1. Population Distribution and the Paths toward Sustainable Development.[1]

1. The relationship between population and environment

Over the course of the last forty years, Mexico's total population has increased significantly and, during the same period, the pace of changes in the environment has accelerated in an unprecedented way. Considering this steady population growth and the environmental degradation associated with it, it is really important to lay emphasis on the relationship that exists between population dynamics and environmental changes, in particular from the perspective of population distribution.

Population distribution refers to the concentration or dispersion of individuals in a given territory. This location pattern establishes a type of interaction with the environment that translates into pressure on natural resources as a result of the need to meet basic food, housing, health or recreation needs. But this population-environment interaction in a given place and space is characterized by a series of *accumulated effects,* considering that past history exerts an influence, that can sometimes be decisive, on the current situation and its future course. In other words, the current territorial population distribution pattern is not the result of the current natural advantages and potentialities of each space, but a complex set of historical decisions that have endowed each territory with material, social and cultural wealth in different moments (ECLAC, 2012: 23).

In other words, a country's distribution of the population by regions –or in urban and rural locations, or according to its size- not only reflects multiple decisions made by individuals and families in response to social inequalities, economic crises and political processes (endogenous conditions), but is also a response to global processes such as economic, environmental, and even cultural changes (Sklair, 1991; García Canclini, 1999; Bauman, 2007) that have an impact on all scales, from the local to the global.[2]

There are two trends of the demographic dynamics that have an influence on environmental pressure in each region: first, the differential pace of demographic growth that occurs in the territory and causes some areas to grow above the national average, exerting more pressure on natural resources, while others grow a slower pace. And, second, national and international migratory flows, which result in a redistribution of the population and lead to a higher or lower

1 The author wishes to thank Josefina Hernández and Diana Guerrero for processing statistical data and preparing all the tables and graphic materials.

2 Cited in Aguilar and Graizbord (2014: 783).

demographic weight (depending on whether positive or negative balances are generated), increasing or reducing pressure on local environments. Both trends are reflected in a certain level of population density, which is a useful indicator of population variations by region or territorial unit. The increased pressure on natural resources due to the increase in density tends to result in a scarcity of agricultural land and water and energy sources, among other things.

However, production and consumption patterns, rather than the magnitude of the population, may be the key to achieving efficacious and efficient situations that can sustain future generations. The process to overcome gaps in a developing country like Mexico exerts a lot of pressure on the environment. Creating full employment, increasing income and fighting poverty require a higher level of sustained economic growth, but this will only increase environmental pressure, especially if the economy is dependent on extractive industries such as oil, and also if a higher demand for food increases agricultural exploitation with the consequent deterioration of the environment (UNFPA, 2012: 6-7).

Figure 1.1 shows a conceptual description of the relationship between population dynamics and environment in a deliberately simple fashion. Population size is closely linked to the environment, considering that every individual requires a certain amount of resources and contributes to environmental deterioration. Population distribution refers to the dispersion/concentration of the population and its density, which exerts different levels of pressure on the environment. The composition of the population can be related to age and income structures where young people are prone to migrating, and those with higher income levels are correlated to higher production and consumption levels. In its relationship with the environment, the population has several mediating factors that can accelerate or reduce environmental pressure, such as technology, institutions, policies and cultural factors, among others. Today's environmental deterioration can be clearly exemplified by two long-reach impacts, to wit, global climate change and land use change.

Figure 1.1

In this higher density dynamics, in the last decades, population trends have been characterized by a significant level of concentration in urban areas. In the particular case of cities, the size of the population alone has caused the pressure on environmental change to become more complex and multiply in the territory, a situation that leads to a lack of infrastructure and regulatory mechanisms to reduce pollution and other environmental damages (Hunter, 2000: *xiii*). As stated by Vitousek *et al.* (1997: 494), the urbanization process, the humanization of the space, or using a more contemporary expression, the *human domination of earth's ecosystems,*

through the adoption of changes in land use to produce all types of goods and services, represent the biggest human alteration of the earth's system, creating global warming (or climate change) and causing irreversible losses in the planet's biological diversity. The repercussions of these major changes in our cities have been evident for quite some time.

Urbanization involves the construction of artificial structures that modify the environment and have an impact on the pressure on resources by unit of territory. It is generated in two different ways: first, as a result of the higher density that occurs in urban areas; and, second, as a result of the lifestyles and higher income levels of urban populations, which are linked to certain patterns of production, consumption and generation of waste harmful to ecosystems (ECLAC, 2012: 121). In fact, the impacts of urbanization on the environment are not only limited to the territory it occupies or its surrounding areas, but also extend to distant ecosystems, where the extraction of resources for urban consumption (*e.g.* water or food) is common.

The relationships between urbanization and sustainable development are established in different spheres. According to Hunter (2000: 25-26) and ECLAC (2012: 121), they materialize in four different forms:

i. Ecosystemic transformations that result from the impact on natural resources. In this case, we can point to two particular aspects: first, the generation of waste that, due to its magnitude, exceeds the environment's capacity to absorb it and translates into high concentrations of contaminants; and, second, changes in land use, where the most significant expression is the loss of vegetation or agricultural land to the benefit of urban uses;

ii. The alteration of local climate that results from the presence of artificial materials, such as concrete, that alter temperature variations and lead to heat islands, as well as climate change, due to the emission of greenhouse gases resulting from the operation of industries and motor vehicles;

iii. The rapid pace of urbanization, especially in large cities, which limits the availability of appropriate infrastructure or the creation of regulatory mechanisms to manage environmental impacts; and

iv. Disasters associated to natural phenomena, where urbanization has an effect that multiplies the damage due to the larger size of the population and the higher number of buildings or material possessions by area unit exposed to these phenomena. Disaster vulnerability in cities has grown due to the increase in the number of high density urban areas that face limitations in infrastructure and lack the means to mitigate disasters, which is the case of poor areas in conditions of irregularity..

Cities are the scenario where both *population/climate change* interactions, such as the location of human settlements, and disaster risk patterns, are predominantly defined. According to UNFPA, UNISDR and UN-HABITAT (2012: 11), this notion of *vulnerability growth* has been proposed not only as a mere reflection of the increasing number of people who live in environments prone to the impact of threats, but also the fact that disaster impact vulnerability also feeds on itself in conditions of poverty, environmental degradation and weak governance.

One of the most characteristic traits of current urban growth is peripheral urbanization or *peri-urbanization*, which represents new urban expansion patterns. These particular forms of occupation of the territory must be addressed given their implications for socio-economic development and environmental sustainability. The average density of cities experienced a rapid decline in the last ten years, at a rate of 1.7% in developing countries, and 2.2% in industrialized countries. Over the course of the next thirty years, those cities with more than 100,000 inhabitants in developing countries are expected to triple their constructed area to 600,000 km2 (United Nations Population Fund, 2007: 47).

Urban growth dispersion in the territory has become a global phenomenon. Dispersed urban expansion is closely linked to low land occupation densities; a significant separation between urban activities that leads to land use fragmentation; social segregation by income (or by age: Garrocho and Campos, 2015a; 2015b; 2015c); the consumption of important natural resources such as agricultural land and open spaces, and an increased mobility of the population, which must travel longer distances and becomes dependent on motor vehicle transportation.

In Latin America, urban policy favors this pattern of occupation of urban zones in urban peripheral areas, especially land owned by the public sector or communal land. In addition to this, poverty and social exclusion also expand city limits through informal settlements that must face significant shortages of public services and precarious living conditions. All of the above is replacing the model of more dense and compact cities with a process headed in the direction of *peripheral urban dispersion.*[3]

It is also necessary to highlight that scarce and dispersed rural settlements can have predatory effects on the environment. In their analysis of this issue, Álvarez and Herrera (2014: 289) maintain that, under certain conditions, a significantly dispersed population will deteriorate the environment and will modify land use, with serious consequences for biodiversity and the balance of ecosystems. By way of example, they point to two concrete circumstances: first, the case of rainforests in the southeast of Mexico, where large farms of hundreds of hectares were initially established but, more recently, a model of small production units was adopted through a process of colonization with *ejidos* (communal lands for agriculture) and communities mainly engaged in cattle raising and agricultural activities, and a large number of small communities of less than 50 inhabitants; and, second, the case of the Monarch Butterfly region, where a high level of population dispersion was identified in small communities, a situation associated with a higher level of environmental degradation, areas with a high level of marginalization and the presence of indigenous populations (Álvarez and Herrera, 2014: 299, 303).

3 Generating what Garrocho (2011) calls "the peripheral location trap": in those places where the poor can live there are no jobs, and in those places where they can work there is no housing.

2. Recent population distribution trends in México

Population distribution in the country is a really important indicator of the level of attraction each space has had in the past, the current opportunities offered by different areas in the national territory, and the magnitude of environmental pressure in each individual region. In this pattern, there are spaces that stand out due to their population concentration and their appeal to the population. And these same areas will likely continue to receive a larger number of persons, unless redistribution policies are implemented to transform the economic foundations of other locations and radically change trends.

It is important to note that the economic trade openness model adopted in the country in the late 1980s had significant territorial impacts, including a redistribution of the population and productive activities in new destinations of interest to private capitals, a process supported by economic development policies. As stated by Aguilar (2014: 194-196), this can be summarized as follows:

- A reinforcement of territorial patterns that were already predominant at the time, such as the consolidation of large metropolitan areas and the emergence of others. A notorious aspect was the process of deindustrialization in the largest cities and the consolidation in them of a tertiary sector, both advanced and low-skilled, that turned them into large consumption centers;

- The promotion of industrial activities in middle-sized urban centers, such as large-scale manufacturing in the Center-North region and the maquila areas along the northern border;

- The promotion of tourism in comprehensively planned resorts along the coastal tourist corridor of the state of Quintana Roo and the Pacific coast;

- On the opposite side of the spectrum, the "losing spaces" in this territorial reconfiguration process are those linked to rain-fed rural areas, difficult-to-reach areas with large indigenous populations, and small and middle-sized urban centers not integrated into the productive systems reactivated by economic globalization.

All the above contributed to revitalizing new territories, especially those far away from the largest cities, such as middle and small-sized urban centers, and reoriented migratory flows to new destinations in the country, not only between rural and urban areas, but also between large cities and smaller urban centers, and between cities and rural areas. However, it is also important to note that, despite this recent dynamics, significant *socio-territorial inequalities* still persist between regions and between urban and rural areas.

The following is a description of four major aspects of population distribution in the country and their most important environmental impacts:

i. Population density and its relationship with water availability;

ii. The urbanization process, atmospheric pollution and municipal waste;

iii. Dispersed urbanization and land consumption; and

iv. Rural population and the loss of vegetal cover

2.1. Population Densification and Water Availability

Recent population processes have led to a concentration of the population in certain regions in the territory and, with it, to an increase in population densities by area unit. According to the 2010 Census on Population and Housing, the country had a total population of 112.3 million inhabitants, which represented an increase of 14.8 million compared to year 2000: the population grew at an annual average rate of 1.4% over a ten-year period. However, the distribution of the population is highly uneven: while some states have a scarce population relative to their area, others have a high concentration of inhabitants. The most populated states are the State of Mexico, the Federal District and the state of Veracruz (with 15.1, 8.8 and 7.6 million inhabitants, respectively), but the states that grew the most between 2000 and 2010 were the states of Mexico, with 2.0 million, Jalisco, with one million, and Chiapas, with 875,000 inhabitants. In other words, the central part of the country maintains a strong population concentration trend (Aguilar, 2013a: 186-187).

When it comes to settlements, another way of looking at regional inequalities is through density figures. In 2010, the country's average density reached 57 inhabitants by km2, compared to 25 in 1970, which represented an increase of a little more than twofold. But the central part of the country maintains the highest densities, notably the Federal District and the states of Mexico and Morelos, with values of 5,920, 679 and 364 inhabitants per km2, respectively. On the other hand, the territories with the smallest settlements are found in the north of the country and the two peninsulas (Baja California and Yucatán). For example, Baja California Sur, Chihuahua and Durango had densities of 8.6, 13.7 and 13.2 inhabitants per km2, respectively. Obviously, the highest densities are associated with urban growth in different territories in the country.

A review of the map of municipal population densities in the country as of 2010 (see Figure 1.2) clearly shows the settlements with the highest concentration levels. First, we have the central strip of the country, where densities have increased and led to a highly populated territory due to the multiplication of urban centers and the expansion of metropolitan areas. All of it linked to a dense network of ground communications that enables functional relationships and flows between human settlements. The map shows a high density area in the west-east direction that basically extends from the city of Veracruz to the city of Guadalajara.

In the northern region of the country, the highest densities have been clearly linked to specific locations, such as the outskirts of border cities, the Monterrey-Saltillo metropolitan areas, the Torreón-Gómez Palacio metropolitan area, and the Nayarit-Sinaloa and Sonora coastal strip,

In the southern region of the country, on the other hand, population increases have occurred in the states of Tabasco, Yucatán and Chiapas, as well as the outskirts of the main cities, especially those linked to oil drilling and tourism.

This population distribution clearly shows the territories subject to strong environmental pressure. One clear example worth mentioning is the strong imbalance between the distribution and natural availability of water resources. The National Water Commission (CONAGUA) has divided the country into 13 Hydrological-Administrative Regions that, despite consisting of groups of basins, respect municipal limits. Natural availability is closely related to the different types of climate, especially as a result of rainfall. In principle, the country's northern region semi-arid climates show a low level of water availability, while the southern region, which has tropical climates, has a much higher level of availability. But the different ways in which water is consumed also determine the efficiency of its use. As stated by Aguilar and Graizbord (2014: 799), in addition to its unequal distribution, water is used in different sectors in a biased and inefficient manner: water losses in the farming sector, the main water consumer, have been estimated at 40-60%, compared to 30%-50% in the case of water for public consumption. Its industrial use is the most efficient, but it is also the one that contaminates the most.

Figure I.2

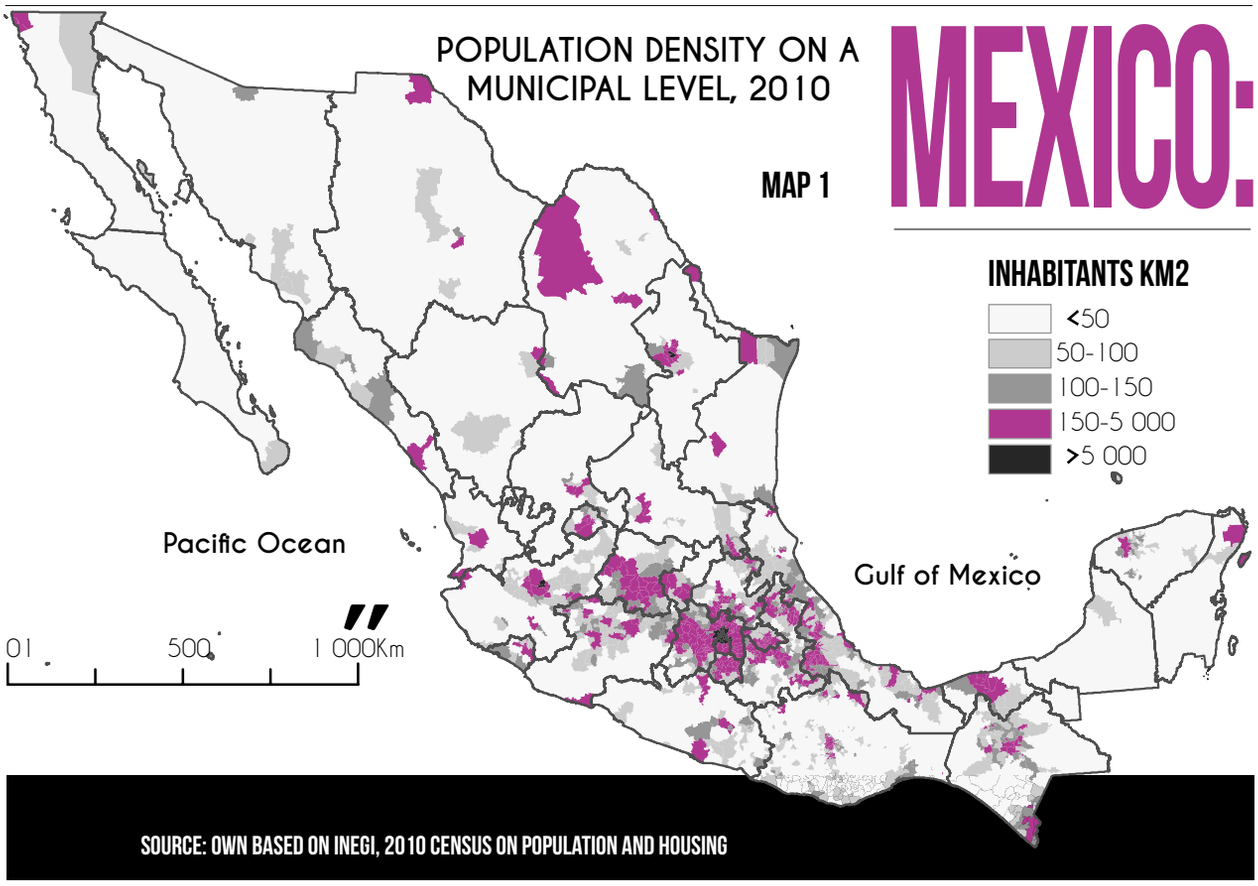


Table 1.1 shows regional differences in population concentration and water availability. One aspect that stands out, above all, is the big difference between the southern part of the country, which does not have water stress and where, in addition, there are low densities and middle-size cities are located, and the country's northern and central regions, which are characterized by strong hydrologic pressure, very high densities and larger urban centers. If we consider the economic development dimension, figures show that the production of goods and services faces a huge challenge, because approximately 60% of the national GDP is generated in regions that already have high and very high water stress levels. That is the case of the Balsas, Río Bravo, Lerma-Santiago-Pacific and Waters of the Valley of Mexico regions. Figure 1.3 shows the level of pressure on water resources and clearly illustrates the above.[4]

Table 1.3

REGIONS HYDROLOGICAL-ADMINISTRATIVE (selected variables), 2014

NO.	HAR	WATER STRESS LEVEL	RENEWABLE WATER PER CAPITA (M3 / INHABITANT / YEAR)	POPULATION (MILLIONS OF INHABITANTS)	NATIONAL POPULATION (%)	DOMESTIC GDP(%)
I	BAJA CALIFORNIA PENÍNSULA	HIGH	4 999	4.29	3.62	3.64
II	NORTHWEST	HIGH	8 324	2.76	2.33	2.86
III	NORTH PACIFIC	MEDIUM	25 939	4.42	3.73	2.72
IV	BALSAS	HIGH	22 898	11.56	9.76	6.14
V	SOUTH PACIFIC	NO STRESS	32 350	4.99	4.21	2.39
VI	RÍO BRAVO ALTO	HIGH	12 757	12	10.14	14.02
VII	NORTH CENTRAL BASINS	HIGH	8 064	4.47	3.78	4.36
VIII	LERMA-SANTIAGO-PACIFIC	HIGH	35 754	23.67	19.99	18.19
IX	NORTH GULF	MEDIUM	28 114	5.19	4.38	2.43
X	CENTRAL GULF	NO STRESS	95 124	10.4	8.78	6.07
XI	SOUTH BORDER	NO STRESS	16 3845	7.48	6.32	5.3
XII	YUCATAN PENINSULA	LOW	29856	4.43	3.74	8.01
XIII	WATERS OF THE VALLEY OF MEXICO	VERY HIGH	3468	22.82	19.27	23.86
TOTAL		LOW	471497	118.4		

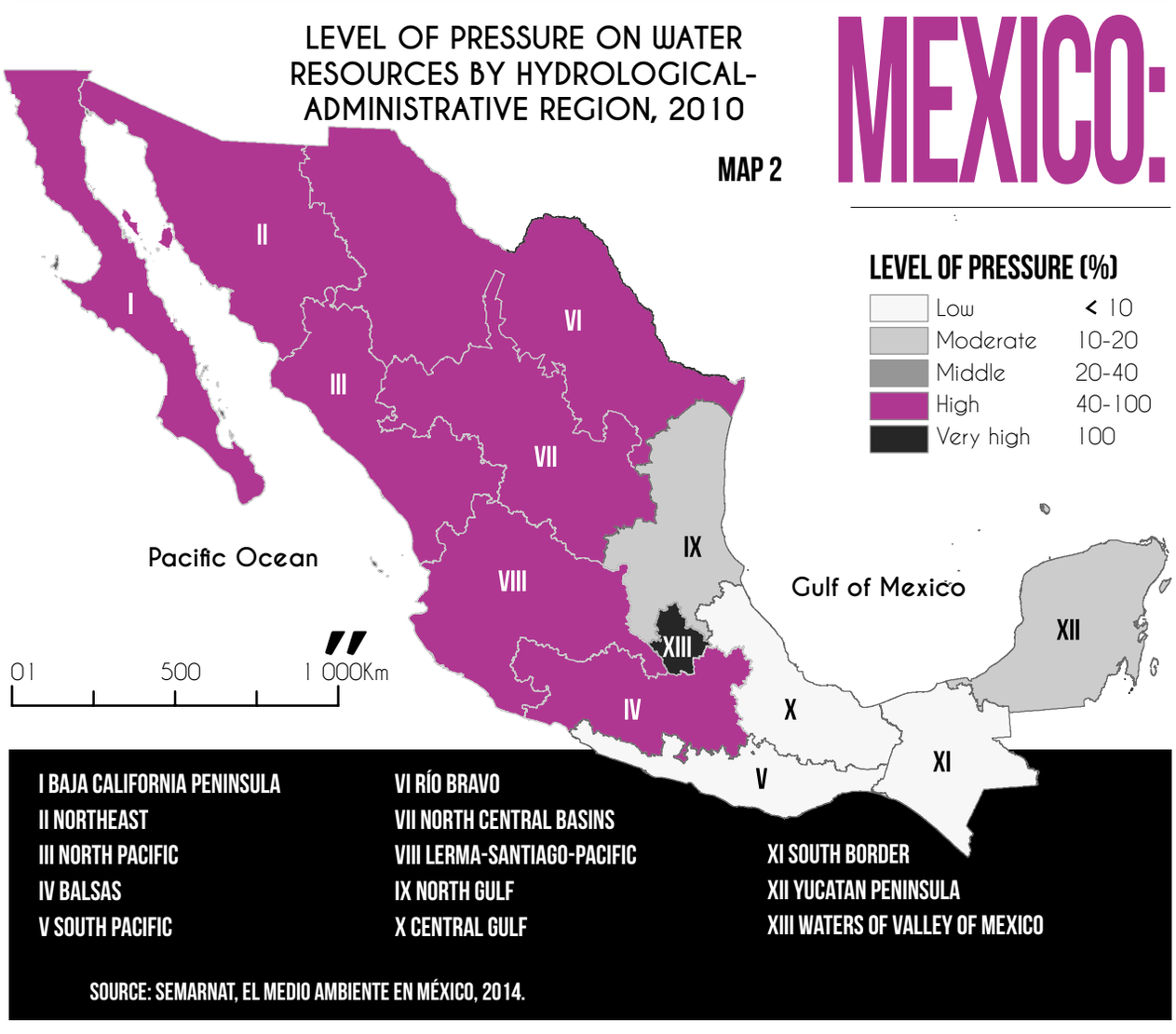
SOURCE: CONAGUA, ESTADÍSTICAS DEL AGUA EN MÉXICO, EDICIÓN 2014
NOTE: HAR = HYDROLOGICAL-ADMINISTRATIVE REGIONS

4 With regard to this issue, Garrocho (2013) states that: "In spatial terms, the basins located in the north and central parts of the country have a limited natural availability of water, because their average annual rainfall is less than 500 mm. However, the economic paradox of water is that it is in these basins that a significant proportion of the population and economic activities are concentrated. This is in contrast to the situation in the Yucatan peninsula (and virtually all throughout the southeast), where the average natural availability of water is high, but less than 10% of the country's population is concentrated. However, it is in Mexico's south and southeast regions that the largest number of inhabitants with no access to drinking water services has been identified. We can call this situation the social paradox of water. In the states of Chiapas and Oaxaca, for example, only one in four inhabitants (approximately 73%) has access to drinking water, whereas in the Federal District and the states of Aguascalientes and Coahuila, more than 97% of the people have this service".

2.2. The urbanization process, atmospheric pollution and municipal waste

Mexico's population has been mostly urban for at least three decades. By 1995, most of the national population (60%) lived in cities of 15,000 or more inhabitants (Aguilar and Graizbord, 2001: 583). The country's urban population has grown systematically in the last few decades, from 47.9 million inhabitants in 1990, to 81.2 million in 2010, with a multiplication of urban centers. With it, the urban population currently accounts for 72% of the country's total population. It is worth noting that this growth has been more moderate in recent decades, and the number of cities of different sizes has diversified, a situation that reinforced Mexico's urban profile, although at a pace slower than that of the second half of the 20th century, and even slower compared to that of the 1950-1970 period (Anzaldo and Barrón, 2009: 53, 61).

Figure I.3



The urban dynamics is reflected in the structure of the different cities in the country, in the role played by some large cities, especially those that have reached more than one million inhabitants and, in general, those that due to their population growth and expansion have become metropolitan areas.

Table 1.2 shows this trend toward urbanization during the 1990-2010 period, with several aspects worth highlighting. The first important aspect is the population concentration in the so-called "millionaire" (more than one million) cities, where the number of inhabitants has virtually doubled, from 22.1 million to 41.3 million, in only 20 years, and the number of cities increased from 4 to 11. This shows the population's strong tendency to agglomerate in the largest cities that already concentrate virtually one half of the total urban population.

The second important aspect is the role of intermediate cities that have multiplied in the different regions of the country as *decentralization hubs* of the urban process. During the above-mentioned period, their number rose from 55 to 84, and their population almost doubled, from 17.6 to 30.3 million inhabitants. One last point we can mention is the case of small cities (between 15,000 and less than 100,000 inhabitants), which increased by a total of 36 over the same period. This shows a significant growth in the number of urban centers in the middle and bottom parts of the urban hierarchy, with an urban system characterized by a more balanced set of components compared to previous decades.

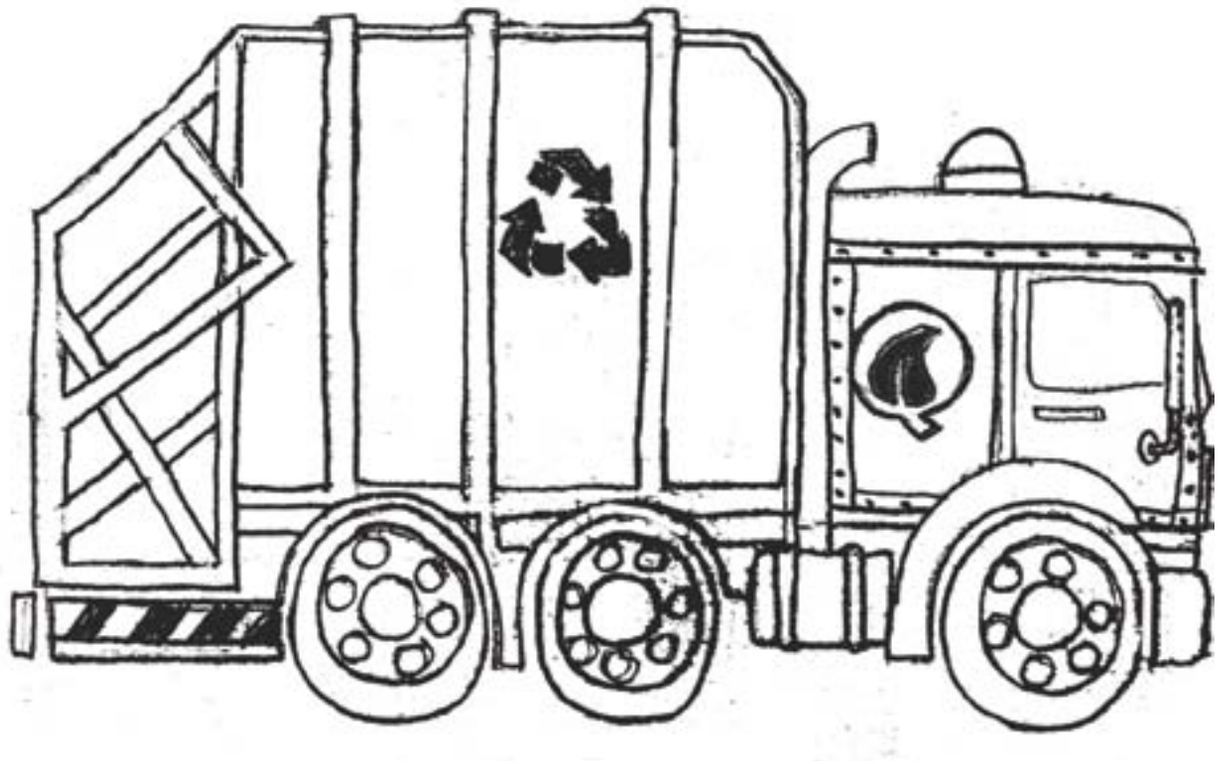


Table 1.2

TOTAL POPULATION AND GROWTH RATE

by population range in metropolitan areas, 1990-2010

RANGE	METROPOLITAN AREAS	POPULATION			AVERAGE ANNUAL GROWTH RATE (%)	
		1990	2000	2010	1990-2000	2000-2010
NATIONAL TOTAL		81 249 645	97 483 412	112 336 538	1.9	1.4
TOTAL NO. OF METROPOLITAN AREAS	59	43 340 530	54 284 700	63 836 779	2.3	1.6
5,000,000 OR MORE INHABITANTS	1	15 563 795	18 396 677	20 116 842	1.7	0.9
1,000,000 TO 4,999,999 INHABITANTS	10	13 260 044	17 405 219	21 252 198	2.8	2.0
500,000 TO 999,000 INHABITANTS	19	9 094 952	11 808 534	14 553 379	2.7	2.0
LESS THAN 500,000 INHABITANTS	29	5 421 739	6 674 270	7 914 360	2.1	1.7
REST OF THE COUNTRY	-	37 909 115	43 198 712	48 499 759	1.3	1.1

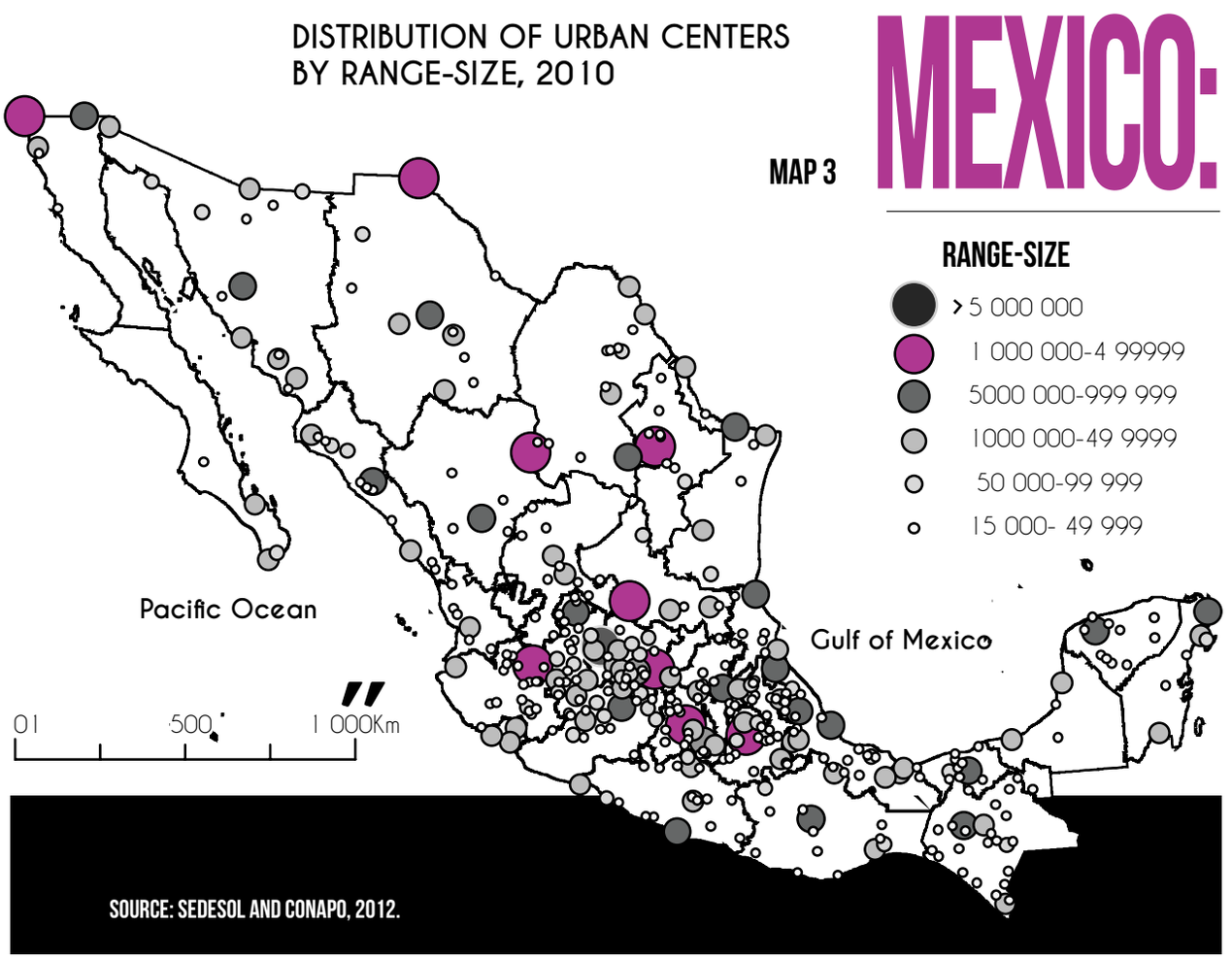
NOTE: THE POPULATION FOR 1990 AND 2000 WAS CALCULATED BASED ON THE UNIVERSE OF METROPOLITAN AREAS FOR 2010
SOURCE: PREPARED BY THE INTERINSTITUTIONAL GROUP BASED ON THE 1990 AND 2000 GENERAL CENSUSES ON POPULATION AND HOUSING

Figure 1.4 shows the distribution of urban centers by *range-size* in the national territory. In it, we can see that this distribution is highly similar to that of the high and very high density areas shown in Figure 1.2 This shows that the urbanization process is the cause of the highest population concentration levels in the country and the highest levels of environmental pressure.

Another factor that can explain population redistribution and the relocation of economic activity is the environmental factor. On one hand, the presence of resources and access to those resources are advantages that will cause a city to grow, compared to other cities affected by shortages (for example, of water). On the other hand, a population that experiences pollution, traffic jams and insecurity will look for better living conditions in other, typically smaller, locations. Migrants (i.e., the population and businesses) are selective; they choose their destinations based on the tacit knowledge and information they have about the advantages offered by some cities and regions compared to others.

Together with this population an economic activity redistribution process, the number and proportion of poor urban people would seem to increase, especially if economic growth is insufficient to generate the quality jobs required and accommodate immigrant labor. At the same time, one of the consequences of demographic growth and urban expansion is an increase in the demand for public and private goods and services and, therefore, an increase in pressures on the ecosystems and their immediate surroundings. From there that urban policy is, in a mostly urban world, a strategic perspective of public policy in general, and social policy in particular (Berry, 2007:3).

Figure I.4



We will now refer to two aspects that, in addition to being clear expressions of urban environmental impact, have become central to the issue of environmental deterioration: atmospheric pollution and municipal waste in the form of solid waste and wastewater.

Atmospheric pollution

The problem of air quality is particularly related to large cities, where emissions of different volumes and compositions are generated. According to Mexico's National Inventory of Emissions, in 2005 approximately 71.2 million tons of contaminants were emitted, 22% of which were generated by natural sources, and 78% by anthropogenic sources. In the case of the latter, the largest volume emitted (61%) came from automotive vehicles. If we only consider anthropogenic sources, the largest proportions of contaminants emitted were: carbon monoxide (CO; 41.9 million tons), with 76% of the total; volatile organic compounds (VOC; 5.2 million tons), with 9%, and sulfur dioxide (SO2; 3.1 million tons), with 6% (SEMARNAT, 2013: 193-194).

If we consider the emissions generated by natural and anthropogenic sources, the five Mexican states that emitted the largest amount of contaminants were the states of Jalisco, Mexico, Michoacán, Nuevo León and Baja California (see Figure 1.5). It is worth noting that, in these states, anthropogenic sources are predominant and, therefore, carbon monoxide emissions are also predominant, while in those states that are less populated, natural sources represent the majority.

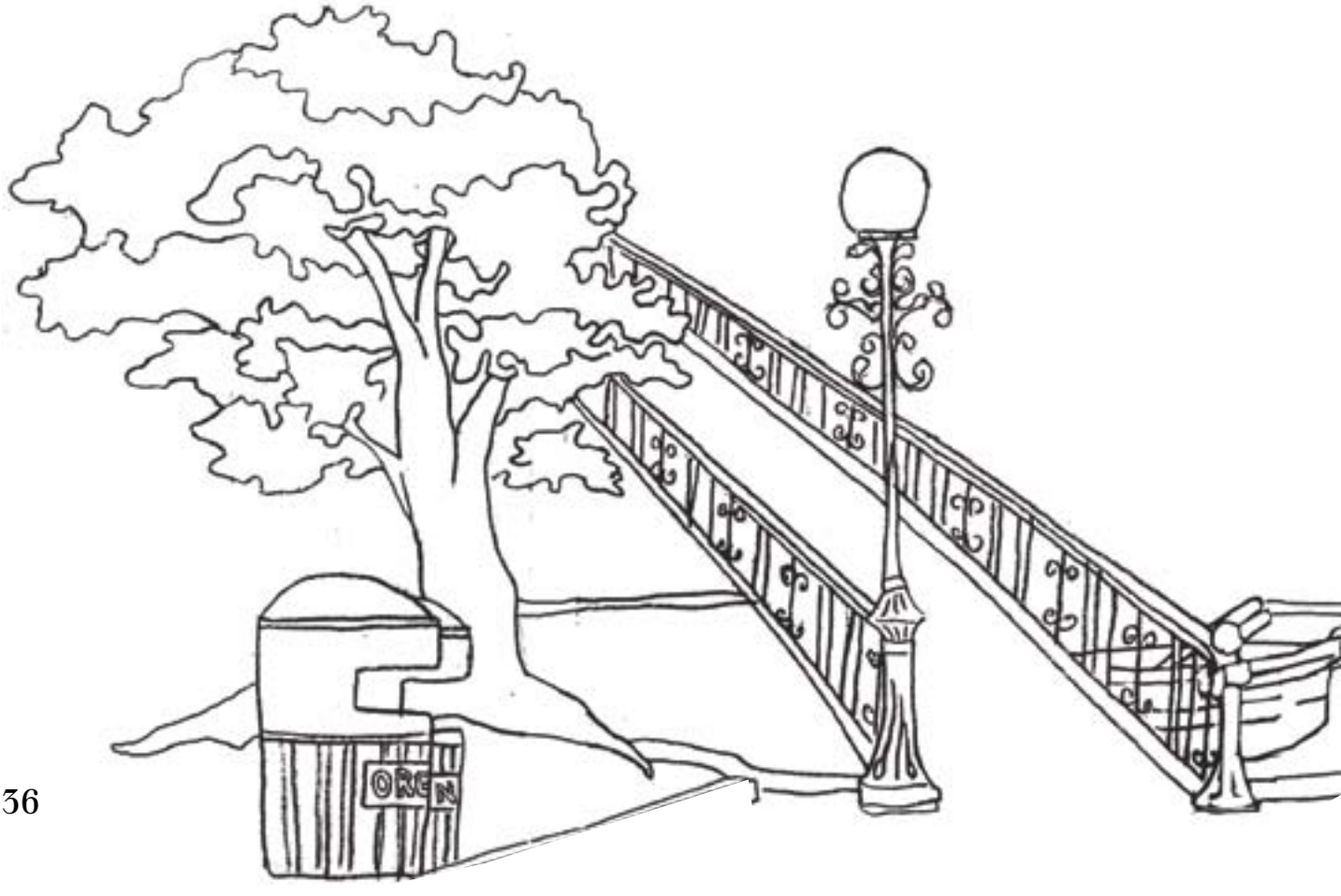
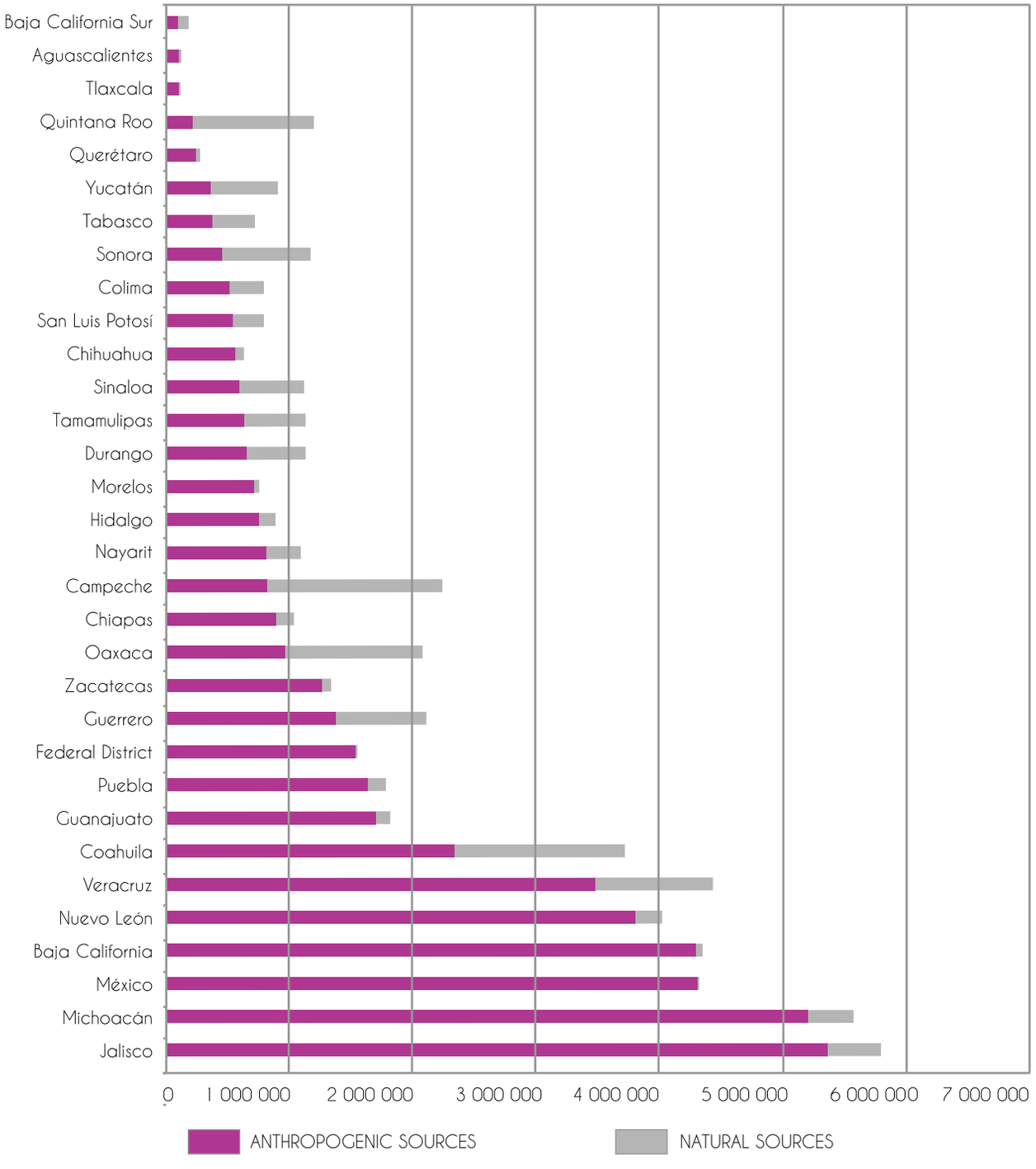


Figure I.5

MEXICO:

EMISSION OF CONTAMINANTS BY STATE, 2008



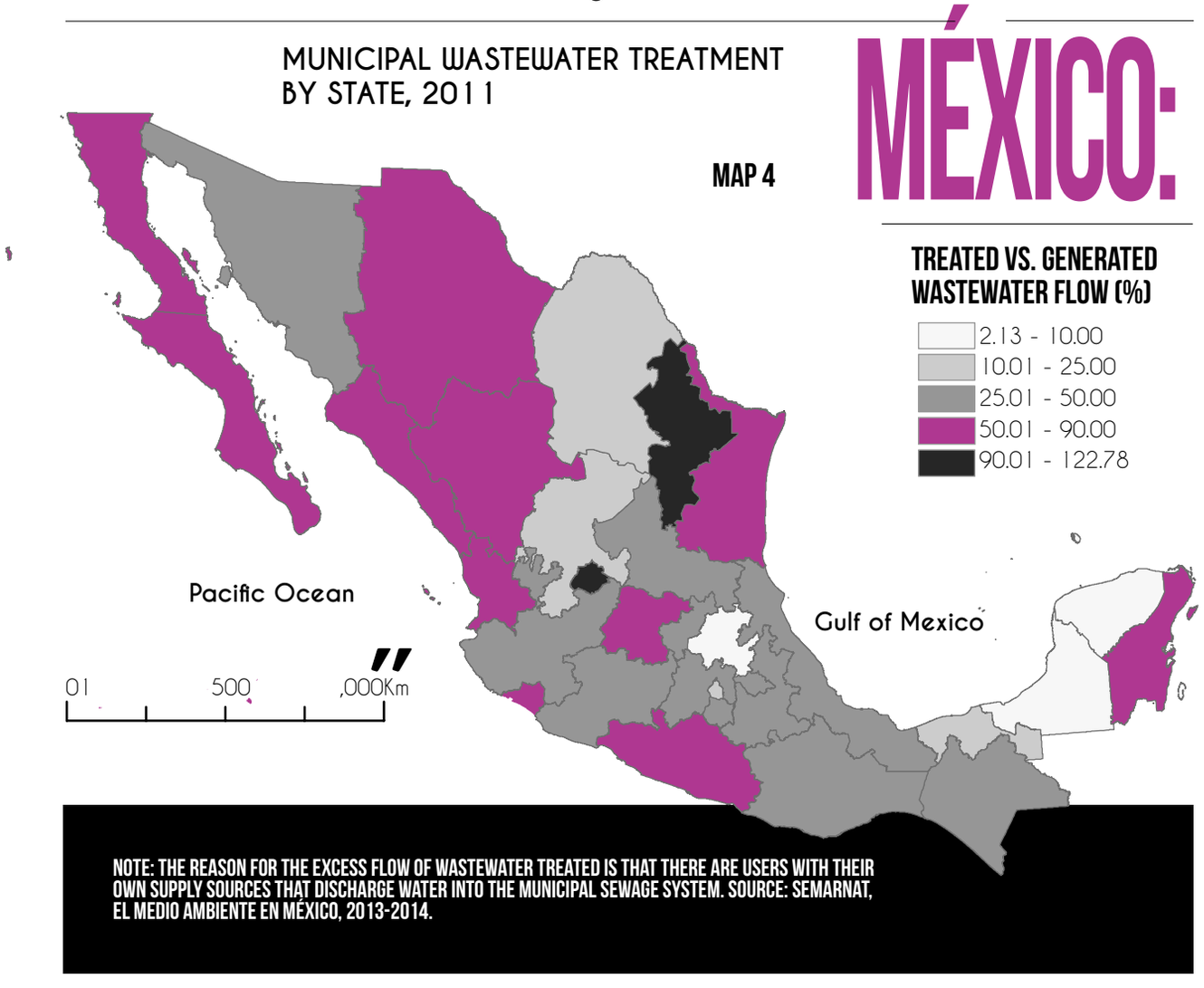
SOURCE: SEMARNAT, EL MEDIO AMBIENTE EN MÉXICO, 2013-2014.

Municipal Waste: wastewater and solid waste

A very common problem is that municipal waste is not treated before being discharged to shallow bodies of water, in the case of wastewater, or deposited in landfills or garbage dumps, in the case of solid waste. In the case of wastewater, if we consider the municipal flow of wastewater generated in 2011, only 41.3% of the total was treated. This figure clearly shows that there is still a significant number of shallow bodies of water that receive a continuous flow of untreated wastewater that contaminates them and affects the health of the population and the different species that exist in those ecosystems (SEMARNAT, 2013: 299).

As can be seen in Figure 1.6, the percentage of wastewater treated by state is highly variable. Most Mexican states have significant treatment deficits, with states in the central part of the country standing out due to their low treatment percentages (10-25%), despite the fact that a significant proportion of the population is concentrated in them.

Figure 1.6



As far as solid waste is concerned, its volume and composition have grown as a result of the population's sustained consumption levels, a situation encouraged by the predominant economic model. Inadequate waste disposal has negative consequences for the health of the population and natural ecosystems: it generates contaminants and greenhouse gases, contaminates soils and bodies of water, leads to the proliferation of pests and causes disease.

There is a direct relationship between the size of a city or community and the generation of solid waste: the larger the size of the city or community , the larger the amount of waste. Thus, Figure 1.7 shows how, in 2011, metropolitan areas and middle-sized cities, as a whole, produced approximately between 75 and 80% of the total solid waste. It has been estimated that only 10% of the total volume of solid waste is treated, and 23% of such waste is dumped in illegal or non-controlled sites (SEMARNAT 2013: 319, 327, 329).

Figure 1.7

GENERATION OF URBAN SOLID WASTE BY TYPE OF CITY OR COMMUNITY, 2011

SOURCE: SEMARNAT, EL MEDIO AMBIENTE EN MÉXICO, 2013-2014

*THIS POPULATION REFERS TO METROPOLITAN AREAS WITH MORE THAN ONE MILLION INHABITANTS.

2.3. Dispersed urbanization and land consumption

Peri-urbanization is particularly significant in the largest cities in the country, whose demographic component is expressed in large population numbers and a large number of intra-metropolitan center-periphery flows, and where functional relationships go beyond the political-administrative limits of the territory where they expand, thus leading to the creation of metropolitan areas.

In Mexico, since the late last century, the evolution of the metropolitan phenomenon has been a really important process that intensified over the course of the following decades, thus leading to a multiplicity of metropolitan complexes with broad diffuse strips characterized by urban-rural traits. While in 1980 Mexico had 26 metropolitan areas that consisted of 131 municipalities or *delegaciones* (boroughs), by 2010 the number of metropolitan areas had increased to 59, which included 367 political-administrative units. In other words, the number of municipalities or boroughs almost tripled. By 2010, the demographic concentration in these metropolitan areas had reached 63.8 million inhabitants, which accounts for 56.8% of the national population (SEDESOL, CONAPO, INEGI, 2012: 15). These data confirm, in territorial terms, a predominance of the process of expansion of metropolitan peripheries in the urban landscape.

Urban sprawl has a deep impact on the population's mobility. Diffuse expansion not only increases commute times; it also increases the use of private motor vehicles, which leads to a series of environmental problems linked to the dependence on cars. Urban dispersion is closely linked to the predominance of market forces, a largely unplanned occupation of land, a high level of dependence on automobiles, a larger consumption of fossil fuels and environmental degradation, all of which exacerbates social problems.

Urban sprawl, or peri-urbanization, is highly predominant in developing countries. It represents a form of reducing the concentration of urban growth; however, it is characterized by forms of land occupation that do not follow urban regulations or make a rational use of land, a situation that leads to urban development patterns that have become unsustainable from an environmental, social and economic standpoint. This statement is confirmed by several data, for example, the fact that in Mexico, from 1970 to 2000, the physical expansion experienced in its urban areas was almost four times higher than their demographic growth (UN-HABITAT, 2013: 77). More specifically, it has been estimated that the largest cities in the group of cities with more than one million inhabitants, that is, Mexico City, Guadalajara and Monterrey, experienced a population growth of less than 2% during the 1980-2010 period, while their urban area expanded by 4% on average. On the other hand, during the same period, smaller cities such as Puebla, Tlaxcala, Toluca and Querétaro experienced a population growth of 3%, on average, while their urban area grew by 12.5%, 26.9% and 16.1%, respectively (SEDESOL, 2012: 12-33).

This expansion process integrates additional land into the urban perimeter, a situation that will have important implications in the future, considering that ecosystems are being transformed and the lifestyle of the local population is changing (see Table 1.3).

Table 1.3

MEXICO: URBAN EXPANSION OF CITIES WITH MORE THAN 500,000 INHABITANTS, 1980-2010

CITIES	1980	2010	1980-2010 DIFFERENCE
	AREA (HECTARES)		
TOTAL	141 038	1102 027	960 989
MA – VALLEY OF MEXICO	51 908	185 291	133 383
MA – GUADALAJARA	12 726	48 585	35 859
MA – MONTERREY	12 855	63 018	50 163
MA – PUEBLA-TLAXCALA	4 871	61 301	56 430
MA – TOLUCA	1 309	352 083	350 774
MA – TIJUANA	6 101	26 679	20 578
MA – LEÓN	2 502	17 031	14 529
MA – JUÁREZ	4 125	25 828	21 703
MA – LA LAGUNA	2 364	18 993	16 629
MA – QUERÉTARO	782	12 612	11 830
MA – SAN LUIS POTOSÍ-SOLEDAD DE GRACIANO SÁNCHEZ	2 000	14 863	12 863
MA – MÉRIDA	4 775	22 598	17 823
MA – MEXICALI	4 763	17 782	13 019
MA – AGUASCALIENTES	1 587	9 750	8 163
MA – CUERNAVACA	2 552	17 450	14 898
MA – ACAPULCO	1 389	13 036	11 647
MA – TAMPICO	2 906	15 471	12 565
MA – CHIHUAHUA	2 589	19 441	16 852
MA – MORELIA	1 633	10 120	8 487
MA – SALTILLO	1 497	19 177	17 680
MA – VERACRUZ	1 838	7 765	5 927
MA – VILLAHERMOSA	319	9 610	9 291
MA – REYNOSA-RÍO BRAVO	2 291	14 001	11 710
HERMOSILLO	2 118	11 161	9 043
MA – TUXTLA GUTIÉRREZ	927	14 145	13 218
MA – CANCÚN	478	12 340	11 862
CULIACÁN ROSALES	1 833	8 312	6 479
MA – XALAPA	917	7 927	7 010
MA – OAXACA	873	13 441	12 568
MA – CELAYA	967	7 484	6 517
VICTORIA DE DURANGO	984	6 049	5 065
MA – POZA RICA	1 664	6 101	4 437
MA – PACHUCA	595	12 582	11 987

NOTE: MA = METROPOLITAN AREA
SOURCE: SEDESOL, "LA EXPANSIÓN URBANA DE LAS CIUDADES, 1980-2010"

The territorial fragmentation of productive processes and the absence of more strict land occupation regulations lead to a *diffuse* urban model, the main implication of which is the *expansion* of the urban peripheral space. Thus, the city experiences a significant expansion of its territorial influence and, by including a larger number of political-administrative jurisdictions, makes the metropolitan government's coordination and territorial planning efforts more complicated. This peri-urbanization tends to fragment the urban and rural space in unpredictable ways, which unavoidable raises the question: What will be the form of future urban growth in our cities? (Aguilar and Escamilla, 2009: 6).

Due to this urban *sprawl* , which occurs in the city's periphery, a *rural-urban strip*, with increasingly indefinite limits between these two realities, tends to form. Since it is really difficult to find a universal definition of this territory, the best position may be that of adopting a *continuum* approach, considering the difficulty in defining its precise limits which, in addition, change constantly. It is advisable to examine the two ends of the continuum, the urban and the rural, and understand the dynamics of the change that affects the different cities and communities in the peri-urban area and how their condition is gradually transformed (MacGregor and Thompson, 2006: 10-11).

The following are the main characteristics of peri-urban areas that must be taken into account:

i. In this *urbanization* process, which is regional in nature, the city's influence expands to a large regional territory, a process facilitated by technological advances and a new territorial production logic;

ii. There is a mix of *activities and land uses* that leads to a much more dispersed and fragmented urban space where traditional peri-urban agriculture takes place next to new urban housing projects, industrial parks, corporate urban developments, recreation sites or environmental reserves. Usually, due to the severe lack of infrastructure and the poor conditions of transportation systems, the wealthiest groups do not move to the periphery in massive numbers; instead, the periphery is a place of poor and informal settlements, which leads to new forms of *polarization and socio-territorial segregation;*

iii. Severe environmental impacts occur and, together with the intense dynamics of change in land use, negative impacts are generated on the local environment. Some common elements are the lack of support for agricultural and animal husbandry activities, the disposal of solid and hazardous waste in bodies of water and the ground, the extraction of construction materials, the pressure resulting from the occupation of environmental reserves, the overexploitation of aquifers, and the disruption of natural conditions that increase vulnerability to floods and landslides (Douglas, 2006);

iv. The *overflowing of the city* is favored, because the periphery offers cheaper labor and land, as well as larger spaces with a certain "natural" environment. These conditions are highly suitable for the construction of housing affordable to poor people and migrants in scattered locations with significant deficits of services, often times in illegal conditions, which leads to a peripheralization of poverty with a concentration of population that lives in precarious conditions (Aguilar, 2009: 26);

v. These spaces *lack good "governance"*, because they integrate an increasing number of political-administrative units that are far away from the central city and sometimes belong to other states or jurisdictions. Due to their peripheral condition and the fact of belonging to other jurisdictions, land use regulations and the enforcement of urban laws and regulations become more difficult. Also, the new political-administrative units recently integrated into the city lack a good institutional structure and the technical and political capacity to manage urban growth.

It is important to highlight the fact that the territorial expansion of cities must treat the periphery as an integral part of the city, rather than a fragment thereof. In other words, it is necessary to adopt a comprehensive view of the city. It is also important to remember that the center-periphery link includes several factors: the supply of agricultural and animal husbandry products, water supply, environmental preservation and environmental services areas, labor displacement, the extraction of construction materials and recreational areas, among many others (Aguilar, 2009: 27).

2.4. Rural Settlements and the Loss of Vegetal Cover

The settlement pattern of the rural population is characterized by a huge dispersion in the territory in a multitude of small towns or communities. However, these areas also experience population losses, and their populations faces persistent situations of poverty and food insecurity and, with it, a generalized deterioration of their quality of life (Aguilar and Graizbord, 2014: 816-819; Ávila, 2014: 270-272).

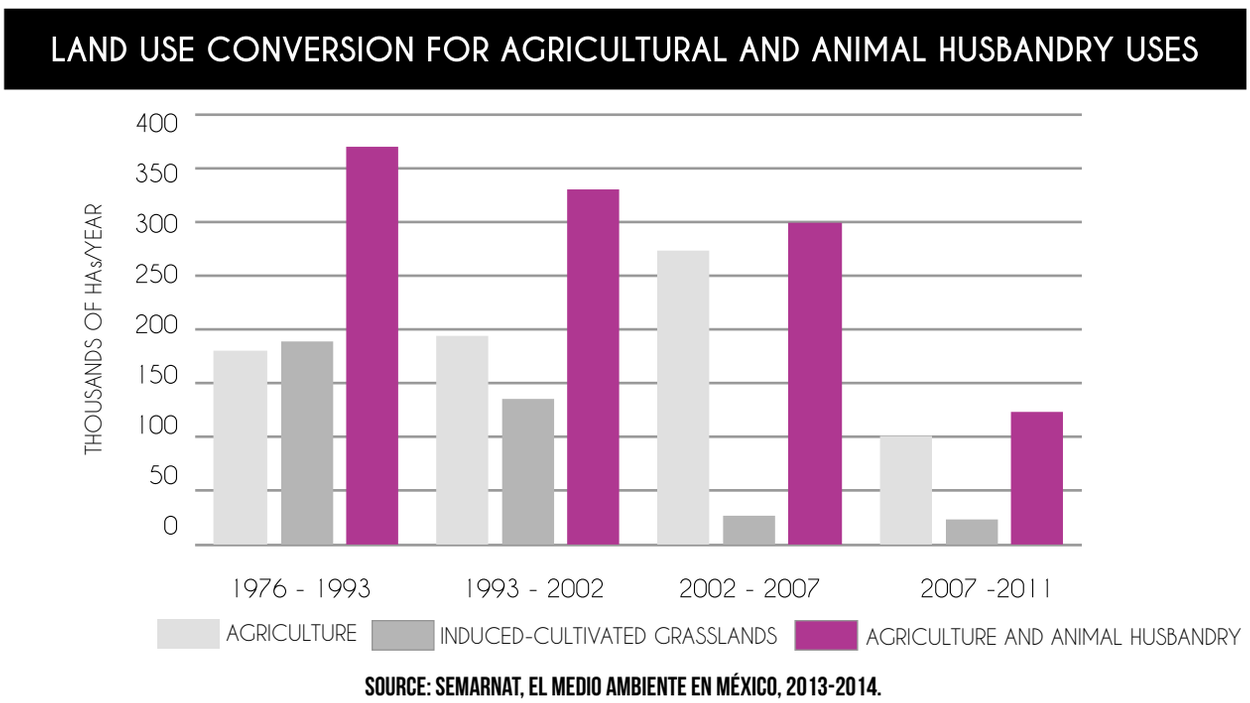
The above translates into an out-migration process that shows how rural areas lose part of their population due to the search for urban destinations, as well as international migratory flows. The reason for this is the lack of job opportunities in regional markets, in addition to a lack of basic infrastructure such as health and education centers, and deficient communications, which prevent them from improving their access to middle-sized urban centers. Of course, the effects of all these factors vary by region, but in those areas where all of them are combined, the conditions of poverty and social backwardness worsen, to the extent that in some areas the demographic structure has changed with a predominance of children, women and elder people due to the out-migration of the male component (Aguilar and Graizbord, 2014: 816).

In 2010, the country had 188,593 rural communities (that is, with less than 2,500 inhabitants), which accounted for 98% of the total number of cities or communities in the country. 74% of them had less than 100 inhabitants (Ávila, 2014; Tables 1.1 and 1.2), which reflects the huge dispersion of the rural population. Most rural communities are usually far from middle or large-sized urban centers, and they are part of a scarce socio-economic development environment, which means their conditions are not appealing to productive investment. The most isolated communities are far more vulnerable, because they have a higher level of poverty, lower levels of access and a higher dispersion. According to CONAPO (2012: 50; Table 1.3), 92% of the most isolated rural communities have a high or very high level of marginalization.

Álvarez and Herrera (2014: 298-303) affirm that there is a direct relationship between the loss of vegetal cover and the distribution pattern of rural settlements, and that disorganized dispersed communities, with a weak social fabric, are more prone to mismanaging natural resources in fragile ecosystems. In fact, the ecological regions with the largest number of small and isolated communities are temperate rainforests, humid rainforests and dry forests.[5]

The conversion of land for agricultural and animal husbandry uses is one of the main causes of deforestation. Land use change figures in the country show that the area of land for agricultural use has continued to grow, and that growth has accelerated in recent years. A little more than 179,000 hectares were converted annually (on average) between 1976 and 1993. This figure rose to 272,000 hectares between 2002 and 2007, and then dropped to 100,000 hectares between 2007 and 2011. In these last two periods, most of the natural vegetation transformed into agricultural land corresponded to sub-humid rainforests (31%), xerophilous bushes (23%) and temperate rainforests (15%) (SEMARNAT, 2013: 80). In contrast, the areas dedicated to cattle-raising and cultivated or induced grasslands have been steadily declining (see Figure 1.8). Thus, demographic dispersion resulting from the existence of a large number of very small communities becomes an environmental imbalance factor.

Figure 1.8



SOURCE: SEMARNAT, EL MEDIO AMBIENTE EN MÉXICO, 2013-2014.

5 In their analysis, Álvarez and Herrera (2014: 310) state that "a single family under the slash-and-burn system can dismantle up to 20 hectares in a single three-year cycle".

3. Public Policy Responses to the Territorial Demographic Dynamics and Sustainable Development

3.1. General Policy Considerations

The 1992 Rio Declaration on Environment and Development stated that "human beings are at the center of concerns for sustainable development". This principle has remained valid throughout the years, and, in 2011, it was reaffirmed in the Laxenburg Declaration, which stated that "Any analysis of sustainable development must recognize the differences among people in terms of their impacts on the environment and their vulnerabilities to risk, which depend on their age, gender, location, and other socioeconomic characteristics. New evidence indicates that human capital, enhanced through education and health, can make a substantial difference in people's contributions to sustainable development and their capacity to adapt to environmental change". (UNFPA, 2012: Annex A; Chapter 2). In other words, promoting wellbeing and an increase in the standard of living are not only objectives of the development policy, but also important means to address the population dynamics and promote sustainable development.

It is important to establish that the path toward sustainability does not rely on policies that focus on the population *in itself,* but rather on policies that focus on a *series of elements* that contribute to the population's wellbeing. In the case of the latter, we refer to those that focus on aspects related to land use, consumption or productive processes that have the potential to induce environmental changes in the different places where the population lives (influencing migration patterns), in production or in the application of new technologies, among many other things. For example, environmental deterioration due to the distribution and redistribution of the population can be mitigated through restrictions on local land use with zoning regulations, the designation of preservation areas, or technological regulations and laws in urban-industrial areas.

One essential element is that all sectoral policies must integrate the population dynamics into their actions. This type of active planning must include a systematic use of information on the demographic dynamics and its projections in the mid and long-term on the national, state and micro-regional levels. The current dynamics and potential demographic change scenarios must be taken into account in rural, urban and national development strategies, as well as in sectoral plans for the development of infrastructure and services (UNFPA, 2012: 12).

Policies in the areas of environment and population dynamics require a comprehensive approach that recognizes the important interactions *between population, environment and mediating factors*. In the case of climate change, for example, a reduction in population size can create positive cost-benefit effects in the long run. However, the demographic dynamics should not be the only important consideration; the same applies to changes in consumption patterns, alternative energy sources and the economic development models that play a crucial role in greenhouse gas emissions (Hunter, 2000: 69).

It is important to reflect on the most appropriate territorial model for the development we aspire to achieve. The large cities model does not seem to be the most appropriate (although

the debate is intense: Glaeser, 2012; Moretti, 2012; Storper, 2013).[6] Instead, we need a more balanced and cohesive model that consists of a dispersed and decentralized, but highly interconnected, system of settlements that favors *cooperative competition* (Garrocho, 2013). It isnecessary to promote socio-territorial processes complementary and alternative to urban concentration, and evolve into territorial convergence (Aguilar, 2013a: 197). We must also prevent the territorial exclusion process from continuing and accelerating the weakening of many local territories, in addition to overcoming the challenge of integrating local territories into the internationalization and/or competitiveness circuits.

3.2. Specific Policies

The implications of environmental pressure that derive from the population size suggest how important it is for sustainability to slow down the pace of demographic growth. Careful land use planning must be coupled with a series of reorientations in the distribution of the population, in particular taking action in connection with *migratory flows* headed in the direction of environmentally fragile areas, as well as in connection with the increase in densities in the most populated areas. It is also important to have strategies in place to reduce the expulsion factors that affect migrants in their places of origin, which are linked to the lack of employment opportunities, infrastructure and efficient equipment.

Rural areas require a revitalization process that motivates the local population to settle down. We must have policies in place to encourage a sustainable use of natural resources, especially in areas with scarce agricultural land. The application of technological innovations, or the intensive use of technologies currently used, is an essential requirement in a stage of higher demographic pressure. The quest for increased productivity with a better management of natural resources will be of great support to ensure food production in the mid and long-term.

It is imperative to design policies that tend to mitigate *situations of poverty* and build human capacities. One of the priorities must be a shift toward inclusive economic development that generates productive employment, increases household income, reduces poverty and strengthens social cohesion (UNFPA, 2012: 10). It is necessary to make sure that growth-oriented policies guarantee social transfers to the most vulnerable groups, both in rural and urban areas, and increase access to healthcare services, including reproductive health, as well as access to education levels above primary and secondary education.

Actions are required to strengthen human capital in those areas with higher levels of backwardness, with policies that promote investments in reproductive health (for example, to reduce adolescent fertility), in addition to providing training for young people with the aim of increasing their permanence in the education system and delaying marriage and the age of onset for reproduction (UNFPA, UNISDR and UN-HABITAT, 2012: 35). These measures will lay the foundations to materialize the potential benefits of the *demographic dividend* that contribute to higher economic growth.

It is necessary to recognize the *structural and, to a large extent, irreversible nature* of the urbanization process, which requires a different attitude in order to recognize the advantages

6 Still, a large city will always fare better than a small city. However, the central issue is not the dimension of the city (the pace of growth would also be important), but the quality of its management. In Mexico, unfortunately, quality in the management of cities has not been the rule.

it can offer and implement policies that can maximize its economic advantages, the application of new technologies and the environmental benefits of concentration. In this regard, we must address the *urbanization of poverty* and lead future growth by taking care of the poor settlements that require access to decent housing, lack income and basic infrastructure, and are highly vulnerable to disasters.

The *rapid expansion of the area occupied by cities* demands creative responses on the part of those actors that deal with urban planning and real-estate development. These solutions must consider metropolitan areas as a whole, as well as the city-region phenomenon. It is necessary to promote negotiation and cooperation between adjacent state and municipal governments in order to meet basic needs, especially those of the most disadvantaged populations. All of this must be done from the perspective of a sustainable use of the territory, so that the growth expected can fit, to the extent possible, into the space in an efficient and fair manner.

As far as the urbanization process is concerned, the priority has not been the care and preservation of the environment. A very obvious example is that of *urban infrastructure related to municipal waste* (for example, solid waste and wastewater), which has serious deficiencies in the different communities that exist in municipalities, regardless of their size. It is urgent to overcome those deficits in order to find a balance between urban development and environmental protection, and take action based on the principles of sustainable development.

As regards the perspective of cities or towns with different ranges or sizes, it is important to identify those *urban-rural subsystems* that favor the linkage between settlements of different sizes and can also define those cities with the best capacities for development, in particular from the standpoint of the presence of natural resources such as water and land for urban development, so that they can become alternative destinations outside of the most populated areas. This strategy will trigger regional and micro-regional development.

Strategies to mitigate the population's vulnerability to disasters associated with natural phenomena must contribute to encourage the preservation of the environment and the sustainable use of natural resources in all population centers to reduce their vulnerability to disaster and risk situations (Aguilar, 2014: 217). There are several areas in the country that are exposed to a series of natural phenomena that cause disasters and significant losses, both in terms of human and economic lives: highly seismic areas and areas exposed to cyclones and prone to floods, where the relationship between population and environment is clearly expressed.

The current physical expansion of cities is excessive compared to the pace of growth of their populations, and it does not contribute to sustainable urban development. It is urgent to adopt a stance in connection with the future form of urban growth in our cities, and consider the application of the principles for the design of compact cities in new urban developments (guaranteeing vertical transportation for a rapidly aging population).

Peri-urban belts must be part of a comprehensive policy that considers the periphery as an essential part of the city, and not as a separate unit. Providing these belts with services and sufficient jobs will contribute to reducing *intra-metropolitan inequalities*. Current peripheral developments require a truly regional land-use planning policy that guarantees the strict application of urban laws and regulations on land use and controls the land market so land use can be more efficient.