportation resulting in difficult access to

the central business district, huge economic investment in freeways, and exhaustion of the traditional economic base of the central business district (Fuentes 2001).

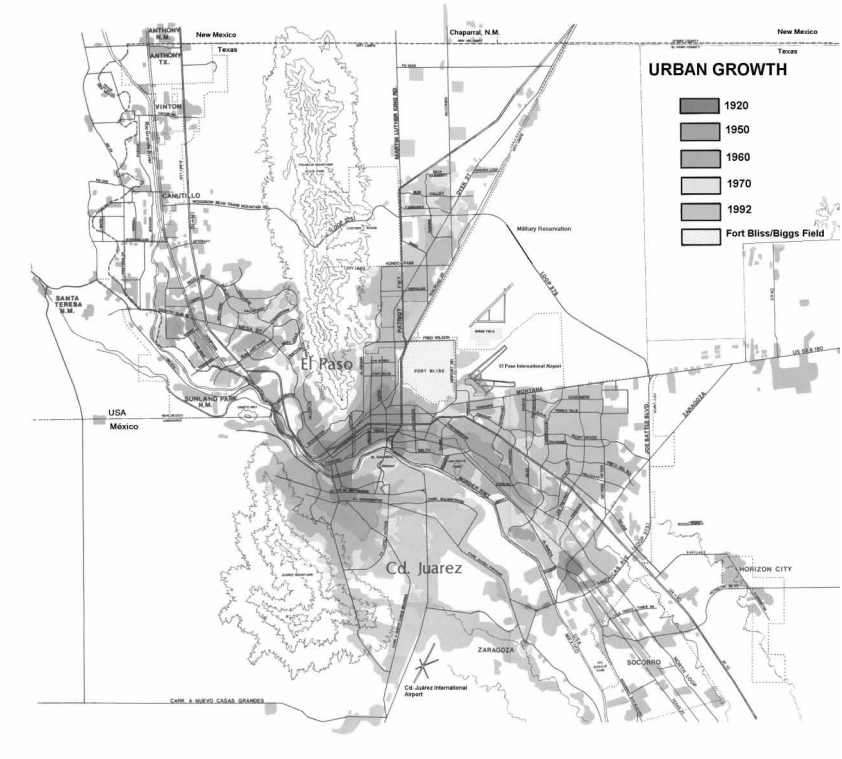
Because of the sprawl induced by these factors, the plan of the Junta Municipal de Agua y Saneamiento (JMAS) notes that the part of the irrigation district closest to Ciudad Juárez has seen a decline of more than 1,000 hectares as a result of conversion to urban use. The Instituto Municipal de Investigación y Planeación (IMIP) (2001) projects the use of urban land in Ciudad Juárez will total 32,421 hectares by 2020. Compared to today's total of 21,572, future expansion will add 10,848 new hectares of land to urban development. IMIP estimates that about one-quarter of that new urban land will be converted from land previously in agricultural use. Figure 1 depicts the spatial distribution of urban growth in Paso del Norte from 1920 to 1992.

Land Use and Water-Related Infrastructure

Understanding trends in land use is crucial to water planning because the water needs of irrigated farmland are different from those of residential and industrial uses. Also, they are affected by different factors. The portion of the city with water service has been declining since 1998 because infrastructure construction cannot maintain pace with the rapid expansion of the city. In 1998, the demand for water in different sections of the city was almost completely satisfied—92% of the urban area and 85% of the population were served. However, just two years later only 88.1% of the urban area and 88.3% of the population were covered by water service.

In 1999, an analysis of water use by different types of users showed that 78.2% of water is used by residential, 9.11% commercial, and 8.38% industrial. Residential users were sub-classified into socioeconomic groups (low, middle/lower, middle, and upper) based on housing type and location within the city. The current domestic population is divided into socioeconomic groups in the following percentages: low (34.6%), middle/lower (41.69%), middle (15.24%), and upper (8.47%). In terms of water use, the low-income group uses 25.36%, middle/lower 32.25%, middle 13.30%, and upper 7.35% (Table 3).

Figure 1. Urban Growth for El Paso-Ciudad Juárez, 1920–1992



Source: Border Environment Cooperation Commission

Table 3. Water Use in Ciudad Juárez by User Type (1999)

User Average Consumption	Registered Accounts	Annual Volume (m^3/yr)	Annual Volume (af/yr)	Average Consumption	
				Liters per Capita per Day	Gallons per Capita per Day
Domestic	232,013	87,373,286	70,835	322	85
• Low	80,275	28,308,600		270	71
• Mid/lower	96,726	36,007,559		339	90
• Middle	35,351	14,851,458		386	102
• Upper	19,660	8,205,669		521	138

User Average Consumption	Registered Accounts	Annual Volume (m^3/yr)	Annual Volume (af/yr)	Average Consumption (m^3 per User per Month)
Commercial	10,533	10,175,108	8,249	88.9
Industrial	996	9,364,124	7,553	802
Public	1,087	4,707,198	3,797	402.3
Subtotal	244,647	111,619,716	90,492	
Unregistered	22,857	20,356,566	16,503	
Losses		18,016,355	14,606	
Total	267,504	149,992,637	121,601	

Source: Paso del Norte Water Task Force 2001

The irregular pattern of per capita water consumption is related to the rate of population growth and territorial expansion. In 1940, per capita water consumption was 1.03 cubic meters per capita per year (cmpcy). However, in 1950, 1960, and 1970, per capita water consumption was reduced to 0.60, 0.78, and 0.71, respectively. In 1980, per capita water consumption began to increase and reached 1.10 cmpcy, and in 1990 the city reached the highest per capita water consumption at 1.37 cmpcy. In 2000, per capita water consumption declined to 1.14 cmpcy.

JMAS's plan notes that these projections do not assume any change in per capita use as a result of conservation programs, nor any improvement in metering or reduction of system losses (currently 15%). The projections do assume an increment in service area coverage, from 82% in 1999 to between 95% and 100% in 2020.

Econometric Estimation of Urban Growth and Water Consumption

The central objective of this section is to estimate the effect of population growth and urban growth on the volume of water extracted. The estimated model includes the natural logarithm of the variables. One regression was estimated for each variable. The results, based

Table 4. Projected Municipal and Industrial Water Demand for Ciudad Juárez by Category (liters per second)

Year	Domestic	Commercial	Industrial	Public	Total (l/s)	Total (af/yr)
1999	4702.8	362.1	308.2	168.7	5,541.80	141,296
2000	4930.8	472.6	326.1	193.1	5,922.70	151,008
2005	6164.9	590.9	407.8	241.4	7,404.90	188,799
2010	7453.2	714.4	493.0	291.8	8,952.40	228,254
2015	8711.2	834.9	576.2	341.1	10,463.40	266,779
2020	9840.7	943.2	650.9	385.3	11,820.20	301,373

Source: JMAS 1999

on an Ordinary Least Square (OLS) method, are presented in Tables 5 and 6, which summarize the regressions obtained. The following variables were used:

- Natural logarithm of water consumption (dependent variable)
- Natural logarithm of population (LNPOB)
- Natural logarithm of urban area (LNURB)

Table 5. Estimation of Population Growth on the Volume of Water Extracted in Ciudad Juárez (1990–2000) Using LNPOB

Model	B	Std. Error	Beta	T	Sig.
1(Constant)	1.822	1.403	–	1.299	0.251
LNPOB	1.212	0.110	0.980	11.012	0.000

Source: Estimation based on data from JMAS 1999

Table 6. Estimation of Population Growth on the Volume of Water Extracted in Ciudad Juárez

Model	B	Std. Error	Beta	T	Sig.
1(Constant)	9.392	0.572	–	16.411	0.000
LNURB	0.947	0.068	0.987	13.859	0.000

Source: Estimation based on data from JMAS 1999

It is important to emphasize that the transformation of the dependent and independent variables into natural logarithms in the models allows the observation of the parameters as elasticities or percentage changes. For example, a parameter equal to 1 shows that if the independent variable changes 1%, the dependent variable changes 1% as well. The results show that population growth has a greater impact on the volume of water extracted than on urban growth.

The coefficient estimate for population (1.212) is highly significant and indicates that when the population increases by 1%, the volume of water extracted increases by 1.2%. The coefficient estimate for urban growth (0.947) is highly significant and indicates

that when the city's size increases by 1%, the volume of water extracted increases almost 1% to 0.947%; that is, the relationship is proportional.

B+20 Land Use Model

Model Assumptions

The Paso del Norte land use model begins with some basic assumptions that take into account how economic and demographic processes trigger the demand for urban land in the form of residential and non-residential uses such as industrial, commercial, and roads, among others. The assumptions are the following:

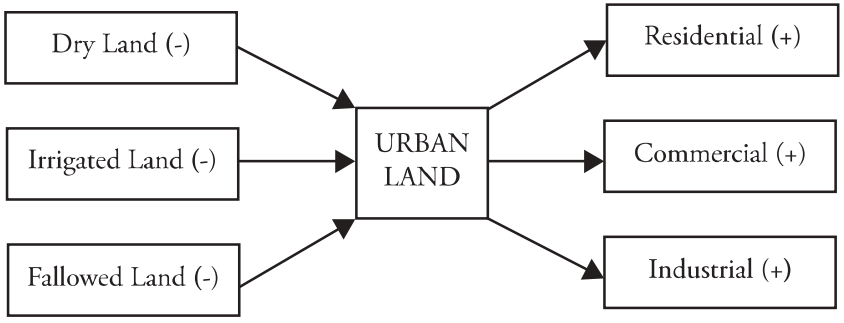
- An increased number of jobs leads to an increased non-residential component of urban land (El Paso and Ciudad Juárez)
- Increased population growth leads to an increase in the number of dwellings, which is synonymous with an increase in the residential component of urban land (the model seeks to quantify this relationship)
- Urban land increases at the expense of irrigated land and/or dry land in El Paso and Ciudad Juárez
- Fallowing irrigated land can lead to increased water availability for urban uses if water transfers are enacted

Model Description

STELLA® software was used to model the dynamics of land use changes in El Paso and Ciudad Juárez (Figure 2). The software allows modeling of a system using four types of relationships. A box represents a stock variable, in this case land is considered a stock that could increase or decrease as a result of endogenous and exogenous factors. There are inflows and outflows represented by arrow icons that feed or drain the stock variable (land), these two flows represent dry and irrigated farm land as inputs that feed the demand for urban land, which in turn is an output transformed to residential, industrial, and commercial use.

The circles with faucets represent rates that convert different inputs into a common denominator or measure. In other words, the stock (land) is a function of several factors or variables that act as inputs. However, since the scale or measurement of the inputs can be different, this rate icon performs the function of transforming or computing different measurements and scales into a common denominator, such as densities or growth factors. Finally, there are auxiliary variables in the form of circles that explain the changes in the stock variable. In sum, the icons allow the modeler to develop a map or conceptual model that links different relationships so the modeler can conceptualize how the system or the "world" operates. The model can be seen as a graphical or conceptual representation of a system of differential equations.

Figure 2. Conceptual Model



Source: Authors

Overview of the Model

The model was initially developed with some basic assumptions. It is assumed that El Paso and Ciudad Juárez are two central places with urban functions surrounded by a hinterland whose main economic activity is farming. Part of the hinterland is dry land unsuitable for farming. Furthermore, El Paso and Ciudad Juárez have politically defined boundaries that may restrict or limit their growth or impose some challenges to the implementation of land use policy. Growth at the urban central place can be accommodated through two, though not mutually exclusive, options: an increase in density

through vertical growth or a constant density with an expansion of physical boundaries by transforming farming and dry land into urban land. Data presented previously show that Ciudad Juárez and El Paso have opted for the second option, given the fact that the ratio of urban land change to population change in the last decade is almost equal to 1 for Ciudad Juárez and has fallen to .81 for El Paso.

The Model

The stock variables in the model represent transfers of land from one activity to another. The losses and gains of the stocks should be equal. In other words, the process can be described as a negative sum game where the gains of land in one sector are the losses of land in another. In this particular case in the model, the gains in urban land have been at the expense of dry land and farming land capture; the variables have been denominated as conversion rate to urban land.

A key question remains: What factors have accounted for the conversion of land from farming to urban uses? The answer is that El Paso is no different than any other community that has lost a significant amount of open space and farm land to urban growth. Several authors (Garreau 1991; Gottdiener 1994; Levy 1997; Kelly 1993; Feagin 1988; Orfield 2002) have described a process of suburbanization of the American cities as a result of the desire for affordable, low-density dwellings combined with suburban amenities. Additionally, the ease of obtaining credit for home construction through federal programs such as those by the Federal Housing Administration (FHA) has also contributed substantially.

In the Border Plus Twenty Years (B+20) model, the assumption is that the conversion of farm land is made through market mechanisms; thus, due to the housing demand, it will be more profitable to supply or convert farm land or dry land into urban dwellings. As well, farmers could not only make money by selling land but also by selling the water rights. As long as there exists a differential in what the farmer can get from farming the land and what urban dwellers are willing to pay, urban sprawl will occur.

The system of land use interdependencies in the case of Ciudad Juárez begins with the growth rate of the U.S. gross domestic product (GDP), which affects the rate of foreign direct investment in Ciudad Juárez and, as a consequence, the growth of maquiladora employment. As maquilas locate in a city, the demand for industrial uses increases. Initially local labor is employed, but due to the rapid influx of maquiladora plants, each employing hundreds of workers (on average), additional "outside" labor is needed. This leads to in-migration and overall urban population growth. The inflow of labor increases the demand for residential land as workers and their families seek housing. Vacant housing units are initially filled, but the escalating number of migrants leads to the development of new residential districts. Population growth also inflates the demand for commercial activities, defined broadly to include wholesale, retail, and businesses/personal services.

The demand for commercial activities leads to the expansion of commercial establishments already in place, as well as the formation of new enterprises, so that the amount of commercial land use rises. The expansion of the commercial sector creates more employment and these employees require additional residential land. Most of the land is taken from irrigated land and desert land. Finally, it is important to clarify that in Ciudad Juárez, unlike El Paso, there are both informal and formal housing markets.

The B+20 model implicitly takes into account those factors as the sources that generate the demand for urban land, whereas irrigated and dry land are supplying the land for urban uses. What are the forces behind this conversion process? The model only takes into account conversion rates, fallowed land, and the requirement of crop rates. The rate of conversion implicitly assumes that farmers, when facing the decision to either sell their land to developers or continue farming, realize that they can make a bigger profit selling two important assets—land and water rights—for which urban dwellers are willing to pay.

Links with the Rest of the Model

The land use sector is linked to the rest of the B+20 model through the demographic sector, which is labeled as changing population (Figure 3). In essence, demographic changes in El Paso and Ciudad Juárez are the driving force behind the demand for urban land and, consequently, the transformation of dry land and agricultural land into urban residential uses.

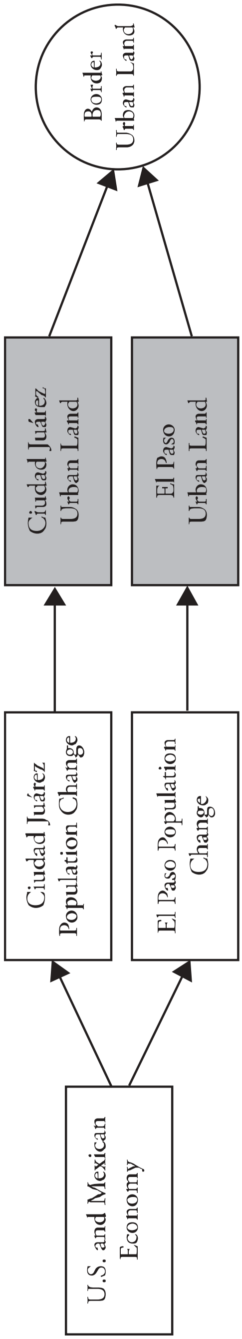
Demographic changes in the B+20 model are a function of employment opportunities. International trade and economic integration have had mixed impacts in the border region. Ciudad Juárez experienced an economic boom from 1980 to 2000. In the same period, El Paso's economy had stagnated and key employers (mainly in the garment and textile industry) left the city. Other employers simply stopped operating, as was the case with the American Smelting and Refining Company's (Asarco) copper mining activities. In recent years, new sectors associated with international trade, such as warehousing and transportation, have experienced employment growth. According to the El Paso Economic Adjustment Strategic Plan (1999), more than 14,500 El Paso workers have been certified as displaced by the North American Free Trade Agreement (NAFTA); overall, El Paso has had a net gain (6,150) in jobs due to NAFTA, but these jobs pay comparatively lower salaries than those lost as a result of NAFTA.

In sum, urban growth in the border region in the last two decades cannot be explained without taking into consideration the impacts employment growth has had on demographic changes, which are the factors behind the expansion of the urban boundary and, consequently, the transformation of dry land and irrigated land into urban uses, as shown in Figure 2. The land use models for El Paso and Ciudad Juárez are shown in Figures 4 and 5.

ENDNOTES

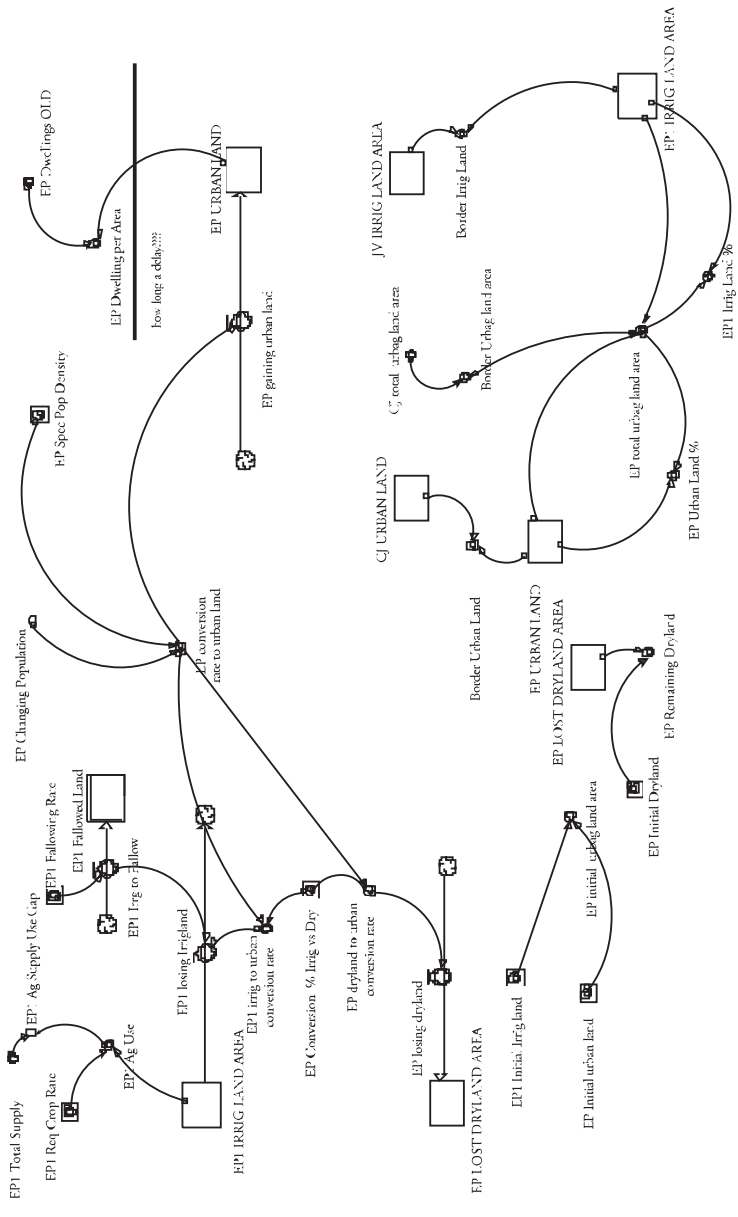
[1] Information comes from The Plan for El Paso, the Municipal Institute for Planning and Research (IMIP) in Ciudad Juárez, and National Institute of Geographic Information and Statistics (INEGI).

Figure 3. Links



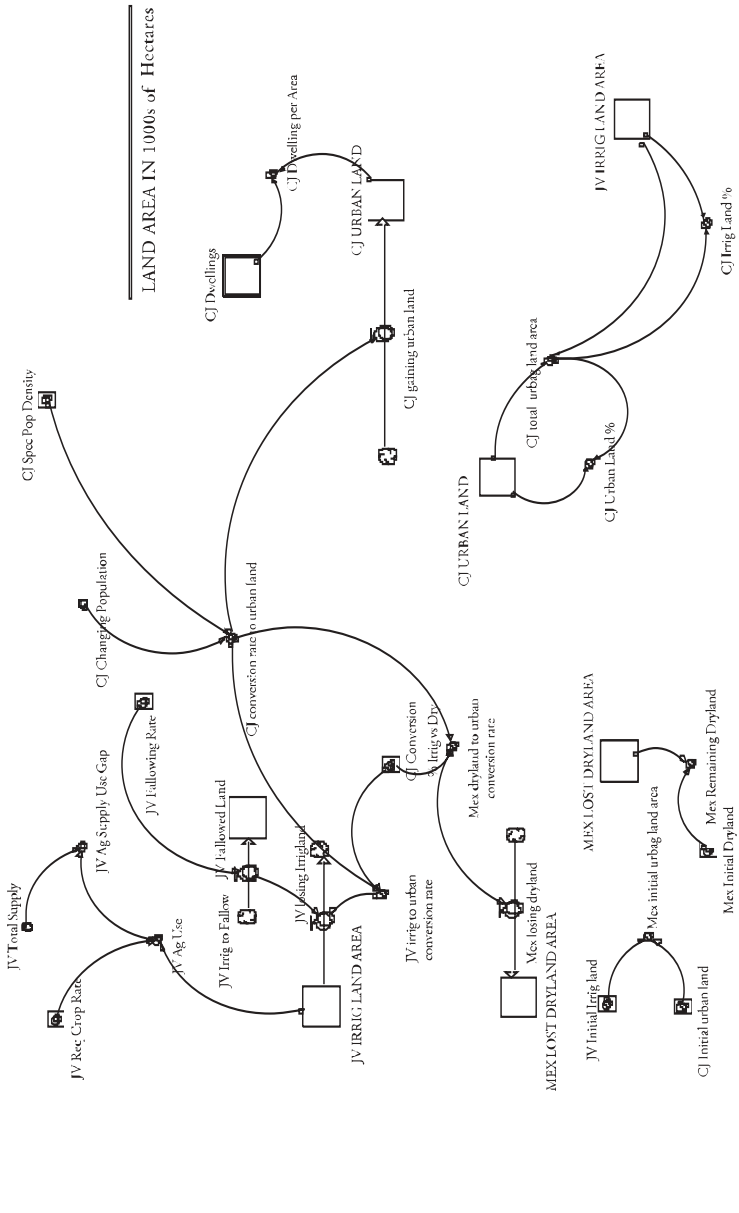
Source: Authors

Figure 4. B+20 Land Use Model for El Paso



Source: Authors

Figure 5. B+20 Land Use Model for Ciudad Juárez



Source: Authors

[2] Data comes from Lorey (1993) and http://www.inegi.gob.mx/estadistica/espanol/economia/feconomia.html.

[3] 1 hectare is 2.47 acres.

[4] The Distrito de Riego 009 has a total area of 61,100 acres.

References

Arreola, D., and J. Curtis. 1993. *The Mexican Border Cities: Landscape Anatomy and Place Personality.* Tucson, Ariz.: The University of Arizona Press.

City of El Paso. 1999. *The Plan for El Paso.* El Paso, Tex.: City of El Paso.

City of Juárez. 1985. *Plan Director de Desarrollo Urbano de Ciudad Juárez.* Ciudad Juárez, Chih.: City of Juárez Urban Development Office.

City of Juárez. 2001. *Plan Director de Desarrollo Urbano de Ciudad Juárez.* Ciudad Juárez, Chih.: City of Juárez Municipal Institute for Planning and Research.

Director de Desarrollo Urbano de Ciudad Juárez. 1995. *Actualización del Plan.* Ciudad Juárez, Chih.: City of Juárez Urban Development Office.

Feagin, J. 1988. *Free Enterprise City: Houston in Political-Economic Perspective.* New Brunswick, N.J.: Rutgers University Press.

Fuentes, C. M. 1992. "Usos del Suelo y Configuración Urbana: The Case of Ciudad Juárez, Chihuahua." *Rio Bravo* 2(1): 12–21.

Fuentes, C. M. 2000. "Urban Function and Its Effect on Urban Structure: The Case of Ciudad Juárez, Chihuahua." *Journal of Borderlands Studies* 15(2): 15–23.

Fuentes, C. M. 2001. "Los Cambios en la Estructura Intraurbana de Ciudad Juárez, Chihuahua: de Monocéntrica a Muticéntrica." *Frontera Norte* 13(25): 95–118.

Gottdiener, M. 1994. *The New Urban Sociology.* New York: McGraw Hill Inc.

Gurreau, J. 1991. *Edge Cities: Life on the New Frontier.* New York: Anchor Books Double Day.

Instituto Nacional de Estadistica Geografía e Informatica. 2000. *Estadísticas de la Industria Maquiladora.* Aguascalientes: INEGI.

Junta Municipal de Agua y Saneamiento. 1999. *Plan Maestro para el Mejoramiento del los Servicios de Agua Potable.* Ciudad Juárez, Chih.: City of Juárez Ciudad Juarez Water Utilities.

Kelly, E. 1994. *Managing Community Growth: Policies, Techniques, and Impacts.* Westport, Conn.: Praeger.

Levy, J. 1997. *Contemporary Urban Planning.* Upper Saddle River, N.J.: Prentice Hall.

Lorey, D. 1993. *United States-Mexico Border Statistics Since 1900: 1990 Update.* Los Angeles: UCLA Latin American Center.

Orfield, M. 2002. *American Metropolitics: The New Suburban Reality.* Washington, D.C.: Brookings Institution Press.

Paso del Norte Water Task Force. 2001. "Water Planning in the Paso del Norte: Toward Regional Coordination." http://www.sharedwater.org.