AMBIVALENCES AND ASYMMETRIES IN THE URBANIZATION PROCESS IN THE GULF OF MEXICO: ENVIRONMENTAL PRESSURES AND POPULATION CONCENTRATION

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FRAMEWORK: A DEFINITION OF THIS SPACE

Three different countries surround this great marine water body; human activities both inland and in coastal zones and marine areas have modified, and will continue to modify this space's biochemical, ecosystemic and, of course, socio-economic conditions. Such activities can be formally identified as the Gulf of Mexico's economic and social space. From a historical perspective, they have had certain common traits and have perhaps been evolving at different intensities, but at least in a parallel fashion. The pace of changes has left marks shaping the landscape that can be "read," yet unfortunately, in most instances these comprise an expansion and sequence of deleterious transformations.

The boundaries of the Gulf of Mexico and, therefore, of what is considered to be its coastal zone, were defined *a priori*. Actually, they are of an operational nature so as to be able to deal simultaneously with three dimensions: the terrestrial landscape analyzed as ecoregions; socio-demographic dynamics studied on the basis of municipalities (or counties); and urban cores or cities, which enable us to easily visualize population concentration. Thus, the coastal zone was delimited as a mostly terrestrial strip having municipal boundaries (and therefore jurisdictional ones) and landscape features.

As a result, this is not necessarily a region in the economic or geographic sense but rather, most likely, it is composed of asymmetrical, disconnected, and perhaps complementary territorial and political units which at most depend upon one another to a certain degree. This issue remains to be seen in view of the scope of this chapter. Nevertheless, the implications of the connectivity between these units are not to be overlooked. For operational reasons and in an attempt to gain greater insight into complex systems, we would have to set a limit allowing us to take into account contour conditions (in the sense proposed by García 1986, 2000), by means of which this vast zone interacts with areas outside it. For this reason, as well as for reasons of scale, there would be an inland limit to the coastal zone, and another offshore, with an imaginary centroid located in the center of the Gulf of Mexico, surrounded by these three countries, outside of which there are innumerable phenomena with which they interact and which connect them and make them dependent upon one another (e.g., currents, climate, shared natural resources, economic flows, migration).

Beyond this framework, in oceanographic and climatological terms, there is the influence and influx of Caribbean currents and their outflux via the Straits of Florida; the entry of hurricanes, as well as larvae of microorganisms, fish, reptiles, mammals, etc. Outside we would also find, for example, economic activities such as trade, maritime oil transport, the flow of people and commodities going through the Panama Canal towards the Pacific or tourist connections, including the flow of cruise ships to the Caribbean. This system is connected to the outside world in many different ways, be it through oil exports to Europe or Asia or the passage of migratory birds. Outside it, but taken into account, would be inland connections facilitated by rivers. The Gulf of Mexico receives water from three major international river basins: that of the Mississippi River, that of the Rio Grande (Río Bravo), and that of the Grijalva-Usumacinta (and,

to a lesser degree, that of the Río Hondo), all shared by two or more countries. In addition, in its geographic space, different human activities are conducted. To a greater or lesser extent, these influence the quantity and quality of the Gulf's waters and, therefore, the manner in which they reach it. This is also true of all the other minor river basins that also flow towards the Gulf. Hence, the conditions of delta zones or those in contact with the coast (generally coastal lagoons and estuaries) are a direct consequence of activities that have been carried out inland in the course of history.

The Gulf of Mexico could be modeled as a series of elements overlapping across borders. Such elements can be seen, on different scales, as a set of subregions comprised of: a) marine and atmospheric phenomena which, within the Gulf itself, determine currents, the presence of upwelling, and areas of cyclonic or anticyclonic circulation; b) terrestrial phenomena that influence and are manifested on the littoral, which could also be called the "coast," a transition zone between the sea and the land (coastal lagoons-beaches-deltas-river mouths-reefs); and, naturally, c) human activities occurring in each of these territories, human settlements, primary productive activities (agriculture-livestock, fishing), secondary activities (industrial) or tertiary activities (trade, services, finance).

This economic landscape is composed of and also crisscrossed by a series of processes or dimensions, e.g., maritime transport and its intensity or specialization: traffic, ports, oil extraction, etc. On the other hand, there are political-administrative territorial limits, for example, each country's Exclusive Economic Zone, the terrestrial boundaries between them, and their states or provinces (in the case of Cuba), municipalities or counties (in the case of the United States), all of which break up the territory. Then we have shared resources such as rivers and groundwater along borders or fish stocks in the sea. Yet at the same time, and perhaps more important than all of the above, there is another type of connection such as flows of pollutants, commercial commodities, and imports and exports of goods and services (food, tobacco, oil, etc.). And it is precisely within this complex that it is essential to examine human population dynamics.

The coasts of the Gulf of Mexico and the Caribbean constitute an extremely important natural space where urbanization has only occurred relatively recently. While the emergence of urban localities dates back to the colonial period, their demographic growth and proliferation throughout the territory did not take place until the mid-twentieth century. The reasons for this relative delay in the establishment of the region's urban spaces are varied, and it is fundamental to analyze them in order to gain an understanding of some of its current environmental problems.

Throughout the entire colonial period, the coasts were considered unhealthy, dangerous places. European culture was not ready to deal with the challenges posed by the humid tropics, and so colonization was carried out preferentially in temperate zones. But the need for ports providing connections with the metropolis obliged colonial authorities to establish human settlements on the coasts. Populating them entailed a challenge not easily met, for mortality rates were so high that few people dared to live there. Only through coercion was it possible to ensure the establishment of human groups that would attend to basic activities in ports, hence the importance of slavery and of the African population in this region. To cite just one example, the history of the city of Veracruz shows that its population had to confront huge complications in order to make its urban space habitable. The introduction of water and drainage obsessed municipal officials for many years, but it was not possible to meet those needs until the latter part of the colonial period and, even then, only partially. For the people living in that era, investing in what we now call urban utilities and infrastructure posed quite a dilemma; due to the insecurity

prevalent in the region in the form of piracy, it was more advisable to leave that zone uninhabited (Rodríguez 2002).

Once independence had been gained, throughout the 19th century political instability kept the region from prospering in economic terms, and this also put off the introduction of improvements needed for populating it. It was only in the last third of the 1800s, during the administration of Porfirio Díaz, that the coasts benefited from significant investment in infrastructure (Connolly 1997). From then on, a demographic surge was possible. Sanitation of the coastal zone helped eradicate the fear of yellow fever,the principal cause of mortality, and enabled the influx of migrants to rise, providing the region with the labor it needed to conduct its economic activities.

As of that period, when the region was incorporated into the world market, the Gulf of Mexico and the Caribbean underwent four basic economic processes modeling urbanization and associated with a set of specific processes or products: ports, plantations, oil, and tourism. In historical terms we could say that each of these processes was accompanied by different stages of settlement and styles of urbanization. Thus, for instance, the development of oil extraction and processing led to different waves of urbanization, so that it is possible to speak of oil city cohorts or generations, which flourished by pursuing the most profitable oil fields, as well as the economic cycle of industrialization and exportation of crude oil and its by-products.

BACKGROUND FOR DEFINING URBANIZATION IN THE GULF REGION

Without purporting to offer a formal historical description, we could state that the Caribbean Region was originally organized around colonial trade, slavery, and sugar cane plantations, and then cotton and tobacco plantations. Subsequently, it was based on different agricultural and cattle-raising activities (up until the Green Revolution). In the course of the 19th century, there arose what we could term the first modern generation of cities, superimposed on colonial ones, but now associated with a market that operated not only trans-nationally, but also regionally. In this same period, oil exploitation began, concentrated on the coasts of Texas and Louisiana in the United States, as well as on the coasts of the states of Veracruz, Tabasco, and Campeche in Mexico.

As part of this technological and geographic expansion towards the ocean's depths, on the coast itself industrial and port development (mainly in the U.S.) led to a different urban growth pattern, a new generation of cities or a re-adaptation and transformation of old ones. Commerce expanded and at the same time became more concentrated, with an intensification of trade routes and transport of commodities and oil. Meanwhile, fishing resources were virtually eliminated from the entire ocean surface and depths by the fleets of these three countries and by ships flying the flags of other nations.

In the early 21st century, the Gulf of Mexico's natural resources had reached a critical stage. On the one hand, because of the need for water to conduct productive activities and, on the other, in view of the growing demand posed by cities, this apparently abundant resource became scarce, and it suffered unrestrained deterioration as a result of an increase in the demand and a decrease in its availability and quality. That was the case of the Rio Grande, which for all practical purposes ceased to discharge its waters into the Gulf. Pollution of water bodies, produced by agricultural-livestock, industrial, agro-industrial, and extractive activities and also by maritime transport (especially of hydrocarbons), has had serious consequences for the Gulf. Hydrocarbon charge and discharge in coastal zones is one of the activities that produce the

greatest negative externalities (Vergara 1981). Similarly, agricultural-livestock expansion also had significant impacts: in some areas, it has left just small, highly fragmented natural patches in the landscape (e.g., ravines, mountains, coastal lagoons, dunes or mangrove swamps), and vast expanses of altered land lacking its original plant cover. This is true of Chontalpa program in the State of Tabasco and of cattle-raising expansion in southern Mexico (see Restrepo 1988; Toledo *et al.,* 1989; Tudela 1992; Damascos *et al.* 1995). For example, Toledo (1996) estimated that

> "…wetlands in North America are disappearing at a rate of 200,000 ha a year…. Agriculture has been responsible for 87% of the loss of these wetlands; urban development has caused 8% of the losses…. And barrier islands have not been immune to these impacts…. The greatest impact has been caused by dredging operations… [and] stabilization structures…. Both coastal wetlands and barrier islands are subject to erosion… with rates estimated for the coastal plains at 20 m/year; and 100 km^2 for wetlands."

At present, to the "old" causes of high levels of deterioration we would have to add new socio-economic forces linked to urbanization phenomena (e.g., increased population, poverty, demands for energy and resources), as well as technological expansion. In this chapter, we aim to explore the socio-demographic dynamics of this region and their spatial expression, as a way of discussing these trends and considering the related environmental implications. To this end, we have adopted an arbitrary definition of coastal zones in which, for the purposes of our analysis, territorial units are comprised of municipalities (or counties) and ecoregions (CEC 1997) or landscapes located within a 130-km-wide belt (see del Toro-Madrueño 2002 and León *et al.* 2003). This definition allows for an international comparison along these coastlines (as well as between both oceans), and was used as a criterion for standardizing and facilitating analysis at the continental level. Since landscape units are superimposed and overlap with municipal boundaries, the width of the above-mentioned belt varies so that it contains complete municipal units (del Toro-Madrueño 2002; León *et al.* 2003).

First we will conduct a macro-analysis of population dynamics by country and by ecoregions, simultaneously assessing the fragmentation of these landscape units and asymmetries associated with the economy. Then we will present data on the Mexican portion of the Gulf confirming urbanization trends and their implications for pressures exerted on natural resources.

AN ASYMMETRICAL REGION

The analytical approach suggesting that major marine problems and especially coastal ones originate in land-based activities was put forth formally in 1995 within the context of the United Nations (UNEP 1995). Among the meeting's (known as GPA) many contributions, it explicitly acknowledged that, although it is quite obvious that the majority of problems involving oceans and coasts arise on terra firma, this fact had not yet been recognized as of major importance.

In some areas of the Gulf of Mexico, that statement is especially applicable. For instance, the State of Veracruz has the shape of a huge amphitheater facing the Gulf. The ocean, lagoons, river meanders, swamps, and low plains crossed by four river basins and forty rivers responsible for 26% of the nation's total runoff, are contrasted by mountane landscapes which, thanks to their vegetation and cool temperatures, capture the moisture collected over the sea by monsoonal

winds in the summer and by *nortes* [strong northerly winds] in the winter. Boege and Rodríguez (1992) acknowledged that

> "…the amphitheater shape and the amount of runoff lead us to conclude that everything the hand of humans transforms in the highlands has inevitable repercussions on coastal lagoons and the ocean, places that are the deposits of soils carried by erosion and resulting from the destruction of forestlands. One of the most important effects of this devastating scheme is not only the depletion of genetic banks that are essential for the future of Mexico and of all humankind, but also the economic loss of immense natural forest riches. To this process we would have to add soil loss, which proceeds inexorably: siltation in large dams, river basins, and coastal lagoons, and also the loss of rich fish stocks in the Gulf are all mute witnesses to the price we pay for the dominant style of development, which closes the door to future possibilities."

Nutrient inputs to the ocean (among them, nitrogen and phosphorus) derived from human activities are intimately related to high population concentrations, but also to the intensity of their economic activities or their economic capacity. We can observe that, at least for North America, and particularly the Gulf of Mexico, the U.S. coast stands out among all the countries of the world in terms of its level of discharges. The estimated load is much higher than those of Cuba and Mexico, and this is also evident if we look at another indicator, namely the intense bright light emanating from urban centers at night, strongly concentrated on U.S. coasts, which has the virtual appearance of a continuous coastal urban corridor, whereas Cuba and southern Mexico, while also visible, are comparatively much less so (Fig. 37.1).

In the Gulf of Mexico we find marked socio-economic asymmetries expressed in the capacity to transform, disturb, and even conserve nature. If this were not enough to show that regardless of the length of each country's coastlines, the dissimilarities between one and the other are considerable, we would have to mention features involving income or the economy in general. Thus, in 1990, the GDP of the United States was 17 times that of Mexico: 5.9 trillion dollars in the U.S. as compared to 329 billion for Mexico or 20 billion for Cuba (UN 1997) (Fig. 37.2).

In North America, the population is not distributed homogeneously. While in the United States it is concentrated in coastal cities, in Mexico the largest cities are located on the Altiplano (Fig. 37.3); a much higher level of economic activity is associated with such cities than with Mexican coastal cities. One way of gaining an overview of this is to compare the movement of port freight in the Gulf of Mexico. Freight traffic at U.S. ports is several orders of magnitude greater than that of Mexico (Fig 37.4).

In order to estimate the relative weight of landscape diversity vis-à-vis pressure exerted by human populations and their activities, we can divide of the coastal zone using ecoregions (Fig. 37.5) to construct a belt with municipalities (or counties) and, at the same time, ascertain the type of landscape or ecoregion they contain. Since only the United States has a legal and geographic definition of the coastal zone (which includes river basin units) that is useful at this scale, we used it as a reference for delimiting a coastal belt (see León *et al.* 2003) (Figs. 37.6 and 37.7).

Despite the controversy over whether it belongs to the Caribbean Region, the Gulf of Mexico has been considered as a section or subsystem of the "Wider Caribbean" (Hernández-Santana et al. 1999). As we have pointed out, it is composed of three countries (the United States of America, Mexico, and Cuba) and on its borders we find fourteen different states or provinces

Fig. 37.1. The Gulf of Mexico at night. Image from NOAA National Geophysical Data Center.

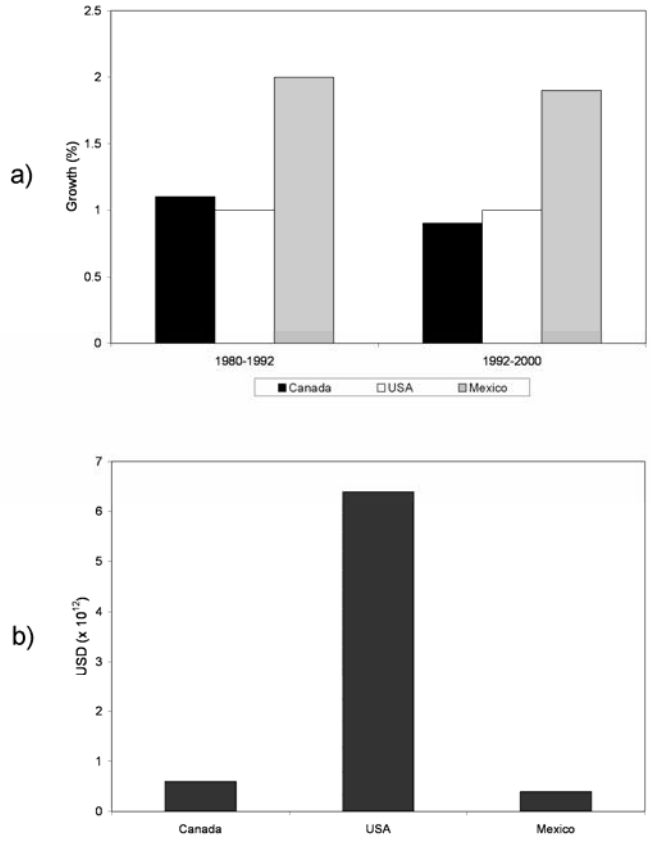

Fig. 37.2. Socio-demographic and economic asymmetries: a) annual population growth rate (%); b) 1992 gross domestic product (billions of USD).

Fig. 37.3. Population concentration in North America (from U.S. Department of Transportation *et al.* 2000).

(Fig. 37.8). However, in view of the definition given previously, only certain municipalities or counties can be considered as coastal at this scale. We are referring to those adjacent to the coast and other neighboring inland ones included in the coastal belt we have defined. And their inclusion can be significant, e.g., due to interconnection processes and phenomena arising thanks to the presence of river basins or rather, to demographic reasons and, of course, the ecoregion itself (Fig. 37.9).

For the year 2000, total population for the Gulf of Mexico Region was approximately 38,692,000. Fifteen major terrestrial ecoregions are present; each is subject to different processes of change, alteration, or disturbance as a result of human activities. Moreover, these landscapes are fragmented not only by the countries' geopolitical boundaries (in the case of the Mexico-U.S. border), but especially because of limits of provinces or states and municipalities (Table 37.1).

Some ecoregions are shared by more than one state and, at the same time, by a countless number of municipalities, such as in the case of the Humid Gulf of Mexico Coastal Plains and Hills, which spans three states (Veracruz, Tabasco, and Campeche) and, as a whole, is divided into more than 130 municipalities (Table 37.1). Over six million people inhabit this ecoregion, with high population densities of more than 70/km^2. From a conservation standpoint, efforts to

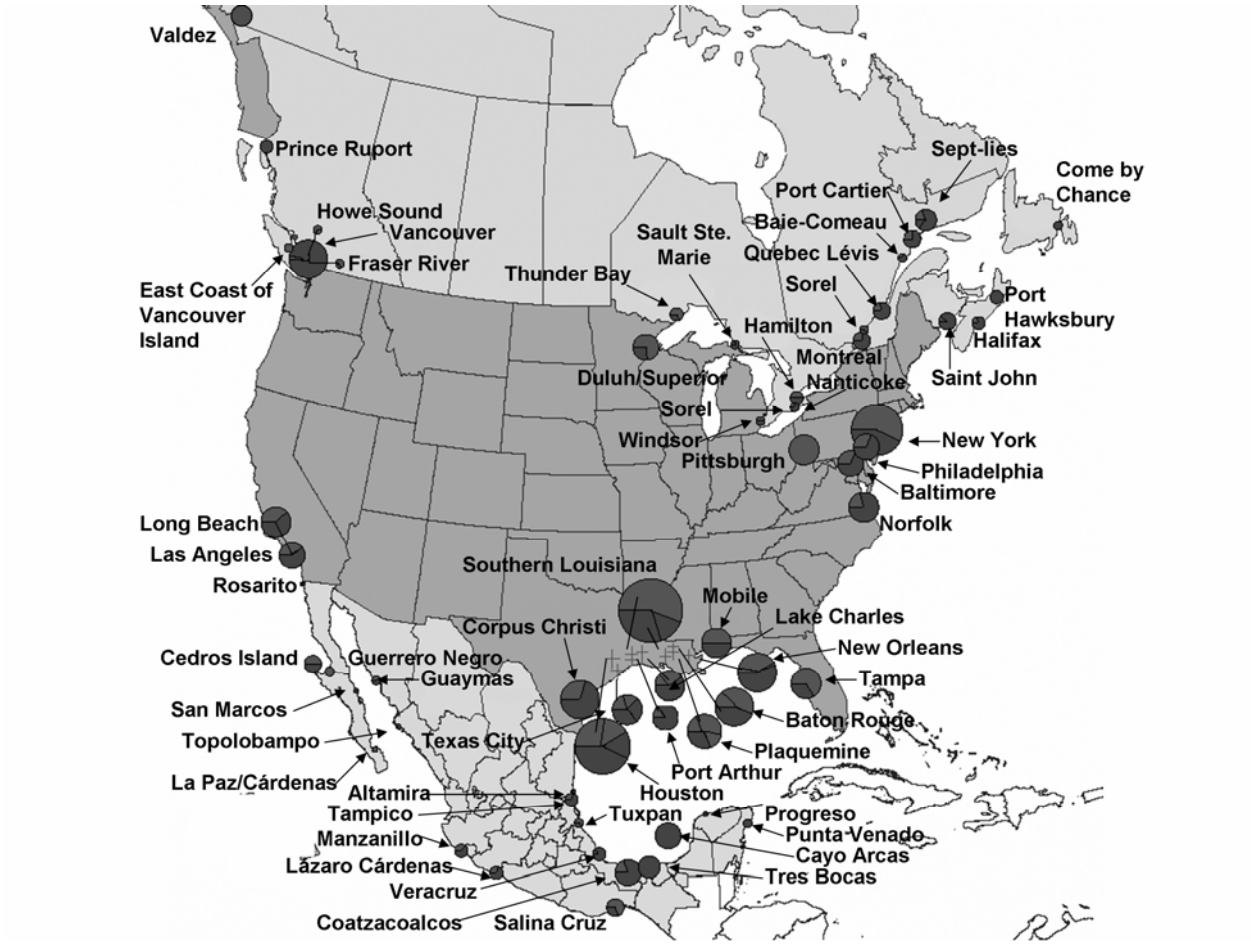

Fig. 37.4. Port freight traffic in North America (from U.S. Department of Transportation *et al.* 2000).

maintain and preserve these ecosystems would entail a coordination of actions and policies among the three states and in all the municipalities included in them.

The Gulf of Mexico coastal zone is not completely homogeneous with regard to its ecoregions. These units exhibit certain degrees of richness or diversity, even at this geographic scale (i.e., semi-continental), but we should make special mention of nodal areas and their tributary areas. That is to say, although in this chapter we are not studying specific localities or human settlements, it is possible for us to visualize that there would be a series of points with high population concentrations (the cities or municipalities containing such high concentrations) and inter-nodal areas that may be described as tributaries of those points, viewed on a formal plane as rural spaces.

For example, in the Transversal Neo-Volcanic System (Ecoregion 13.4), where Xalapa, the capital of the State of Veracruz is located, there are more than 1,000,000 people and a population density of 226/km^2. These high densities clearly evidence the pattern of major concentrations and rural spaces with a relatively low population density in intermediate spaces. This is also applicable to the United States: the Everglades (Ecoregion 15.4) has a population of over 2.5 million with a density of more than 176/km^2.

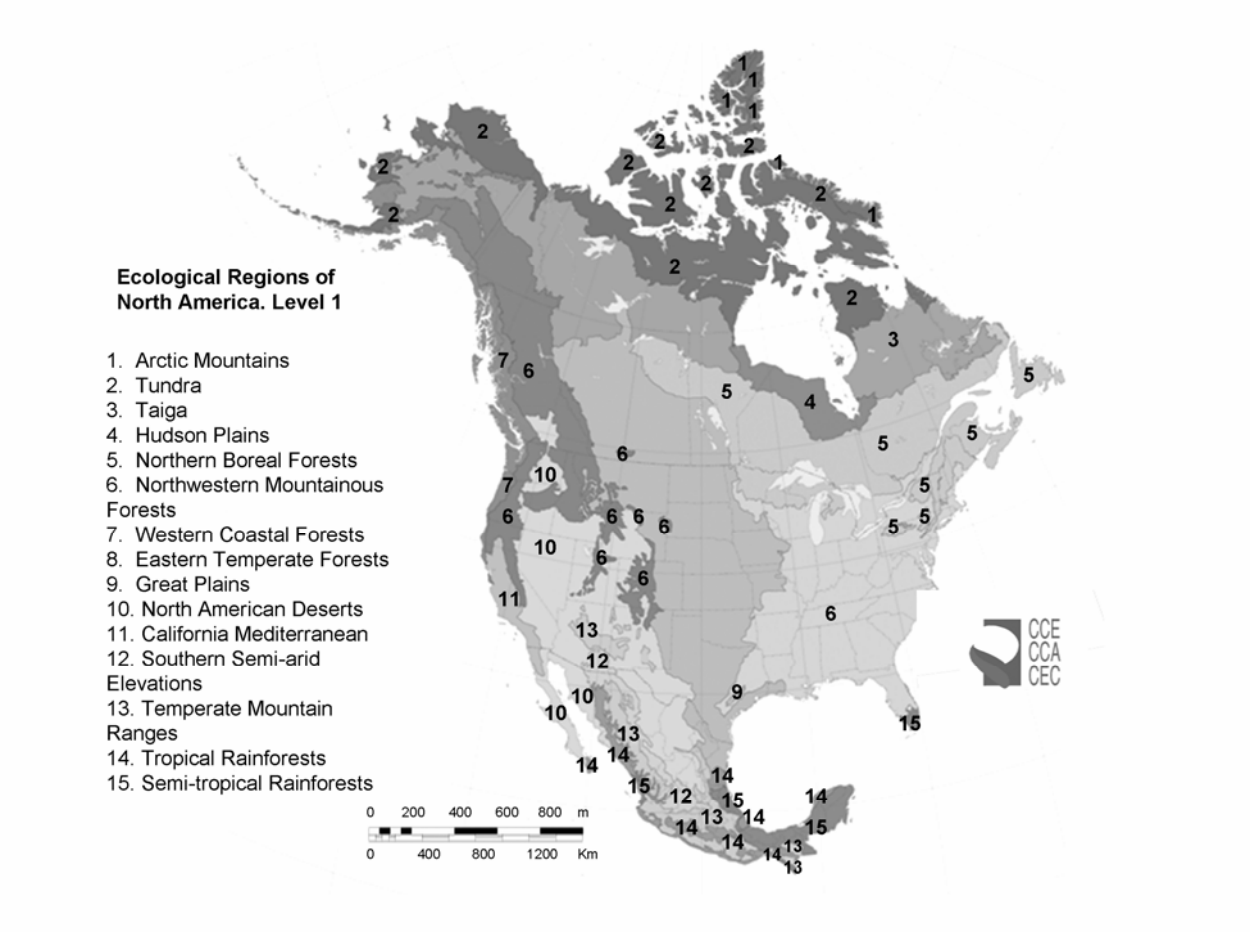

Fig. 37.5. Ecoregions in North America (from CEC 1997).

At the same time, other ecoregions exhibit low densities, such as the Tamaulipas-Texas Semi-Arid Plain (Ecoregion 9.6). All in all, the average population density of the coast ranges from 57-61 people/km^2. There are extreme variations ranging from 5 up to 3,000 people/km^2 (the latter, in the case of Havana City; see Table 37.1). In addition, ecoregions like the Southeastern Alluvial Plains of the Mississippi River and Coastal Plains (Ecoregion 8.5) and the Texas-Louisiana Coastal Plain (Ecoregion 9.5) have the greatest populations, with over 7 million people each (Fig. 37.10).

The United States of America has over 50% of the total population living in the Gulf of Mexico coastal zone and also a similar proportion of the land area. Nevertheless, overlooking the fact that it shares two ecoregions with the U.S., Mexico has almost twice the diversity in terms of ecoregions, i.e., in a smaller area, it has a greater number of landscapes and, therefore, higher diversity of ecosystems and, undoubtedly, species (Table 37.2). Thus, we observe two dimensions of this asymmetry: the magnitude of the population and the land area. Clearly, the U.S. coast has a greater influence in this region. And on the Mexican side (Fig. 37.11) we find a wider variety of landscapes, leading to greater biodiversity.

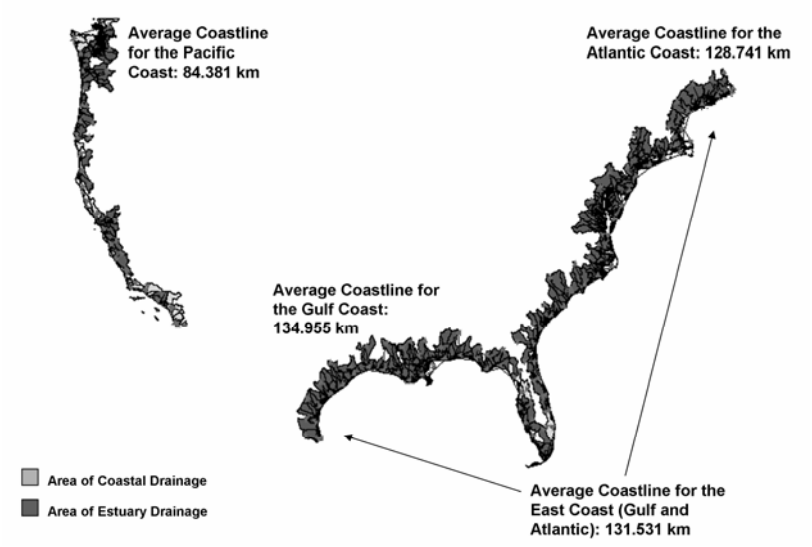

Fig. 37.6. Average widths of the U.S. coastline. Distances were measured every 100 kilometers. Starting at the U.S. southern border with Mexico and ending at its northern border with Canada, at every point measurements were taken of the distance of the coastline up to the farthest limit of the belt comprised by the polygons of the Coastal Drainage Area and Estuarine Drainage Area perpendicular to the coast.

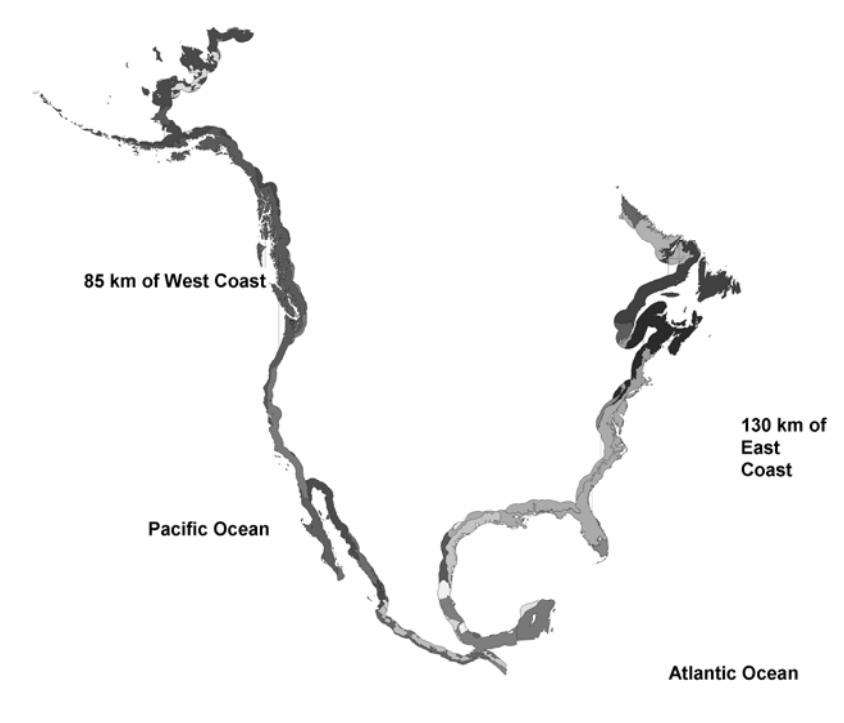

Fig. 37.7. Width of coastal ecoregions in North America.

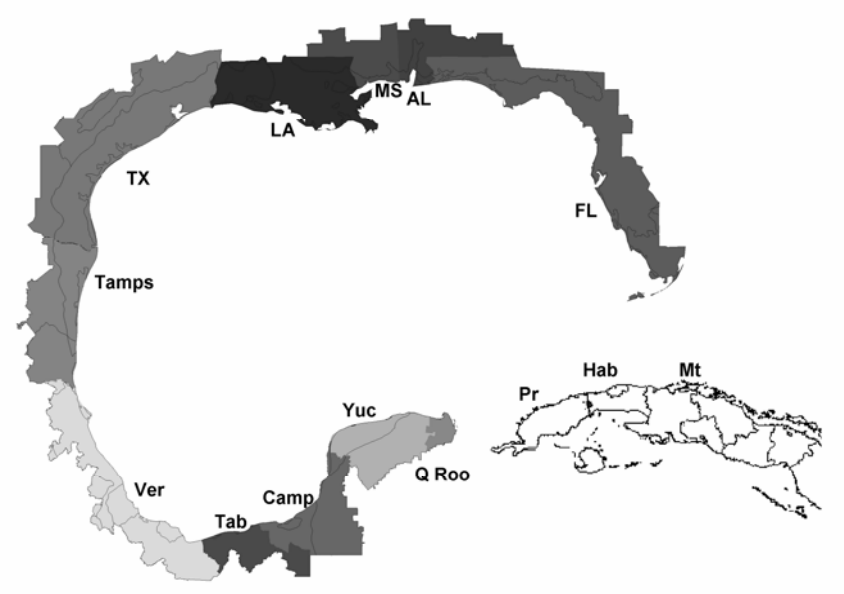

Fig. 37.8. Ecoregions and states on the Gulf of Mexico.

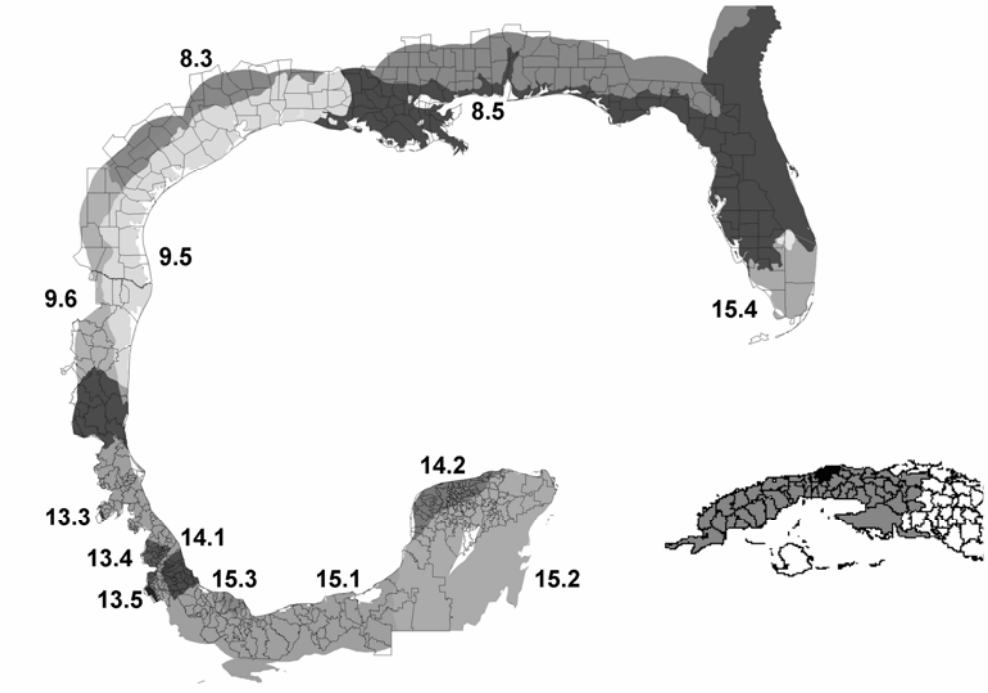

Fig. 37.9. Ecoregions, municipalities, and counties on the Gulf of Mexico. The numbers refer to the CEC ecoregions listed in Table 37.1.

Table 37.1. Gulf of Mexico coastal population by ecoregion in 2000.

Ecoregion	State	Population	Municipalities	Area (km^2)	Population Density (#/km^2)
13.3 Sierra Madre Oriental	Veracruz	31,049	2	677	45.86
13.4 Trans-versal Neovolcanic System	Veracruz	1,036,669	37	4,578	226.45
13.5 Southern Sierra Madre	Veracruz	285,267	19	1,337	213.36
14.1 Dry Gulf of Mexico Coastal Plains and Hills	Tamaulipas	841,021	10	17,629	47.71
	Veracruz	1,058,619	25	6,736	157.16
14.2 Northwestern Plain of the Yucatán Peninsula	Campeche	80,188	3	4,679	17.14
	Yucatán	1,189,740	58	15,078	78.91
15.1 Humid Gulf of Mexico Coastal Plains and Hills	Veracruz	4,121,484	118	54,977	74.97
	Tabasco	1,891,829	17	24,828	76.20
	Campeche	180,477	2	14,331	12.59
15.2 Plain and Hills of the Yucatán Peninsula	Yucatán	468,470	48	24,664	18.99
	Quintana Roo	451,539	3	6,400	70.55
15.3 Sierra Los Tuxtlas	Veracruz	317,080	6	3,758	84.37
	Campeche	338,014	3	25,649	13.18
15.4 Everglades	Florida	2,584,328	3	14,613	176.85
8.3 U.S. Southeastern Plains	Texas	769,752	20	45,841	16.79
	Louisiana	382,778	6	10,222	37.45
	Alabama	908,001	12	30,276	29.99
	Mississippi	743,416	17	25,540	29.11
	Florida	976,522	14	27,733	35.21
8.5 Southeastern Alluvial Plains and Coastal Plains of the Mississippi River	Louisiana	2,340,156	21	38,204	61.25
	Florida	5,237,909	31	64,722	80.93
9.5 Coastal Plains of Texas-Louisiana	Tamaulipas	1,083,049	6	23,975	45.17
	Texas	6,350,037	25	65,093	97.55
	Louisiana	568,227	8	17,959	31.64
9.6 Semi-arid Plains of Texas-Tamaulipas	Tamaulipas	89,723	10	16,257	5.52
	Texas	72,849	4	13,757	5.30

Table 37.1. Continued.

Ecoregion	State	Population	Municipalities	Area (km^2)	Population Density (#/km^2)
Subtotal		34,398,193	528	599,513	57.38
Cuba – Sierra de Guaniguanico[1]	Pinar del Río	737,342	14	10,924	67.50
	La Habana	707,764	19	5,731	123.50
	Havana (metro area)	2,186,632	15	727	3,006.10
Cuba-Cíenaga de Zapata	Matanzas	661,901	14	11,969	55.30
Total		38,691,832	590	628,864	61.53

[1] Proposed ecoregions from Atlas Nacional de Cuba (1970).

Table 37.2. Coastal population of the Gulf of Mexico (2000).

Country	States	Municipalities, Provinces and/or Counties	Population	% Population	Area (km^2)	% Area	Ecoregions[1]	% Ecoregions
U.S.	5	162	20,933,975	54.10	328,420	52.22	5	33.33
Mexico	6	357	13,464,218	34.80	245,553	39.05	10	66.67
Cuba	3	62	4,293,639	11.10	54.891	8.73	2	13.33
Total			38,691,832	100.00	628,864	100.00	15	100.00

[1]Two ecoregions found in both Mexico and the U.S. are counted twice.

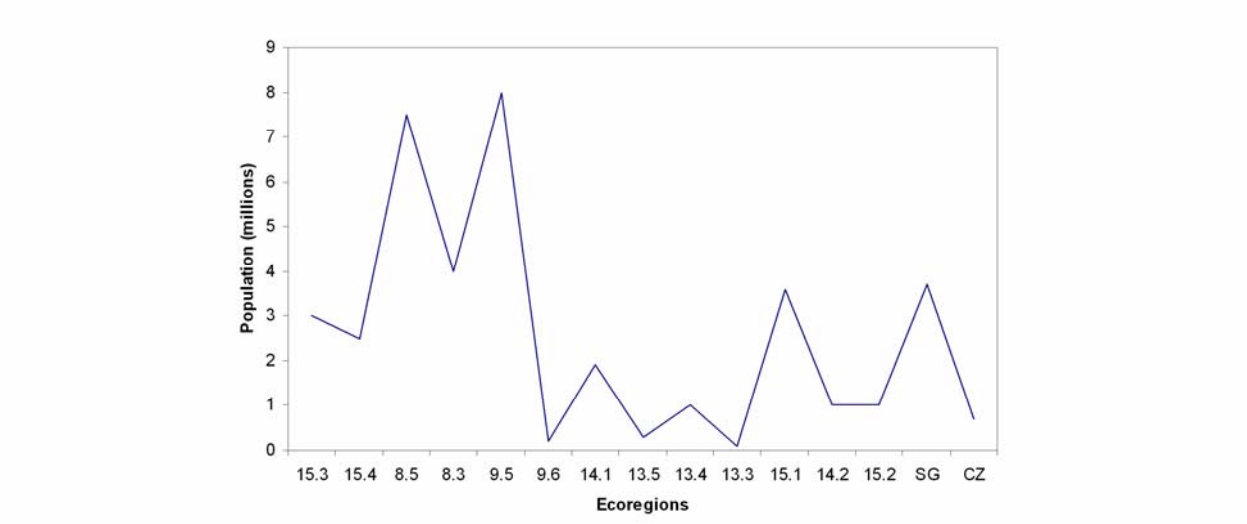

Fig. 37.10. Coastal population on the Gulf of Mexico by ecoregion, 2000.

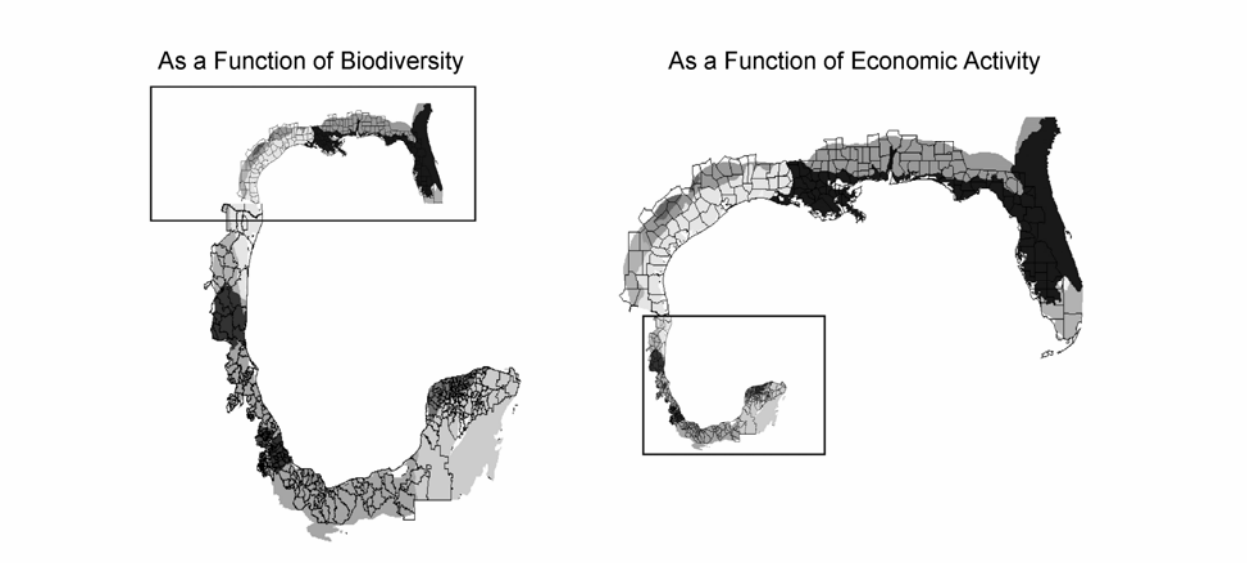

Fig. 37.11. Relative importance of the Gulf of Mexico coastal zone.

As we shall see later on in this chapter, the population residing on Mexican coasts, and particularly on those of the Gulf of Mexico and the Caribbean, has been concentrating in urban localities at an amazing rate. Regardless of whether or not the total population of this region may be considered large (over 38 million in 2000), the population growth rate and, at the same time, its concentration in urban localities constitutes a significant process due to its implications for the environment. Of the ten municipalities and counties with the highest growth rates in this region, four belong to the U.S. and six to Mexico. The municipality in which Cancún is located (Benito Juárez), in the State of Quintana Roo, evidenced the highest growth rate in the entire Gulf Region, doubling its population in just ten years, increasing by over 200,000; in terms of meeting municipal needs or challenges, that entailed a substantial increase as regards the demand for public services (water, housing, etc.) and consumption in general (Table 37.3). A similar situation was experienced in Montgomery County in Texas, whose population rose 30% in the past decade. This indicates that overall, population concentration, migration, and natural population growth in the Gulf of Mexico Region have been occurring at rapid, relatively homogeneous rates. So we would not expect stabilization of the population.

POPULATION GROWTH AND ECONOMIC DEVELOPMENT: THE CASE OF MEXICO

In the following paragraphs, we would like to give a very succinct summary of the way that the urbanization process took place in the Gulf of Mexico Coastal Zone, placing particular emphasis on Veracruz, the Mexican state with the largest area along the coast. We aim to examine certain economic and demographic indicators in order to offer a basis for comprehending the nature of environmental problems caused by urban development in coastal areas, and at the same time to explore future challenges posed by these trends.

Recent urbanization in Mexico, resulting from the interaction between population growth and economic development, is associated with market geography and the distribution of transportation routes and labor (Brambila 1993). In this sense, expansion of urban areas is a consequence of both natural population growth and what is known as social growth: migration. The population moves following communication routes, as well as information and support networks. Population mobility occurs for different reasons, but undoubtedly the most important is employment. A city becomes attractive for migrants as soon as it is possible to find well-paid work there. On the contrary, a city drives population away when sources of employment shut down and workers find it difficult to keep steady, decent paying jobs. Over the course of the last few decades, cities have experienced periods of demographic expansion, stagnation, and contraction which, in turn, are the result of labor market dynamics. The latter are determined by the logic of capital investment and profitability.

Business location factors vary over time: during one period, businesses seek to locate near national consumers; yet during another, they prefer to set up shop near export markets. Once again, in a certain period they attempt to retain proximity to raw materials and energy supplies, while in another, rather than seeking to be close to cheap or skilled labor sources, they propose to attract the migrants they need, even from distant places. According to the sector to which it belongs, a firm follows a specific logic when determining its location: in some cases, it needs to be close to a suppliers' network with which it establishes a linkage; in others, the firm may import its inputs from far away, functioning like an enclave, without linkages to producers in the region where it is located.

Table 37.3. Municipalities and counties on the Gulf of Mexico with the greatest population growth 1970-2000.

Municipality or County	2000 Population	Density (#/km^2)	Ecoregion	Increase 1980-1990	Increase 1990-2000	Growth Rate (%) 1970-1980	Growth Rate (%) 1980-1990	Growth Rate (%) 1990-2000
Benito Juarez (Quintana Roo)	419,815	182.93	15.2	139,575	243,050		16.87	9.04
Montgomery (Texas)	293,768	105.63	8.3	53.714	111,567		3.55	4.89
Collier (Florida)	251,377	45.58	15.4	66,128	99,278		5.87	5.15
Cosoleacaque (Veracruz)	97,437	355.61	15.1	2,955	50,711	7.86	0.66	7.63
Nacajuca (Tabasco)	80,272	152.61	15.1	20,970	29,481	3.18	5.47	4.68
Sumter (Florida)	55,345	35.28	8.5	7,305	21,768		2.67	5.38
Kanasin (Yucatán)	39,191	388.03	14.2	17,392	14,688	1.25	13.17	4.81
Wakulla (Florida)	22,863	13.85	8.5	3,315	8,661		2.69	4.88
Ixtlahuancillo (Veracruz)	11,914	229.12	13.4	2,650	5,361	1.23	5.32	6.16
Tlalnelhuayocan (Veracruz)	11,484	319.00	13.4	2,368	4,521	3.78	4.24	5.13

Each of the cities we have included in our analysis forms part of a region (a subsystem) within the national urban system. In this sense, each is connected by a network of relationships where there is a hierarchy, i.e., an order in which the prime city affects the performance of all the cities forming part of the subsystem. Therefore, we could point out the following subsystems with their respective nodes:

a) Northeastern Subsystem: Monterrey, Tampico, Ciudad Madero, Matamoros, Nuevo Laredo, Ciudad Victoria, Reynosa, Ciudad Valles, Ciudad Mante, Linares, Cadereyta.
b) Gulf Subsystem: Veracruz, Villahermosa, Xalapa, Córdoba, Orizaba, Coatzacoalcos, Minatitlán, Cosoleacaque, Poza Rica, Tuxpan, Cárdenas, Comalcalco, Frontera, Tenosique, Cosamaloapan.
c) Yucatán Peninsula Subsystem: Mérida, Campeche, Cancún, Ciudad del Carmen, Chetumal, Progreso, Champotón, Escárcega, Valladolid, Carrillo Puerto, Ticul.

The fortune of these cities is inextricably linked to the country's economic life. When the national economy grows, cities expand. However, the model of economic growth can stimulate the development of certain regions, while contributing towards limited development of others. Each urban subsystem's dynamics depend on the way in which each region is incorporated into the country's economic development. Thus, in coastal areas the urbanization process must be viewed taking into account every city as part of a network of economic relationships. The expansion periods of every urban area depend on this.

As is shown in Table 37.4, during the 1950s, Mexico's entire urban system grew rapidly (6.14%/year). Nevertheless, urban systems located on the coasts exhibited specific dynamics. In the Gulf of Mexico Coastal Zone (Tables 37.5 and 37.6), cities recording high growth rates did so because oil extraction and processing activities called for such growth. These cities are in the northern part of the region (with Poza Rica as a dynamizing node); during that decade, border trade contributed to rapid growth rates in Matamoros and Reynosa. At the other extreme, in the south, Coatzacoalcos also expanded due to oil. Thanks to trade, small cities such as Chetumal and Ciudad del Carmen began to develop. On the Yucatán Peninsula, the urban system actually recorded scant development, Mérida hardly grew at all, tourism was just beginning to develop, and Cancún was still not part of the picture.

The 1960s was a decade of great urban growth on the coasts of the Gulf of Mexico. To the north, Poza Rica continued to expand, although now at a slower pace; its growth dynamics also affected Tuxpan. The metropolitan area of Tampico, also involved in the oil industry, absorbed part of the momentum of the industry. In the south, Coatzacoalcos maintained its growth rate, while during those years the city of Villahermosa began to rapidly expand. Cárdenas, in the same state (Tabasco), started to lose its rural character, whereas during the above-mentioned period Campeche and Ciudad del Carmen (in the State of Campeche) both recorded high growth rates.

In the 1980s, Mexico's economy underwent a period of crisis. The exhaustion of the Import Substitution Industrialization (ISI) model brought about a change in the urbanization process throughout the country. Major cities appeared to offer fewer opportunities for economic development and that curbed migratory inflows of people. The dynamism of certain cities that had grown during previous decades halted, and these cities even lost population, such as in Poza Rica. On the whole, cities in northeastern Mexico expanded more slowly. The oil crisis also affected Coatzacoalcos: its growth rates, which had averaged 5% during prior years, were reduced by half. In the south, a new urban emporium appeared: Cancún, which virtually came

Table 37.4. Total national population growth (%) and average annual population growth (%) in urban areas and coastal urban areas.

Decade	National	Urban	Coastal Urban	Atlantic	Pacific
1900-1910	-1.09	1.96	3.83	3.89	3.68
1910-1920	-0.51	1.07	1.80	3.18	-2.53
1920-1930	1.61	4.00	4.66	4.04	7.10
1930-1940	1.73	3.04	3.13	2.23	5.75
1940-1950	2.75	5.89	7.23	5.49	10.64
1950-1960	3.08	6.14	6.73	5.45	8.43
1960-1970	3.28	5.33	6.61	6.76	6.44
1970-1980	3.32	5.16	5.10	5.48	4.63
1980-1990	1.97	2.75	9.84	3.50	4.26
1990-1995	2.33	3.30	3.64	3.27	4.07

out of nowhere. A pale second to it, Mérida saw its dynamics interrupted and so did Ciudad del Carmen.

In the 1990s, oil activities continued to be restructured and for this reason, cities such as Coatzacoalcos, whose growth rate had already decreased, now began to lose population. In contrast, Ciudad del Carmen experienced somewhat of a boom and constituted a new oil development node. With the collapse of industrial activity in this region, the service sector began to play an important role in economic development. Cozumel and especially Cancún stand out as highly dynamic tourist areas. In the north, Reynosa, Matamoros, and Laredo, all border cities, managed to maintain high growth rates; their geographic position favored commercial and even industrial development thanks to the maquiladora industry. The Tampico metropolitan area achieved moderate growth due to its lively port Altamira, which gave a boost to industrial development there. The same was true of Veracruz, where the port helped reactivate the city's economic life.

As we all know, in the 1990s Mexico's economy shifted towards a new development model. From as early as the mid-1980s, measures aimed at liberalizing trade and cutting back the presence of the State in the economy were introduced. Although they were still significant, oil exports took a back seat and there appeared a series of other activities with greater export dynamism. The maquiladora industry, tourism, and ports were the sectors offering the greatest number of jobs. Confronting the crisis of traditional manufactured goods and labor adjustments in the public sector brought about by the application of liberal economic policies, the population started to look for work in border cities and even in the U.S. labor market. Informal employment in urban areas also expanded significantly. And the drop in income among the working population was translated into a widening of poverty.

During those years, we witnessed a redefinition of migratory patterns in coastal cities along the Atlantic Ocean. According to Cabrera (1993), in the coastal region of the Gulf of Mexico and the Caribbean, localities with over 100,000 inhabitants grew at an average annual rate of 4.92% from 1970 to 1990, whereas the smaller ones expanded at a rate of 2.18%. Hence, we are able to posit the existence of a migratory flow from smaller localities to larger ones within the same region. Cabrera (1993) ruled out the possibility that inhabitants in the smaller localities migrated to non-coastal territory in their own coastal states, since the population of the

Table 37.5. Dynamics of urban localities, 1900-2000 (from Gutierrez *et al*. 1990; CONAPO 2000).

Year	National Total	Urban Total	Coastal Urban Areas			Atlantic			Pacific		
			Total	%	# Localities	Total	%	# Localities	Total	%	# Localities
1900	13,607,259	1,675,905	166,915	9.96	9	116,759	69.9	5	50,156	30.1	4
1910	15,160,369	2,035,828	242,988	11.94	11	171,005	70.4	6	71,983	29.6	5
1921	14,334,780	2,288,156	295,651	12.92	10	241,325	81.6	7	54,326	18.4	3
1930	16,552,722	3,257,950	445,291	13.67	16	344,534	77.4	10	100,757	22.6	6
1940	19,653,552	4,396,784	606,033	13.78	23	429,734	70.9	12	176,299	29.1	11
1950	25,791,017	7,796,090	1,218,233	15.63	39	733,513	60.2	19	484,710	39.8	20
1960	34,923,129	14,150,370	2,335,825	16.51	56	1,246,772	53.4	26	1,089,053	46.6	30
1970	48,225,238	23,781,346	4,430,575	18.63	90	2,397,672	54.1	50	2,032,903	45.9	40
1980	66,846,833	39,316,903	7,283,993	18.53	117	4,088,175	56.1	68	3,195,818	43.9	49
1990	81,249,645	51,591,221	10,615,971	20.58	152	5,765,953	54.3	84	4,850,018	45.7	68
1995	91,158,290	60,687,878	12,692,622	20.91	175	6,773,052	53.4	92	5,919,570	46.6	83
2000	97,483,412	63,234,553	13,666,236	21.60	209	7,130,493	52.2	118	6,535,743	47.8	91

Table 37.6. Size of coastal localities (from Guitierrez *et al.* 1999; CONAPO 2000).

City Size	National Total		Atlantic Coast		Pacific Coast	
	# Localities	Population	# Localities	Population	# Localities	Population
10,000-15,000	65	787,024	31	368,869	34	418,155
15,000-50,000	98	2,604,132	63	1,722,860	35	881,272
50,000-100,000	17	1,267,601	7	515,365	10	725,236
100,000-500,000	24	5,484,916	16	3,860,869	8	1,624,047
>500,000	5	3,522,563	1	662,530	4	2,860,033
Total	209	13,666,236	118	7,130,493	91	6,535,743

latter grew at an even lower rate, i.e., 2.05%. In conclusion, localities with more than 100,000 inhabitants were growing, on average, nearly three times as fast as those with less than that number of inhabitants, essentially enlarged by population from their own region.

Up to 1990, the most attractive cities, where accumulated immigration varied between 191,000 and 133,000 people, were the Tampico and Coatzacoalcos metropolitan areas and Cancún. In those cities a total of 451,000 immigrants were concentrated, equivalent to 35% of all immigrants on those coasts. In the 1965-1970 period, Tampico and Campeche stood out due to the number of immigrants they received: 25,000 and 20,000, respectively. The Tampico metropolitan area has managed to retain its appeal, while on the other hand Campeche has seen its attractiveness diminish and its position taken over by other cities (Gutiérrez and González 1999). In the 1990s, six localities had become attractive areas: Reynosa, Nuevo Laredo, Matamoros, Veracruz, Mérida, and Villahermosa; in all, they accounted for 427,000 immigrants. The first three cities mentioned represented 70% of all immigrants on the Atlantic Coast. These cities were attractive for three reasons: oil, border trade, and tourism. Population growth among cities in the Yucatán Peninsula was attributable to immigration; more than 50% of their inhabitants were non-natives.

Throughout the final decade of the twentieth century, coastal cities appeared to have consolidated their ordering. As can be seen in Tables 37.7 and 37.8, the principal localities which define central places in the different subsystems are clearly defined: border settlements, traditional oil localities, and port and tourist centers. Settlement hierarchy reveals that on the Gulf of Mexico, unlike on the Pacific Ocean, localities varying between 15,000 and 50,000 inhabitants are more important. This is indicative of greater urban population concentration on the western coastline, and a higher degree of dispersion on the Atlantic.

As we have pointed out, demographic dynamics reflect the ups and downs of the economy. This, in turn, determines population mobility by means of the opportunities afforded by the job market. How have the urban economies of the Gulf Region responded to the new economic scenario created by an opening up of trade and a contraction of the State? An initial approximation to this question consists of examining over time the breakdown of the employed population by sector. How does the application of workforce energies change over the course of

Table 37.7. Gulf of Mexico urban system: population and growth rate (%), 1990-2000. Prepared by CONAPO, based on INEGI 1995, 2000.

National Rank	City	State(s)	Population			Growth Rate (%)		
			1990	1995	2000	1990-1995	1995-2000	1990-2000
15	Tampico Metro Area	Tamaulipas-Veracruz	567,334	620,012	664,692	1.6	1.6	1.6
16	Heroica Matamoros	Tamaulipas	266,055	323,794	376,279	3.5	3.6	3.6
17	Nuevo Laredo	Tamaulipas	218,413	273,797	308,828	4.1	2.9	3.6
20	Mérida Metro Area	Yucatán	658,452	772,645	842,188	2.9	2.0	2.5
24	Coatzacoalcos Metro Area	Veracruz	573,263	627,052	612,808	1.6	-0.5	0.7
25	Veracruz Metro Area	Veracruz	473,156	560,200	593,181	3.0	1.3	2.3
33	Poza Rica Metro Area	Veracruz	198,810	209,214	211,405	0.9	0.2	0.6
43	Reynosa	Tamaulipas	265,663	320,458	403,718	3.4	5.5	4.3
44	Cancún	Quintana Roo	167,730	297,183	397,191	10.7	7.0	9.1
45	Villahermosa	Tabasco	261,231	301,238	330,846	2.6	2.2	2.4
56	Campeche	Campeche	150,518	178,160	190,813	3.0	1.6	2.4
64	Cuidad del Carmen	Campeche	83,806	114,360	126,024	5.7	2.3	4.2
65	Chetumal	Quintana Roo	94,158	115,152	121,602	3.6	1.3	2.6
68	Cuidad Valles	San Luis Potosí	91,402	102,226	105,271	2.0	0.8	1.5
84	Cárdenas	Tabasco	61,017	72,739	78,637	3.2	1.8	2.6
88	Tuxpan	Veracruz	69,224	74,692	74,527	1.4	-0.1	0.7
101	Cozumel	Quintana Roo	33,884	47,841	59,225	6.3	5.1	5.8
120	Papantla	Veracruz	46,075	49,916	48,804	1.4	-0.5	0.6
123	Acayucan	Veracruz	43,383	49,256	47,826	2.3	-0.7	1.0
129	Playa del Carmen	Quintana Roo	3,098	17,621	43,613	36.1	23.6	30.5
135	Las Choapas	Veracruz	43,868	42,132	41,426	-0.7	-0.4	-0.6
156	Pánuco	Veracruz	29,817	33,122	34,192	1.9	0.7	1.4
190	Cosamaloapan	Veracruz	26,751	28,520	28,496	1.1	0.0	0.6
212	Lázaro Cárdenas	Veracruz	25,596	25,586	25,909	0.0	0.3	0.1
229	Isla	Veracruz	18,484	22,315	24,036	3.4	1.8	2.7

Table 37.7. Continued.

National Rank	City	State(s)	Population 1990	1995	2000	Growth Rate (%) 1990-1995	1995-2000	1990-2000
233	Catemaco	Veracruz	21,260	22,965	23,631	0.3	-1.2	-0.4
242	Alvarado	Veracruz	23,411	23,776	22,608	0.3	-1.2	-0.4
319	Cardel	Veracruz	14,708	17,876	17,686	3.5	-0.2	1.9
	Total Mexico		81,249,645	91,158,290	97,483,412	2.1	1.6	1.9
	Total Nacional Urban		50,629,952	58,448,196	63,234,553	2.6	1.9	2.3
	Total Gulf of Mexico Urban		4,530,564	5,343,848	5,855,912			

Table 37.8. Largest coastal cities in 1995 (Gutiérrez and González 1999).

Very Large Cities				Large Cities			
Atlantic	Population	Pacific	Population	Atlantic	Population	Pacific	Population
Mérida Metro Area	772,645	Tijuana	966,097	Matamoros	323,794	Mazatlán	302,888
Tampico Metro Area	705,302	Acapulco	592,528	Reynosa	320,458	Ciudad Obregón	244,028
Coatzacoalcos Metro Area	627,052	Culiacán	505,518	Villahermosa	301,238	Ensenada	192,550
Veracruz Metro Area	560,200	Mexicali	505,016	Cancún	297,183	Los Mochis	188,349
				Nuevo Laredo	273,797	Guaymas Metro Area	183,232
				Poza Rica Metro Area	191,488	Tapachula	163,253
				Campeche	178,160	La Paz	154,314
				Cuidad Valles	102,226	Puerto Vallarta	121,844
				Chetumal	115,152	San Luis Río Colorado	115,596
				Cuidad del Carmen	114,360		

a decade of productive transformations? With the support of evidence produced between 1987 and 1997 by the Encuesta Nacional de Empleo Urban (ENEU, National Survey of Urban Employment), we can appreciate the most relevant changes undergone by the principal urban areas on the Gulf. Our analysis centers its attention initially on cities where the oil and petrochemical sector has been dominant.

Therefore, first we will examine the changes experienced by the economy of the Tampico-Madero-Altamira urban area. From 1987 to 1992, we observed a significant loss of the population employed in oil activities. Whereas in 1987 this area absorbed 15% of the EAP, that figure dropped to 8.5% in 1992, and then even lower, to 5% in 1997. Manufactured goods remained somewhat stable throughout this period, fluctuating around 12%. The less important role of oil gave rise to growth in other areas; trade went from 16.5% in 1987 to 21% in 1997 and services (excluding financial and governmental) rose from 23.2% in 1987 to 28.8% in 1997.

Concerning the cities in the south, we only have data for the most recent period (1992-1997). Until 1990, PEMEX claimed to be employing 31,050 workers in its complexes and refineries, while the private sector in the chemicals branch recorded a total of close to 6,000 workers. In 1992, the ENEU gave a figure of a little more than 22,000 workers in the oil extraction and refining branch, and slightly over 13,000 in the transformation industry as a whole. As we noted previously, changes occurring in this zone are very rapid and significant. The ENEU reported that in Coatzacoalcos in 1992 the oil sector absorbed 19% of the employed population, by 1997 it only accounted for 12.2% of that population. Manufactured goods were not immune to this process, going from 11.1% to 7.3% in that same period. Simultaneously, trade and services increased their share; the former went from 18.8% to 20.4%, while the latter rose from 23% to 27.5%. In the case of Villahermosa, the employed population also evidenced notable changes, with the oil sector's share dropping from 8.1% to 5.2% of the total. Nevertheless, manufactured goods experienced slight growth, from 8.2% to 8.7%. The service sector also had a moderate degree of growth, going from 28% to 30%.

From a global perspective, the restructuring of economic scenarios in this region meant a redesigning of employment alternatives for the working population. Because occupational patterns were altered, there began a complex process whereby labor mobility was redistributed. Rural populations, that during the previous period had moved to urban areas in search of salaried work, encountered opportunities in the manufacturing sector. But as of 1985, they found it more difficult to join the urban economy in that sector, and tended to become part of the tertiary sector (increasingly less work as salaried workers and more frequently as informal workers; services and trade). In fact, on the threshold of the 21st century, the northern border and the U.S. job market represented an increasingly important employment option not only for rural workers, but also for urban workers.

To gain greater insight into the nature of the changes taking place in mobility patterns, we need to scrutinize labor strategies adopted by families in order to regain their income levels within a context of limited economic growth, inflation, and cutbacks or stagnation in industrial employment. The dramatic drop in income for males has been associated with the entry of thousands of women into the labor market, and this constitutes one of the most relevant aspects of this new restructuring process. According to statistics from the INEGI, in 1990 the share of women in the EAP was 14.5%, while in 1995 that figure had risen to 32.7%.

After several years of economic reorganization, we were able to note that urban workers with incomes of less than twice the minimum wage accounted for some 40% of the total. Poverty, after various decades of development, seems to have increased. As we can see in Table

37.4, in 2000 the coastal region's most populated municipalities (which are usually also the most urbanized) have managed to meet the majority of their needs for water, drainage, and electricity. But for a few noteworthy exceptions (Ciudad del Carmen, Minatitlán, Tuxpan, and Altamira), it has been possible to overcome lags in infrastructure. However, in those municipalities, income levels continued to be low, and a majority of households were living under crowded conditions. Levels of education tended to be low, and this has repercussions in terms of alternatives for surmounting poverty.

In a certain sense, the environmental problems of coastal cities on the Gulf of Mexico have been determined by the poverty enveloping their inhabitants. If urban job markets find themselves hard pressed to raise wages, it is also true that urban economies face significant limitations for addressing environmental problems caused by development. The social costs of economic development have been turning into environmental ones. Oil cities, the importance of which we have been stressing in this chapter, have accumulated environmental liabilities after several decades, and we could say the same for port and tourist cities. The environmental issues confronted by border cities, closely linked to the development of maquiladora industries, have also grown rapidly and up to the present, they have not been addressed. Now we will examine, from a theoretical perspective, the impacts that each of these cities will have to face.

ENVIRONMENTAL IMPACTS OF URBAN DEVELOPMENT

In the past decades, Mexican society has undergone different critical periods that have hindered the well-being of vast segments of the population. These critical times have left their marks in spatial terms. In space, obviously there are depressed regions, poor neighborhoods, and marginal zones. In times of crisis, poverty-stricken areas expand, either to absorb salaried workers that industrialization had benefited previously or even to assimilate the impoverished middle class.

At the end of the twentieth century, population living in clearly urban areas (more than 50,000) already represented 67% of Mexico's total population of close to 100 million. Rapid urbanization that took place in the second half of that century, driven by accelerated population growth, gave rise to the expansion of cities. Naturally, a large part of the expansion occurred on land that was originally rural. In the face of rapid growth dynamics that overwhelmed housing developers, millions of people were forced to settle in urban peripheries.

In 2000, the national urban system was comprised of some 14.8 million households; it is estimated that of these, 500,000 households (3%) lacked a home to live in, while nearly 3.5 million (24%) found themselves obliged to occupy land in an irregular fashion. These data reflect the inability of the land market to meet approximately 27% of the housing needs of Mexico's urban system. Crowding and irregular settlements are the patterns with the greatest impact on the development of cities, since they have negative effects on health, social cohesion, municipal finances, and environmental conservation.

For citizens in the higher strata, living on the edges of a city may offer them more favorable conditions; thanks to their income levels, they can easily afford the additional transportation costs involved. For citizens with low incomes, living in the periphery can entail an apparently "less expensive" alternative, but whose hidden cost consists of further distance from the infrastructure and services. This peripheral expansion is both spontaneous and deliberate, the result of various concomitant processes. On the one hand, given the limited supplies of land and housing available to the lower classes through government programs and the real estate market

and, on the other, due to the inevitable search for low-cost housing, the expansion of irregular peripheral settlements has been most prevalent.

When growth of a city is uncontrolled, a situation typical of poor cities, its urban periphery often widens until it becomes a mixture of illegal settlements, low-cost housing complexes, agricultural lands (some abandoned, and others under intense cultivation or used for livestock), small-scale industries, and garbage dumps. Disperse physical expansion of a city produces a transitional territory where we find problems such as the waste of a scarce resource (land), environmental deterioration (degradation of water bodies and productive land), and a rise in the price of infrastructure (dwellers are scattered and live further away from already established networks, and must cover rising transportation expenses) (Tudela 1991). For the poor inhabitants of a city, the periphery represents not only a geographical position but also a social status: being marginalized.

Settling at the edge of a city implies being far away from goods and devices that ensure not only access to utilities and infrastructure, but also employment, security, and status. In many cities, the periphery. e.g., suburbs, have come to be dual spaces, areas in which it is possible to find very high-quality, private housing, but also very impoverished residential areas; landscapes of survival, illegality, and clandestine activity, areas characterized by crime, migration, and degraded, depressed, and dangerous neighborhoods.

A number of researchers have observed that urban environmental problems go through a variety of transformations, some of which can be ordered in a series of stages. The initial phase consists of the presence of pathogenic biological organisms that may be derived from inadequate sanitation, scarce clean water supplies or poor wastewater management. In particular, improper treatment of body wastes is a problem. Subsequently, one can observe phases involving pollution, including that produced by industry, such as smoke and solvents. This stage has also been linked to the "epidemiological transition," or shift from infectious diseases in cities (such as cholera) to chronic illnesses or conditions, such as lead poisoning or malnutrition.

In theory, we could expect cities to experience a smooth transition from one phase to the next. However, for some cities or segments of society, the transition towards the latter phases may occur before it does for the country as a whole. The poor population of some cities may, therefore, continue to be exposed to pathogenic organisms after more favorably located parts of the city have adopted improved sanitation systems. In some cases, industrial hazards may coexist with sanitation problems.

Institutions involved in land ownership and housing have a bearing on the poor population's exposure to environmental hazards. Recent migrants, who face the risk of expulsion, have few incentives to adopt protective mechanisms or invest in water and sanitation. Often, the poor also build their houses in places that are exposed to environmental hazards and impacts, for example, land subject to landslides or flooding, or near municipal dumps.

For the urban poor, some of these problems are relatively new or something they are not familiar with; consequently, they do not know how to address them. And several of these problems, such as pollution or solvent or lead poisoning, are even hard to identify or detect as a cause of their symptoms. In terms of pollution, cities'area of influence and type of influences are expanding and changing. On the one hand, there are substances emanating from cities, seen as solids (i.e., municipal garbage), gases (e.g., industrial emissions) or liquids (i.e., sewage discharges), while on the other, there are the effects of growing urban demands, including agricultural-livestock expansion to meet food needs.

One way of visualizing the fact that the kind of influences cities have been having on the environment has been changing is to consider whether sewage discharges have been treated or not, and that these have been increasing as a direct consequence of population growth, although at the same time we know that the wide variety of medicines or other chemicals consumed by the population are also rising on a daily basis. Many pharmaceuticals such as antibiotics, hormones, and other organic compounds used in repellents, detergents, steroids, and disinfectants, have been monitored in rivers or on the coasts of the United States. This shows that, for one, treatment plants are inefficient and, for another, pollution there exhibits levels as unexpected as their impact on aquatic flora and fauna is unknown (Kolpin *et al.* 2002).

Once they have entered the environment, substances discharged by urban drainage potentially have direct effects. Increases in drug consumption, which varies according to people's financial capacity and the very structure of the population, are a cause for much concern. For example, with a population dominated by youths, such as in the case of Mexico, and in the face of rising contraceptive use, although no monitoring of this is done, it would not be far-fetched to argue that these substances are present in discharges and that undoubtedly, they will increase in volume, complexity, and effects. The toxicity of these types of substances are just recently being assessed, but it has already been observed that the combination of their effects on marine biota is considerable (Cleuvers 2003). Similarly, in sediments in Japan, Hosokawa et al. (2003) found what have been termed "endocrine disruptors," i.e., high concentrations of agrochemicals and other dioxin-type products, in virtually all the bays of their country. These authors' findings indicate the permanence of substances, in high concentrations, in sediments dating back 40 years; they underscore the need not only for in-depth studies, but also for public policies to modify the effects of such substances. This could explain certain phenomena such as the population decrease of certain species, and modifications in the proportion of the sexes among aquatic life forms.

We would also have to examine urban solid waste, among which industrial products are especially toxic and, generically, waste that should be disposed of in sanitary landfills. The lack of hazardous waste dumps and of sanitary landfills is without a doubt extremely serious in Mexico, and no less so in the Gulf of Mexico Region as a whole (CONAPO 1999; SEMARNAP 2000).

From the standpoint of the relationship between economic structure and poverty in urban zones, Mexican cities are confronted with three major problems. First, degradation of the urban environment has a disproportionate negative impact on the poor since they often inhabit the areas at greatest risk and the poor pay more for basic services and infrastructure. In addition, the economic structure shapes the framework in which environmental problems arise. The location of economic activities in and around cities exacerbates the severity of environmental problems. Economic variables influencing environmental problems are: spatial patterns involving the location of industries with impacts on health, effectiveness of industrial pollution control, energy uses, and size and nature of the informal sector. Lastly, the level of urban wealth is associated with certain environmental problems; sanitation is a problem in low-income cities; hazardous waste, atmospheric pollution, and scarcity of green areas are top-priority problems in high-income cities. Pollution of water bodies and inadequate solid waste management are problems affecting developing urban areas, regardless of their level of wealth.

In short, throughout this chapter we have attempted to demonstrate, on the basis of much empirical evidence, the principal demographic, economic, and environmental features characterizing the Gulf of Mexico Region. We might suggest that the asymmetries of this

complex system can be grouped into three major dimensions and processes. On the one hand, from a demographic viewpoint, we observed that in the U.S. urban system, population is concentrated in continuous and relatively concentrated or uniform cities (nodes) with more than 600,000 inhabitants. On the other, in the case of the Mexican urban system, we found greater dispersion of these nodes, with generally few cities having more than 600,000 inhabitants, and many that are smaller and growing, whose internodal spaces, rural zones, are in sharp contrast with the cities. In certain instances, these may be classified and distinguished as new urban centers, as would be the case of oil cities.

The demographic pressure caused by this peculiar form of spatial distribution of the population is linked to an equally unique form in which economic development has taken place in both zones of the Gulf of Mexico. Thus, in terms of production, we noted that exploitation strategies in both zones evidence certain constant factors, but also significant differences. It would suffice to recall the weight of the U.S. economy as an explanatory framework for such contrasts; but as the reader can see in Fig. 37.4, port traffic in both nations shows important differences. For the U.S., communication among industrial zones on both of its coasts calls for vast freight traffic through the Panama Canal and on the Gulf of Mexico itself. In contrast, for the Mexican economy, freight traffic essentially takes the form of oil exports. Lastly, in terms of the natural system, we would have to note that, while biodiversity in the southern portion of the Gulf is greater compared to the U.S. coast, the ways for exploiting it and the dynamics of its deterioration exhibit distinct patterns.

Rural and urban poverty have been showing new symptoms and linkages, migration to coastal cities has imposed new spatial patterns, and challenges have arisen for management, not only of natural resources or conservation, but in particular new challenges for local governments, which face the need to provide services despite their limited financial capacity; all of this compromises development. Thus, these asymmetries are also expressed because U.S. cities are facing different kinds of challenges.

In the Mexican portion of the Gulf, there are also spatial differences, i.e., sectoral ones. For the past few years we have witnessed a sort of "modernization" of cities on the Gulf, especially those devoted to tourism: spatial segregation models in which the historical downtown areas are abandoned for the sake of a style of urbanization centered around business areas for high-income sectors that seek to enjoy the environmental advantages and landscape values of the coast.

The above considerations are in opposition to the dynamics of oil cities, which in the 21st century have been acquiring new features and have produced at least two generations of model cities, which not only contrast with, but also exclude other sectoral interests, such as tourism. In the very near future, we may possibly witnesses new conflicts in both urban and rural areas related to the exploitation of a new generation of fuel deposits, for example, those discovered and announced by PEMEX off the coast of Chicontepec and in its paleocanal, and the exploitation of gas in the Río Papaloapan or in the Burgos Basin.

The attraction of certain cities will not diminish; this is true of the supply of jobs offered by the maquiladora industry, which at one time was concentrated on Mexico's northern border, and today is even expanding beyond the city of Mérida. We could state that sea and air communications have erased and extended this "border effect."

In contrast, in the agricultural-livestock sector, in the internodal space we have referred to, be it upstream or on the coastal plains, the importance of certain crops that had retained the rural population of this entire zone (e.g., corn, sugarcane, fruit) has begun to decrease. Loss of

employment alternatives in the countryside, as well as occupational restrictions in the cities, are generating migratory flows towards the region's major cities. Conservation programs or public policies with a view towards building a platform for development intended to overcome environmental lags and liabilities, while generating new economic opportunities, will also have to take these phenomena into account so as to avoid new failures.

FINAL CONSIDERATIONS AND RECOMMENDATIONS

Policies aimed at curbing the pace of environmental deterioration in the Gulf of Mexico Region would have to be divided and regionalized, and complement one another at different scales.

For one, policies could be directed towards specific portions of the territory, located and divided into three major areas: inland, coast, and marine. For another, they should complement each other, at the international level, with a view towards shared terrestrial and marine resources (e.g., water, ecoregions, fishing species or turtles) and towards habitat conservation strategies (e.g., bird nesting areas or reptiles and coral reefs).

Naturally, one challenge related to the above is the need to propose cross-cutting policies that avoid the negative effects of sectoral ones, i.e., programs that provide incentives to cattle-raising and the expansion of the agricultural frontier are opposed to and nullify proposals for natural resource conservation and management. In the context of the challenges associated with this coastal territory, that is, the plains or what we have termed inland areas (including river basins), the Mexican Government has a responsibility, and the states and municipalities, other duties. The federal and state governments conduct their programs on a sectoral basis, and neither the governments nor their programs are usually coordinated with one another.

Even within a single sector, there is ignorance or a lack of knowledge concerning certain elements of the territory that make problem-solving an even more remote possibility, such as fishing or oil exploitation, whose environmental liabilities (pollution) and social liabilities (urbanization phenomena and social segregation) are quite hard to deal with. In these sectors, there is no vision of coastal areas such as the one we have proposed here; no clear distinction is drawn of what is the open ocean and what is specifically the coastline, so offshore exploitation (of oil or fishing resources) occurs independently of urban processes in one case, or of coastal fishing, in another. Institutions fail to promote policies or solutions in a parallel fashion that is coordinated between both geographical spaces constituting this region.

In yet another dimension, in what we call inland areas, both the space and policies should be differentiated in terms of population concentrations, urban zones or nodes, and inter-urban spaces. There are no policies geared towards keeping rural inhabitants in their respective spaces and localities, with decent levels of employment and income, and productive alternatives that do not extend the agricultural frontier and which, on the contrary, ensure the restoration of ravines and natural vegetation. These processes are interrelated. At its heart, both in rural areas and in urban ones, the condition of our citizens is undergoing a serious crisis. And just as they have no alternatives, our local governments, which are responsible for providing services to a growing population, also lack alternatives, while our backwardness increases year after year.

Urban and rural policies are complementary, but in particular, many of the solutions for purifying water, distributing it, and then collecting wastewater, comprise a technological and financial bottleneck. Needed are public policies that identify different technological solutions, as well as financial schemes for new kinds of investment. We feel that it is a grave mistake on the

part of Mexico's federal government to fail to develop proposals for national policies geared to addressing problems that are legally under the jurisdiction of local governments, such as the case of garbage and wastewater treatment.

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