



## México

**National Report on Environment (1989-1991)  
for the United Nations Conference on  
Environment and Development**

**SUMMARY**

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Secretariat of Social Development

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FRONT PRINTING

The exceptional variety of existing species in the Mexican territory terrestrial or aquatic animals, plants and microorganisms have enriched the society daily life, it's history and traditions, art and culture as well as it's mythology. Front printing represents, among other elements, the mythic bird, humming-bird or huitzitzilin, that lives around the blossomed tree of life.

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Environment and Development*

*s u m m a r y*

*Secretariat of Social Development*

## FOREWORD

For Mexico, the United Nations Conference on Environment and Development, is the great opportunity between the countries of the planet to progress jointly in the solution of environmental problems.

The country during recent years has been involved in an increasing effort to deepen the environmental policy and the productive protection of natural resources in the search of economic and environmental sustainability of development.

The present report aims to provide an objective view of the progress made and the issues still to be solved. The primary responsibility in the solution of local environmental problems is in our hands, in the solution of the global and regional phenomena we participate following the principles of equity and differentiated responsibility we believe that international cooperation is one of the most fruitful means to solve local and global problems.

The National Report on Environment 1989-1991 (Mexico) for UNCED, responds to the invitation and environmental management efforts in Mexico.

Luis Donaldo Colosio Murrieta  
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FOR THE UNITED NATIONS CONFERENCE ON  
ENVIRONMENT AND DEVELOPMENT  
-UNCED-

**SUMMARY**

**General Outline**

Man has modified the environment all along his existence, since the time when he first developed agricultural means of subsistence. However, it was not until after the Industrial Revolution that natural resources were used in an irrational and excessive manner for the first time, in an attempt to supply the new forms of production that emerged, which offered broader possibilities for the accumulation of goods, as well as a greater variety of them. Thus was born the so called "consumer society", which demanded more and more varied commodities. From then on the model for development has been based on the principle of least investment for maximum gain, and the consequences of such behavior have become evident in recent years.

In Mexico, modern development, both social and economic began in the forties, which means there has been half a century of exploitation of resources and undermining of the environment. In the sixties a rapid succession of events took place. On one hand, scientific understanding of the causes and effects of environmental degradation progressed considerably, and on the other, more adequate programs, strategies, and policies were implemented, along with administrative and legal instruments for sector planning and coordination.

With great awareness, the Mexican people also became conscious of the challenge of environmental degradation and ecological unbalance. This

sensitivity has been shown through different forms of involvement, both individual as well as collective, the latter being a demonstration of the evident development of democratic organization in the country.

Consequently, the increasing number of nongovernmental organizations, professional associations, movements and groups is understandable. These groups comprise a great variety of citizens, all willing to help in analyzing and solving environmental and developmental problems. Media coverage has played a major role in enhancing the public's sensitivity regarding ecological and environmental problems in recent years. This media coverage includes the analysis of scientific products, publishing of local and national problems, up to the evaluation of government policies, actions and solutions.

The pressure generated as a result of social dynamics has contributed to the creation of a growing ecological conscience nationwide. This has prompted municipal, state and federal governments to include topics regarding the environment as well as national and world development in their political agenda. Meanwhile, the country is facing, among others, problems in housing, demographic distribution and levels of income that are not satisfactory for the desired national project.

POPULATION. Regarding this point, the Mexican government has relied on birth control guidance campaigns, within a climate of absolute respect for the family,

with which it has succeeded in decreasing the demographic growth rate over the last ten years, with a predicted mean rate for the 1990-1994 term of 1.8%. In 1990 the country's population was 81 million people, the State of Mexico contributing with the largest population: 9.8 million, followed by the Federal District (8.2 million), Veracruz (6.2 million), and Jalisco (5.3 million), (figures 1 and 2).

**URBAN DEVELOPMENT.** In order to fulfill the specifications of territorial rearrangement included in the National Development Plan for 1989-1994, several strategies of direction, consolidation, and regulation have been defined for population centers of the so called National Urban System.

This system comprises 60% of the country's population, and constitutes the preferable target for actions in urban development. It is made up of the nation's four largest cities (Mexico, Guadalajara, Monterrey and Puebla), 80 mid-sized cities, and 120 small cities, selected due to their characteristics in relation their development potential; their capacity for public service distribution, support of rural activities or the depth of their problems and the urgent need of implementing solutions.

Although air pollution is an inherent consequence of development, so is demographic concentration. In our country the larger urban concentrations suffer from critical problems of air pollution, 40% of the total pollutants being emitted in the metropolitan areas of Guadalajara, Monterrey, and Mexico. Pollution not only affects air quality, it also alters the immediate surroundings, as well as more distant basins and ecosystems. Therefore, territorial strategies for facing urban problems have a high priority within policies and actions: urban concentrations must not

grow in a disorderly fashion. Among the proposals included in the urban improvement programs are: territorial ordering, water and energy saving, waste collection, noise control, and the promotion of wider involvement from the citizens in the solution of these problems.

**SUSTAINABLE DEVELOPMENT.** Now that the country is beginning to bail out of its economic and financial crisis, and has the possibility of reaching reasonable levels of growth and income distribution, there is a need for including the "sustainable" concept within the model for development.







quality. A variety of financial instruments designed to prompt the productive sector towards a better environmental performance have been considered. These instruments include: selective tax rates according to the degree of use of natural resources and pollutant emissions, subsidies for clean technologies used in production or programs for industrial relocation, and others. Sharing responsibilities, improving the organization, and official support are the Federal Government's main policies for facing environmental and development problems.

### *Regionalization*

Mexico's land surface has 1'953,128 km<sup>2</sup> of continental area, and 5,073 km<sup>2</sup> of insular surface. By size it is the fifth largest country in the continent and the thirteenth in the world. It's coast in the Pacific Ocean and the Gulf of California add up to 7,148 km, and in the Gulf of Mexico and the Caribbean the total length is 2,805 km. Considering the area within the 12 mile limit of territorial sea, Mexico has 53,373 km<sup>2</sup> in the Gulf of Mexico, 163,940 km<sup>2</sup> in the Pacific Ocean, and 14,500 km<sup>2</sup> around it's islands. Additionally, there is the so-called exclusive economic zone (EEZ), of up to 200 miles away from the coast, adding to a total of 2,892,000 kilometers.

The Secretariat of Social Development (SEDESOL) seeks to make the framework in environmental action consistent, by means of ecological regionalization, with the goal of optimizing it's different programs, as well as making them compatible with each other.

Environmental phenomena rarely have precise geographical limits, and both their origins and

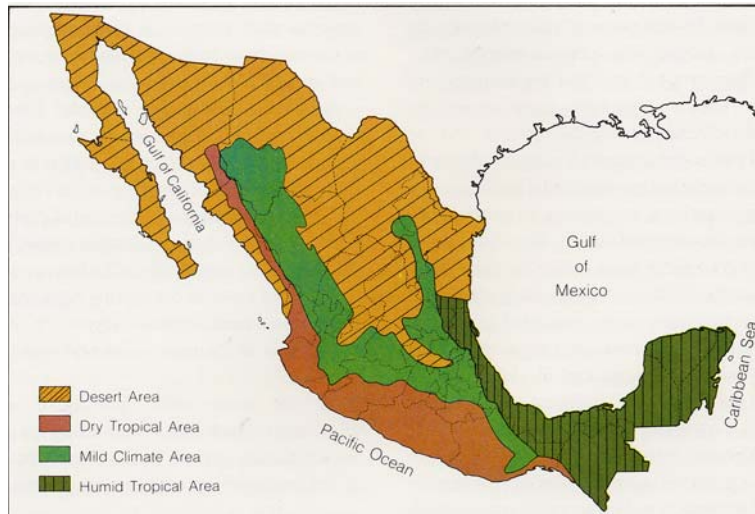
their effects are present in different degrees. Ecological regionalization allows several levels of social perception and manifestation of environmental problems to be defined, by relating them to a given zone. In order to carry out this ecological regionalization, the SEDESOL has used landscape physiognomy as the base criterion.

This offers the following advantages: explain in a clear manner the fundamental causes of the area's morphological differences; allow easy interpretation and the integral appreciation of the different regions, as well as using relatively standardized criteria. The most useful standards for the analysis of environmental problems -included in ecological regionalization- are basically geo-morphological, edaphic and climatological. These standards help in defining a region with the additional support of related aspects like hydrology, flora and fauna, among others. Thus, ecological regionalization is divided into five zone categories: ecological areas (figure 3), ecological provinces, land system, landscape, and natural unit.

### *Ecological Ordering of Territory*

Ecological ordering of the country's territory is the main instrument used by the sector responsible for the nation's ecological matters, to achieve the integral planning of the sector's corresponding activities. It is an essential instrument in the guidance of economic and social growth, as well as for the improvement of living the conditions of the population without detriment to the land, while protecting natural resources. Ecological ordering of territory is structured at three basic levels of action: national, regional, and local (state and





municipal). Special attention has been given to updating the national project for ecological ordering, in addition to the individual chapters of ordering that should be adopted in each ecological zone, as well as to projects for agricultural, forest, industrial, tourist, and urban development. The same may be said for those projects concerning energy production and those designed to be implemented in critical areas or fragile ecosystems.

The first essays on national territorial regionalization, with an ecological perspective, produced a group of nearly 1,900 homogeneous ecological units, which have been called land systems.

This method shall allow different general policies of ecological ordering to be defined, as well as the legal outline of the integral framework for productive development and regional priorities. The national project was carried out based on ecological zone level studies, conducted explicitly to configure the general ecological ordering. This project consists of four specific products: the ecological regionalization map, at a scale of 1:2 000 000, with a technical

memorandum; national level environmental diagnosis, and foreseeable environmental effects obtained from the analysis of scheduled sectorial projects, 1990-1994; a group of legal features for ecological ordering directed towards the most important productive sectors; and the information system for ecological ordering, comprising the basic information required to understand the situation of each one of the ecogeographical systems and their respective location. It is a geographical type system, and offers easy use and handling of the computerized information that supports the general ordering. The legal and administrative analysis that will allow the project to be carried out is being conducted based on the technical material presently collected.

As to productive activities, the SEDESOL has been the principal promoter of ecological ordering studies of different, that may be useful in the supervision of megaprojects that could cause regional ecological unbalance. The resistance capability of ecosystems is evaluated both by these orderings and by other ecological studies. With the given results, and in

coordination with state and municipal governments, alternative models of land use are defined, so that based on their own legislation regarding the use of land, actions for development are implemented in maximum harmony with the ecosystems' conditions of stability, integrality and fragility. At the local level of territorial ordering, it is sought that state and municipal governments conduct the ecological orderings within their jurisdiction as well as manage their most important economic and productive activities, and urban development, in a form consistent with this program framework.

#### **National Policy on Ecology and Environment**

This policy states as basic principles that ecosystems are common property belonging to all Mexicans, and that life, as well as present and future productive possibilities, depend on their balance. It also considers that ecosystems must be used in a way that assures maximum sustainable productivity, which must, in addition be compatible with their ecological balance and integrity. Responsibility for the protection of ecological balance must be shared between the authorities and the individuals, and includes both present conditions and those that will determine the living standards of future generations.

Furthermore, it states: that the prevention of causes that generate unbalance is the most efficient way to counter them; that the utilization of renewable natural resources must warrant the permanence of their diversity and their renewal, and that the utilization of non-renewable natural resources must avoid the generation of adverse ecological effects. As to environmental protection actions, it suggests that it be

based on the concertation between individuals, groups and social organizations, attempting to redirect the relations between society and nature. The State, as it's responsibilities determine, must define the criteria for the preservation and reinstatement of ecological balance. Neither State economies, strongly contested at present, nor the most scrupulous free market economies have been capable of stopping ecological unbalance or environmental detriment; soils, rivers, seas, human settlements, all show signs of the damage done during years of development. Natural and industrial processes have reached a point of contest where environmental and ecological restoration and preservation must prevail.

A central and growing concern of the Mexican Government, as well as other governments around the globe, is that of assigning an economic value to ecological assets. The common good of a healthy environment must predominate over an alleged right of private property that may damage it. In brief, the "polluters-payers" principle can be instated, and painful as the consequences of this axiom may be, they are necessary. It is of the interest of our country that activities carried out within it's sovereign territory do not affect the ecological balance of other nations and, reciprocally, that the activities of foreign citizens abroad do not affect ecological equilibrium in areas under national jurisdiction. Under equal circumstances with other countries, Mexico encourages the re-establishment and preservation of balance in regional and global ecosystems.

Based on these principles, Mexican ecological policy directs all it's actions towards the achievement of a general

objective, derived from the National Agreement for the Productive Improvement of Living Standards, which establishes that the planning and execution of government actions and of all new projects shall have as a basic premise that natural resources are an strategic asset for national sovereignty and a essential reserve for future generations; the general objective of the National Program for the Protection of the Environment is, therefore, to harmonize economic growth with the restoration of environmental quality, while advocating the conservation and rational use of natural resources. Ecological problems are of a structural nature, hence, solutions cannot be immediate. Consequently, the initial goals of environmental policy are directed towards conducting corrective actions that revert the most critical levels of environmental impairment in the main cities and ecological areas.

At the same time, preventive activities are promoted, which may establish the basis for a socioeconomic growth that is compatible with balance of the environment, within a long term perspective.

The following specific objectives are considered:

Regard of ecological ordering of national territory as an efficient element of environmental protection, in rapport with general social development and with the land's natural characteristics and it's ecological balance.

Seek for projects, and all other national development activities to be subject to strict criteria regarding environmental responsibility.

Improve the quality of air, specially in densely populated areas.

Stop and revert water pollution, preserve it's quality and abet it's optimum use.

Prevent and control land pollution, by means of adequate treatment of municipal and industrial solid waste, as well as the correct management of hazardous substances.

Insure the restoration, protection, and preservation of natural resources as well the balance of ecosystems.

Strengthen the ecological legal framework with an integral perspective, in order to avoid actions that damage the environment or natural resources.

Help in making education a channel for increasing ecological public awareness, consolidating communication schemes that bolster public participation.

Use technological and scientific advances for the improvement of the environment, establishing a structure that supports the development of productive processes that do not harm the ecosystems.

Assure that civil society partakes in the responsibility of protecting the environment.

Reinforce international cooperation, allowing the exchange and reciprocal support for the solution of ecological problems.

#### *Legal Framework*

Articles 27 and 73 of the Political Constitution of Mexico establishes the basis of a law with a wide view of environmental protection and ecological balance.

Thus, the General Law of Ecological Balance and

Environmental Protection -in effect as of March 1988-,has such a notion of the environment, and also determines the criteria for decentralization by defining a mechanism for the acquiescence on environmental matters of the three levels of government: federal, state, and municipal. In accordance with the need of including environmental matters within the ordainments that regulate natural resources, the new Forest Law and Federal Fishing Law already contain precepts aimed at the protection, preservation and rational use of those natural resources under their jurisdiction.

In order to endow the General Law on Ecological Balance and Environmental Protection with the legal background that allows it to be efficiently applied, regulations pertaining environmental impact, prevention and control of atmospheric pollution, hazardous wastes, and pollution generated by motor vehicles in Mexico City or its surroundings, were published throughout 1988. One of the innovations of the Law establishes the technical ecological standard -whose devising began in 1988- as an instrument of environmental policy. By 1990 there were already 50 technical standards in store; these specify the maximum permissible limits for emission and discharge of pollutants, the procedures and specifications regarding water, air and land pollution, as well as another five ecological criteria.

Although a set of regulations that has permitted a strengthening of environmental legislation exists, it is necessary to consolidate this legal framework by publishing regulations explaining each and every one of the subjects considered by the Law. By the same token more technical

standards must be established enhance the control on the processes of every activity that could impair the environment. At the same time, all ecology-related legal dispositions should be analyzed; the Hunting Law, the Federal Oceans Law, the General Human Settlements Law, the Rural Development Law, the Public Works Law, and others, so that they include ecological considerations in their regulations.

Regarding the federal states, as of March, 1992, 29 of the 31 states (and the Federal District) already had their own environmental law. They must all, as well as their municipalities, shortly have a legislation on environmental matters, and direct sufficient funds for their application.

As to the regulations of the General Law, meetings between representatives of SEDESOL, the National Water Commission, and the Navy are presently under way to develop a preliminary project for the General Law, in matters concerning prevention and control of pollution in water and water systems.

## **Natural Resources**

### *Land*

Before the arrival of Cortes, our territory was a vast natural habitat with a wide variety of vegetation plentiful forests and rain forests, all varying according to the climate. In time, our country's inhabitants have modified that natural environment so that presently 27.2% of the total surface has been transformed by man, with 27% being destined for farming or grasslands, and only 0.2% for urban or industrial use (Figure 4).

On the other hand, the remaining territory (72.8%), made up of forests, savannas, marshes,

bush land, desert areas, etc., are still being modified by man through activities such as extensive cattle herding, lumbering, and collection.

AGRICULTURAL USE OF THE LAND. Due to its topographical and climate characteristics, Mexico must be considered as a country with limited agricultural potential. This is because more than 75% of the country is mountainous, making level soil scarce and scattered. In addition, more than 50% is either arid or semiarid, with an annual precipitation of less than 600 mm.

The country has 270 182 km<sup>2</sup> of farmland -13.8% of the national territory-, of which 210 574 km<sup>2</sup> are seasonal farmlands, and 58 031 km<sup>2</sup> are irrigated. In general 168 000 km<sup>2</sup> are used for agricultural purposes each year 8.6% of the country's territory.

Seasonal farmlands and tropical plantations are located mainly in the states of Veracruz, Jalisco, Zacatecas, Chiapas, and Guerrero, which together represent a little less than a third of all the seasonal farmland. Of all the irrigation farmlands, almost 51% is in the states of Sonora, Sinaloa, Tamaulipas, Guanajuato, Michoacan and Queretaro. The agricultural use of the farmland reflects the traditional diet of the Mexican people. Their are four main crops: Corn (*Zea Mays*), 16.8 million hectares; Bean (*Phaseolus spp.*), 1.3 million hectares; sorghum (*Sorghum ssp.*), 1.2 million hectares; and wheat (*Triticum spp.*), 1 million hectares. These four crops cover approximately 62.5% of the cultivated surface. The remaining 37.5% is used for other products, like plantations and woodland. Among these products are some of with a high commercial value, like cotton (*Gossypium spp.*), coffee (*Coffea spp.*), tomato

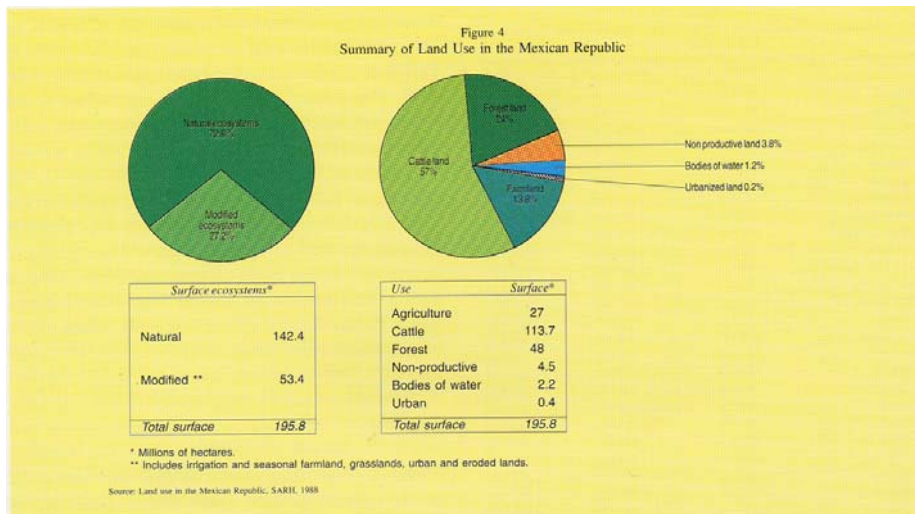
(*Lycopersicum esculentum*), and cacao (*Theobroma cacao*).

USE OF THE LAND FOR CATTLE HERDING. This use is extensive throughout the country because different cattle feed on different types of vegetation. Since cattle eat up the stubble in farmlands, the use of those lands for farming crops like oats (*Avena spp.*), corn (*Zea mays*), sorghum (*Sorghum vulgare*), and alfalfa (*Medicago saliva*) is becoming more widespread.

USE OF THE LAND FOR LIVESTOCK. The extension of land suitable for this type of use is approximately 1 139790 km<sup>2</sup>, and contains a wide variety of vegetation like grassland, savanna, bush land, etc. Of these lands, 263 688 km<sup>2</sup> are natural

and man-made grasslands, which are better suited for livestock use. They are located mainly in Chihuahua, Durango, Sonora, Veracruz, and Oaxaca, that together hold 57% of the nation's total. Untouched ecosystems represent 40% of the country; of these there are several examples: forests, jungles, bushes, swampland, etc.

FOREST USE OF THE LAND. Coniferous trees are the most important economic source. These trees inhabit cold zones and among them are the cypress (*Cupressus spp.*), pine (*Pinus spp.*), the Mexican scared fir (*Abies religiosa*), and the white oak (*Cupressus spp.*). These species are found in the higher part of the mountain areas, specially in the states of Mexico, Chihuahua, Veracruz, Jalisco, Oaxaca, Michoacan, Tamaulipas and Durango. There is considerable woodland in areas with a milder climate, extending over a great part of the territory, and are mainly located in the surroundings of the Occidental Mountain Range, in Sonora, Chihuahua, Durango and



Jalisco, as well as in Michoacan, Oaxaca, Chiapas, and Tamaulipas.

POTENTIAL USE OF THE LAND. The development of agricultural, livestock, and forest activities and their location nationwide generally depend on the environmental conditions that prevail in each ecological zone. Generally speaking, the country's ecological conditions may be considered as poorly suited for agricultural and livestock activities, for the terrain, the quality of the soil, and the climate strongly limit the accessibility of suitable areas for farming and cattle herding. According to an inventory made from a agricultural classification of the land based on it's farming, livestock, and forest capabilities, it was determined that the country has a larger area suitable for livestock activities, followed by forest, and finally fanning (table 1).

DESERTIFICATION. This is a consequence of the generalized impairment or simplification of the ecosystems, which reduces or eliminates their biological potential, enhancing the presence of species from nearby desert areas. Desertification is increased mainly by the effect of human activities. The areas most exposed to this phenomenon, or

already in the process of desertification, are those

adjacent to the true desert areas, and which are the ones that presently produce the greater part of the world's food. The SEDESOL has published a map of the zones most exposed to desertification in Mexico, based on erosion, topographical, and precipitation criteria, as well as their aptness for agricultural and livestock use. The neovolcanic mountain range stands out as the most vulnerable area for desertification due to it's high erosion rate (of hydraulic and eolic nature), generated by the intense timbering. The reduction of underground water deposits in the valleys has produced landslides, desertification, increased salt and alkaline content. This is evident in many lacustrine soils.

EROSION. Erosion due to the effect of air and water is actually the main cause of degradation of soils in our country. Mexico has a moderate rainfall erosion in 63% of it's territory, and only 8% of it's surface is strongly affected. The mean annual loss of soil by hectare in^the country is an estimated 2,754 tons (metric), which are eroded and carried by water flows that generate 535 million tons of sediment; 69% of which end up in the sea, whereas 31% is deposited in natural impoundings.

State	forests	farmland	Cattle land
Sonora	1727668	1056765	13710914
Sinaloa	1283547	1743956	2435733
Nayarit	1548904	554131	519360
Chihuahua	7332986	1539596	15046565
Durango	4915571	1301326	5566322
Coahuila	71324	283570	14609044
Tamaulipas	518351	3561417	3267736
Nuevo Leon	656186	1240439	4147223
Agascalientes	53050	270051	228600
Zacatecas	492460	1852850	5103598
San Luis Potosí	566576	1369727	4292429
Colima	148615	187900	185463
Michoacán	2321223	1357868	2120736
Jalisco	3175341	2567177	1761170
Guanajuato	288896	1418741	1300024
Querétaro	161960	298220	695917
Hidalgo	550027	628890	892118
Tlaxcala	79946	202924	104444
Puebla	714328	912004	1727584
Morelos	55206	200458	229580
México	672989	842537	533533
Tabasco	313301	1108279	731255
Veracruz	136590	3891471	1839342
Chiapas	4507069	1198849	1461170
Oaxaca	3168234	1060771	4620830
Guerrero	2208823	343012	3698109
Campeche	3198718	628841	966585
Yucatán	1168575	903164	1661079
Quintana Roo	3594394	424470	590431
Distrito Federal	48868	13066	30074

Source: SARH, 1989 Agrological classification of land by capacity: agricultural, cattle, forest, and non-productive. General Direction of agricultural and forest Policy and development

### Water

Hydraulic resources are vital for Mexico's socioeconomic development. However, the country's physiognomy and great diversity of climates make water resources unequally distributed throughout the territory. The annual rainfall average in Mexico is 780 mm, which is equivalent to 1.532 billion cubic meters; in the north of the country and the central plateau (52% of the land) the annual average is less than 500 mm, whereas in just one part of the southeast (7% of the territory), there is a mean of over 2 000 mm a year. It is estimated that 50% of the total annual water flow is concentrated in the larger rivers in the southeast, whose hydrological

region comprises only 20% of the national territory. It must be pointed out that while 80% of the country's water resources are located at less than 500 m above sea level, 70% of the total population and over 80% of the industrial activity is concentrated above such point; 55% of this industrial activity being located in the Valley of Mexico, which suffers from great water shortage problems.

In order to use this resource more rationally and have a better control of it, the country has a system of hydraulic works for it's storage, with a capacity of around 125 billion cubic meters, in addition to the 14 billion concentrated in natural lakes and lagoons, which yield a total of 139 billion cubic meters -34%- of the annual water flow.

### Forestry

Mexico's geographical conditions allow the existence of a very varied vegetation, considered to contain one of the widest biological diversities in the world. Thus, within the country's boundaries there are both arid and coniferous vegetation -mainly pine- areas, as well as rain forests, with a great variety of species including fine woods such as mahogany (*Swietenia macrophylla*), red cedar (*Cedrela mexicana*), and other less known but equally valuable species.

The total forest area represents 73.3% of the national territory, which equals 143.6 million hectares, of which the woodland (forest and jungles) represent 38.9 million hectares (19.9% of the total surface). Not all these ecosystems are suitable for wood exploitation activities; the following are considered appropriate: pine forests (*Pinus* spp.), pine-oak forests (*Pinus-Quercus*), oaks (*Quercus* spp.), pin-oak-juniper (*Pinus-Quercus-Juniperus*), balsam *Liquidambar*



spp.), pine-juniper (*Pinus-Juniperus*), Mexican sacred fir (*Abies religiosa*), pine-fir (*Pinus-A. religiosa*), white cedar (*Cupressus* spp.), and eucalyptus (*Eucalyptus regnans*). Also suitable are tropical rain forests, tropical semideciduous forests, tropical deciduous forests, as well as marshlands.

The following states, which contain vast coniferous or tropical woodland regions, are of special economic importance: Chihuahua, Durango, Michoacan, Jalisco, Mexico, Oaxaca, Campeche, and Quintana Roo. They are important not only for their woodland area, but because of the amount of timbering done in them. The total production for the last three years, in millions of cubic meters, was 9.3 in 1988, 8.8 in 1989, and an estimated 8.5 in 1990.

There is no precise information of the magnitude of deforestation in Mexico, greatly due to the illegal nature of the process. However, figures given by the Secretariat of Agriculture and Water Resources (SARH) indicate that 9.1% of the nations surface has been damaged. As for reforestation programs, figures from the same source indicate a relatively low trend: for 1989 and 1990, total reforestation was only 36 and 40 thousand hectares, respectively (table 2). These figures indicate that it is necessary to significantly improve reforestation programs, in order to at least partially compensate the amounts extracted from forests and rain forests. In general, reforestation is not as ample as society would require, particularly regarding the reposition of subtracted resources. There are nevertheless certain encouraging circumstances, like the outset of a nationwide reforestation program. In the same way, the promulgation of the General Law of Ecological Balance and

State	1988	1989	1990*	Total
Aguascalientes	567	1042	530	1139
Baja California Sur	847		44	891
Baja California	405	36.5	119	560.5
Campeche	613	183	327	1123
Coahuila	2497	57	223	2777
Colima	837	68	411	1316
Chiapas	3023	750	2500	6273
Chihuahua	2823	526	1972	5321
Distrito Federal	9773	4000	172	13945
Durango	2010	838	2670	5518
Guanajuato	1478	424	622	2524
Guerrero	1201	456	875	2532
Hidalgo	373	452	393	1218
Jalisco	3077		273	3350
México	11917	802	7000	19719
Michoacán	5695	16000	7958	29653
Morelos	781		296	1077
Nayarit	1216	505	269	1990
Nuevo León	506	160	215	881
Oaxaca	1634	315	357	2306
Puebla	1523	718	349	2590
Querétaro	995	524	250	1719
Quintana Roo	675	382	1009	2066
San Luis Potosí	1043	272	272	1587
Sinaloa	291	95	260	646
Sonora	221	125	167	513
Tabasco	1467	540	175	2182
Tamaulipas	2146	290	2628	5064
Tlaxcala	1621	3000	2096	6717
Veracruz	3685	3015	5200	11898
Yucatán	659	278	180	1117
Zacatecas	370	320	261	951
Total	65969	36171.5	40073	142213.5

- As July 1990
- Source: SARH, Sub secretariat for agricultural and forest development and promotion

Environmental Protection has, over the past two years, allowed a better regulation of forest resources.

#### *Oceans, Islands and their Resources*

Mexico has a privileged geographical position, due to it's location in the American continent, it's access to two oceans and it's extensive coastline, (more than 10 000 km), with a remarkable diversity of ecological environments. Because of it's importance, the Political Constitution of the United Mexican States was amended in 1976, to establish an exclusive economic zone (EEZ). The surface under national jurisdiction was hence increased by 2 892 000 km<sup>2</sup>, making the country's marine portion larger than it's continental counterpart. As to

our country's territorial seas, they reach 12 miles offshore and represent 231 813 km<sup>2</sup>. A decree that confirms the United Nations Convention on Ocean Rights was published in 1983, and finally, to adjust Mexican legislation to the spirit of the aforementioned convention, the Congress confirmed the Federal Ocean Law. There are approximately 216 islands of different ages and origins in Mexico's EEZ, as well as a great variety of shoals, capes, keys, and reefs. Due to their isolated environment, these locations have a high percentage of fauna and flora not found elsewhere, they are areas of great value for the country, which will be subject to further study as well as a detailed inventory in the future.

Climate, submarine topography, current patterns, temperature and salinity, origin and geological evolution, as marine flora and fauna, as well as fishing resources differ notably from the Pacific to the Atlantic Ocean -the two main seas in contact with Mexico-, and although both are located at the same latitude and belong to the same zone of warm waters of the world, they are very different from one another in many respects.

Such a difference is gratefully due to the fact that Atlantic waters are the final product of a superficial flow that begins as an up flow before the coast of Western Africa, whereas Mexican Pacific waters are the origin of a similar system extending to the west, through the tropical zone of the eastern Pacific Ocean.

Consequently, the Atlantic side has a thick layer of warm waters, poor in nutrients, as opposed to the thin, relatively colder, nutrient-rich superficial layer of the Pacific side. These conditions determine the marine

life of both shores: high organic productivity in Pacific waters, moderate productivity in Atlantic waters.

Besides the living resources, on the basin and beneath the ocean floor lie important sources of hydrocarbons and minerals. An example of this are the oil and natural gas deposits located in front of the coasts of Tamaulipas, Tabasco and Campeche in the Gulf of Mexico, and the vast manganese deposits in the Pacific Ocean. The extension, biological diversity, and beauty of the Mexican coast have made it a great tourist attraction for a long time. Over exploitation of fishing resources, uncontrolled tourism, pollution, and the introduction of exotic animals to the islands irreversibly alter the delicate balance of marine and insular ecosystems.

OCEANOGRAPHIC REGIONALIZATION. Mexican seas may readily be divided into regions or oceanographic provinces. For practical purposes the following classification has been adopted: coastal lagoons, and three regions in each coast of the country. In the Pacific: Baja California-Pacific; Gulf of California, and Mexico's eastern tropical Pacific. In the Atlantic: Southeastern Gulf of Mexico, Coast of Campeche, and Mexican Caribbean.

FISHING ACTIVITY. Use of the country's immense marine potential was scarce or nonexistent until the second half of this century. Fishing activity also fits within this definition, although there have been certain fisheries that, because of their size, have caused severe damage to the population of quite a few marine species. It is estimated that 800 species of fish inhabit Mexican waters. Other animal groups are also present, but there are no inventories that may provide information on their quantity or

usable potential. It is known, however, that 15 species of crustaceans, 18 mollusks and only three types of seaweed are exploited.

On the other hand there are a great deal of migrant species that have been utilized in the past and are still being exploited. A special case is that of the sea tortoise: seven out of the eight species in the world come to lay their eggs in Mexican beaches. As of May 29, 1990, their hunting has been totally banned, and protection programs have been implemented.

Small scale fishing in inner waters (1.4 million hectares) is very common; approximately 90 000 fishermen take part in it with an average occupation rate 200 days a year. However, there are certain internal bodies of water that, due to their environmental characteristics and size have generated important fisheries. Mexican sweet water fish fauna is made up of almost 500 species from 47 families; more than 60 of these species are regularly exploited.

All these marine and sweet water resources have made Mexico an important fishing country, (17th in the world), in a relatively short time, with a production of approximately 1 574 000 metric tons from November 1989 to October 1990. A development of aquacultural production has followed, this growth, contributing with 179 000 tons in the same time span.

Several aquacultural farms, some of considerable size, operate in Mexico. However, this development has generated several negative consequences for the environment. There are also several shrimp farms, most of them located in floodlands and saline areas on both coasts. These farms regularly modify the natural water flow, and on occasion contribute to the

destruction of nearby swampland; they also obstruct the free flow of nutrients towards the estuaries, and the continuous movement of organisms between the sea and these ecosystems.

Mexico's tuna fleet has 86 vessels: 20 for rod fishing and 66 for net fishing, which are equipped with special devices that allow dolphins to escape when they have been caught in the fishing net, in accordance with present legislation on this subject. The use of living water resources is not limited to fish: to a lesser degree, some reptiles and amphibians are also subject to certain kinds of fishing. There are presently 15 species of reptiles and amphibians being exploited, the more important of which are sweet water turtles and frogs.

Exploitation of aquatic plants in continental waters centers on those used for decoration in aquariums (only 17 species), and commerce for them exists in the cities of Mexico, Guadalajara, Monterrey, and Merida.

With the participation of the Secretariat of Fishing (SEPESCA), SEMAR, SEDESOL, Mexican Petroleum (PEMEX), as well as research institutions and universities, Mexico has implemented the following programs: the National Program for the Preservation and Protection of the Marine Tortoise, the National Program for the Preservation of Marine Mammals, the Plan for Action on Prevention and Control of Marine Pollution, the Program for Ecological ordering of Coastlines (like the recently created Cancun-Tulum corridor), the Caribbean Action Plan, and the Protocol for the Greater Caribbean, among others.

#### *Non-Renewable Natural Resources*

HYDROCARBONS. Proven reserves added up to 66.450 billion

barrels of crude oil in 1989 (Fig. 5). Proven hydrocarbon reserves by December 1990, considering the extraction of 1.268 billion barrels of crude oil that year, were estimated at 65.5 billion barrels a reduction of 1.4% in one year. Proven reserves in December 1991 were 65 billion barrels of equivalent crude oil. The complexity of the oil industry and the characteristics of the products it handles make it a hazardous industry that is potentially polluting. In this light, PEMEX has adopted, throughout its different productive processes like extraction, perforation, transformation of oil, and basic petrochemistry, as well as during conduction of hydrocarbons through pipelines and land and sea transport, strict security and environmental protection measures in order to minimize risks. Nevertheless, accidents which are out of the company's hands may occur, and which occasionally affect the ecosystems that surround the installations.

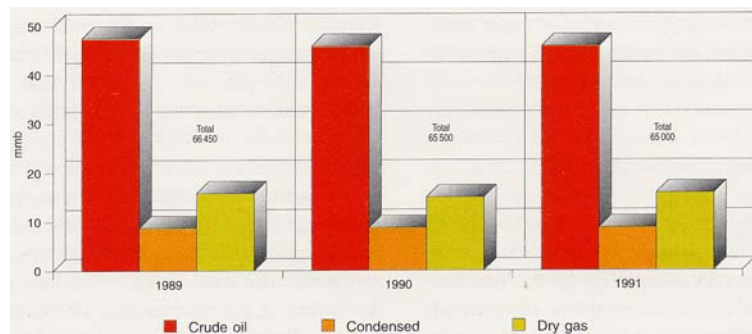
From an environmental point of view, there is the hazard of pollution produced by emission of fumes, dust, and gases, wastewater discharges and oil spills. Aware of these facts, PEMEX has taken the social responsibility for the protection and restoration of the environment.

COAL. Coal reserves are primarily located in the state of Coahuila. Negative environmental impact may be caused due to mining, specially in the

operation of open mines (very large in size), and also while eliminating soluble substances that are carried by rain, polluting lakes, rivers, and underground water supplies with arsenic and heavy metals. In addition, a great amount of ash is emitted by the coal burners needed for the generation of electricity, requiring measures that minimize polluting effects. Proven reserves of coal increased to 600 million tons of thermal coal, of which 4.1 million were used in electric energy generation.

At the same time, proven reserves of coal suitable for making coke reached 1.56 billion tons, of which 7.1 million were used in the steel industry.

MINING. Mining is one of the economic activities with the oldest tradition in Mexico, but a modern conception of mining in the country cannot disregard ecological criteria, for, like some other activities, mining and metallurgy due to their polluting nature, tend to be detrimental to the environment. Many stages of mining activity, like exploration, exploitation, industrialization and disposal, involve risks to the environment. Pollution is present in many forms, one of them within the hydro-metallurgical processes, when wastes and salts are not contained in deposits built for such purpose. The larger part of the wastes presently generated in these processes are harmful to biological systems because organisms are incapable of biodegrading them; this is the



case of heavy metals and mercury. In the case of pyrometallurgical processes, the environment is affected due to the emission of gases into the atmosphere, mainly lead and sulfur. Careful identification of these problems has allowed the implementation of national programs and specific environmental projects that establish appropriate priorities according to their respective magnitude.

#### *Wild Fauna and Flora*

BIODIVERSITY. Mexico is a country with a vast biological diversity, recognized worldwide. A privileged geographical position -between two biogeographical regions- contributes to this fact. The different ecosystems of the land are home to one of the largest inventories of biological diversity in the planet. As to its fauna, Mexico has the second largest variety of mammals in the world (with 449 of the 4 170 species that exist), only second to Indonesia, with 515; it has the twelfth largest variety of birds in the world (1 150 out of 9 198), with 30% more species than Canada, the United States and Russia combined. It has the fourth largest amphibian variety with 282 species out of the existing 4 184 (63% of which are found only in Mexico); it has the first place in reptiles, with 717 out of 6 300 species, 514 of which are found exclusively in Mexico. In butterflies of the Papilionade family, it has the tenth place with 52 of the registered 1 012 as well as 2 000 species of diurnal butterflies. It has 25 000 out of 250 000 species of vascular plants, and an estimated 30 000 more have yet to be registered. Among the tropical countries with a high biological diversity, Mexico is placed first in mammals, seventh in birds, fourth in amphibians,

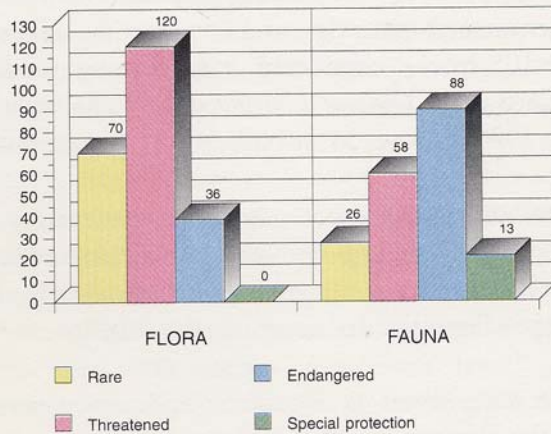
first in reptiles, sixth in butterflies and third in plants.

It is evident that the most detrimental effects on Mexico's biological assets have occurred in the present century, as a consequence of an unprecedented demographic concentration, alongside a technological development which was not in accordance with the well being of the environment. Constant change of land use, increasing pollution of the ecosystems and irrational depredation of wildlife have caused serious transformations to the environment. As to the loss of forests, Mexico has, according to 1989 figures from the FAO, a mean deforestation rate of 1.3%, placing twenty-third in the world and eleventh in Latin America. The world deforestation rate is 0.6% a year, and the animal species most affected by the loss of this habitat are mammals, birds, and invertebrates.

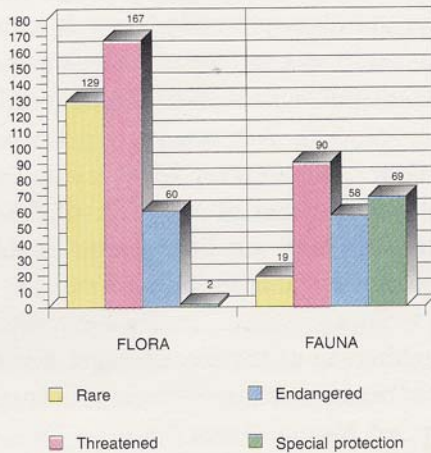
Of the total species of plants and animals in Mexico, it is estimated, in a preliminary fashion, that 242 are endangered, 435 are threatened, and 164 are rare; out of these, 400 are found exclusively in Mexico, of which 124 are endangered, 180 are threatened, and 96 are rare species (Fig. 6). The species that are most at risk are birds, followed by fish and mammals. The activities that are the main causes of biodiversity loss are changes in land use and over-exploitation by legal and illegal traffic of wildlife. Among the most severely affected species of flora are orchids and cactuses, due to the pillage carried out by foreigners in our country.

The Mexican territory is an important hibernation area for migrant species of the north of the continent: it hosts 51 % of the total species of migrant birds of North America, which spend 9 months a year in

Figure 6  
Endemic Species



Non-endemic species



Mexico. If we consider the migrant species that are shared with the United States and Canada, biological diversity is further increased; butterflies, fish, whales, bats, and marine turtles fall into such category. Mexico also houses important marine habitats in both the Pacific coast and in the Gulf of Mexico. The Pacific coast of the Baja peninsula is home to the only known reproductive zone of Guadalupe fur seal (*Arctocephalus townsendi*); the Gulf of California is home, in turn, to the only population of the

harbor porpoise or cochito (*Phocoena Sinus*) in the world.

Mexican flora is also rich in endemic species: more than 2 000 genres of flowering plants, 22 000 known species and 30 000 being registered. Over 15% of these genres are endemic and 45% of the species are as well. These endemic species include: 50% of all the species of bean (*Phaseolus spp.*) in the world are only found in Mexico; 82% of all the species of agave (*Agave spp.*); and 88% of the world's species of sage (*Salvia spp.*).

In Mexico, use of plant resources has been mainly aimed at the massive exploitation of certain taxonomic groups, particularly coniferous trees, fine woods, ornamental plants, fibers, waxes, resins, and rhizomes. However, an estimated 5 000 species of flora are used in some form by the communities.

The predominant vegetation of the territory is bush land, followed by rain forest, forest, and grassland. It should be pointed out the bush land, which takes up nearly 56.1 million hectares, is the type of vegetation that is least affected by human activity. On the other hand human influence on jungles and forests is of great significance.

Utilization of animal resources, on the other hand, has been primarily for hunting/purposes, for leather and ornamental industries, and for scientific research. There 105 species considered in the hunting calendar published in the Official Journal of the Federation on August 1990; of these, 54 are birds, and 51 are mammals.

Non-hunting use is concentrated fundamentally on 74 species of singing and ornamental birds whose capture, transport, and handling are regulated by the corresponding calendar issued by the SEDESOL.

The main threat to Mexico's biodiversity comes from the changes in the use of the land (40% of the country may still be considered a natural habitat), pollution of the ecosystems, and illegal traffic of species. The SEDESOL presently has at its disposal a preliminary list of species that are rare, threatened, or endangered, as well as their endemic nature (Figure 6).

PRESERVATION STRATEGY. Mexico and Brazil, combined, have between 60 and 70% of the world's biodiversity; therefore, our country has established a preservation strategy that includes:

- Strengthening of the present legal framework.

- Consolidation of the National System for Protected Natural Areas.

- Creation of the National Zoo and Breeding House Network, and the Botanical Garden and Nursery Network.

- Exchange of public debt for "ecological swaps" for the creation of information centers and data bases in the National University (UNAM), the Natural History Institute of Chiapas, and the Research Center of Guaymas, Sonora, as well as specific activities that support research activities on the biological diversity of the Lacandon Rain forest and the islands of the Gulf of California; the sponsor being, among others, Conservation International, an American ecologist group.

- Supporting private organizations in the diffusion of knowledge and public awareness on coresponsibility in the protection of biodiversity.

- A World Bank Loan for Actions of Monitoring and Control of Pollution, a National System for Inspection and Surveillance, a National Program for the Preservation and Protection of the Marine Tortoise through the National Network of Turtle Campsites, studies for the creation of biological corridors, and the creation of a National Program for a Center of Confiscation and Rehabilitation of Wild Species.

- Publishing of the list of endangered species in the Official Journal of the Federation.

- Administrative coordination with the Cooperation Agreement signed between the General Attorney's Office and the SEDESOL, for the persecution and prevention of ecological crimes.

- Support the creation of seed banks.

- Coordinated actions of the National Solidarity Program with the World Bank, to obtain a credit for the sustainable development of societies bordering the Lacandon Rain forest, so as to lessen its environmental pressure.

ACTIONS. The great biological diversity of the country demands the application of different forms of use and preservation of wild fauna and flora. Under this light, and with the purpose of promoting the recovery of wild species in Mexico, the SEDESOL has implemented a series of actions among which are the operation of: breeding houses, nurseries, wildlife stations and zoological parks. In addition, it has supported the following: imports and exports of wild flora and fauna, scientific research and recollection, inspection and surveillance.

Finally, as of July 2, 1991, Mexico officially entered the



Convention on International Trade of Threatened Animal and Plant Species.

#### *Protected Natural Areas*

The National System for Protected Natural Areas (SINAP) reinforces the basic infrastructure and enhances the total protected and safeguarded territory of the most representative ecosystems in the country, as established in the National Environmental Protection Program (NEPP), 1990-1994. This Program includes nine management categories, yielding a total of 100 areas under the jurisdiction of SEDESOL. Of these, 68 are handled and managed by the Secretariat, of which 44 are national parks, with an extension of 688 984 hectares; 14 are special biosphere reserves (550 236 hectares); eight biosphere reserves with 4 443 077 hectares; a wild animal and plant protection area covering 37 302 hectares, and; a natural monument (6045 hectares). The 32 remaining areas contain natural resource protection zones, managed by the SARH; these include forest reserves, national forest reserves, and protected forest areas, with a total of 8450701 hectares.

Between 1988 and 1990, the SINAP has grown by 24% (3 426 454 he), with the establishment of four additional natural areas with different management categories: El Vizcaino Biosphere Reserve, in Southern Baja California (2 546 790 he); Calakmul, in Campeche (723 185 he), and El Triunfo, in Chiapas (119 177 he). Also included is the protected area for wild and aquatic animal and plant life Chichinautzin Biological Corridor, in the states of Morelos, Mexico, and the Federal District, with an extension of 37 302 he. The amount of the territory protected by the SINAP, as a percentage of the total national territory, is 7.2%.

Three national parks and five biological reserves are currently being incorporated into the system. In accordance to NEPP goals for 1990-1994, the capacity for surveillance and control of natural protected areas has been increased. Cooperation with federal, state, and municipal authorities was established by means of the corresponding agreements for organized participation.

#### **Environmental Quality**

##### *Air Quality*

The analysis of environmental problems in the country shows a distinct relation between pollution, mountain geography, the size and dynamics of human settlements, and economic growth. Pressure generated by demographic and industrial concentration, plus a lack of integral planning for the use of land and its resources has caused an environmentally unbalanced development.

Atmospheric pollution is a consequence of such type of development, and as an example of the influence of orographic conditions, it may be stated that over 60% of the nation's population reside in place located at more than 500 meters above sea level, where environmental conditions are least favorable. Three sections of the country produce 40% of the atmospheric emissions: the metropolitan area of the cities of Mexico, Guadalajara, and Monterrey. As to the first, the largest urban and industrial concentration, the growing use of motor vehicles, the existence of large eroded areas and seasonal farmlands, as well as excessive energy demand have all contributed to the detriment of air quality; in addition, the geomorphology of the region does not help to the circulation

Sector	Sources	SO	NOx	HC	CO	TSP	Total
Energy	PEMEX	7.2	1.8	5.5	1.8	0.3	2.4
	Thermoelectric plants	28.3	3.7	0.0	0.0	0.8	1.6
Industry and Services	Industry	32.0	16.3	7.0	0.5	2.3	3.7
	Trade	10.7	2.2	0.0	0.0	0.5	0.7
Transport	Automobiles:						
	Private	1.7	23.7	24.7	45.0	1.0	34.9
	Taxis	0.4	5.4	5.6	10.2	0.2	7.9
	Minivans and minibuses	0.4	5.7	7.5	13.7	0.2	10.5
	R-100	2.5	4.5	0.4	0.2	0.1	0.5
	Cargo trucks:						
	State of Mexico	6.3	10.3	0.9	0.4	0.1	1.1
	Gsoline trucks	0.5	9.6	11.9	26.4	0.3	19.9
	Diesel	9.8	14.7	1.3	0.6	0.2	1.6
	Others	0.1	1.5	0.3	0.2	0.0	0.2
Ecological impairment	Eroded areas	0.0	0.0	0.0	0.0	93.1	9.6
	Fires and other processes	0.1	0.5	34.9	0.9	0.9	5.3
	Total	100.0	100.0	100.0	100.0	100.0	100.0
	Totales (ton/year)	205 725	177 339	572 101	2 950 627	450 599	4 356 391

Source: Integral Program against atmospheric pollution, technical intergovernmental secretariat, october, 1990

of pollutants, for in addition to being located over 2 000 meters above sea level it forms a closed valley, favoring the concentration of pollutants.

The other two urban areas are in similar, yet less dramatic, conditions. In Monterrey, industrial activity is represented by over 7 000 firms, and the utilization of non-metallic mineral resources has been decisive both in the development and in the pollution of the region.

Oil and docking industries in the Gulf of Mexico have brought important benefits to the country, however, the concentration of related activities has had a significant effect on the region. The same may be said for the industrial corridor of the Central Plateau and for the Tula-Vito-Asasco zone, where petrochemical industry and electrical energy

generation have surpassed the environment's assimilation capacity, emitting 350 000 tons a year; the most abundant of these pollutants being sulfur dioxide and suspended particles (80 percent). The accelerated industrialization process in the border area of the north of the country has produced air related environmental effects, which are worth considering. Solid waste disposal is also of concern, for only 30% of all generated wastes are presently returned to their country of origin. Furthermore, the creation of approximately 1 500 industries in the border area has prompted an accelerated demographic concentration that will generate new sources of pollution. A common factor in the deterioration of this area is a high fuel consumption for industrial, commercial and service purposes.

MEXICO CITY'S METROPOLITAN AREA (MCMA). Air pollution in this zone is a result of a high demographic concentration. It is important to consider that the

MCMA houses more than 15 million people which generate over 36% of the country's national product, and consume 17% of the nation's electricity. An estimated 12 000 service establishments that use combustion and incineration processes operate in the MCMA.

The thermoelectric centrals of Jorge Luque and Valle de Mexico combined produce more than 9% of the total industrial, commercial, and service related emission of pollutants; production, storage, and distribution of fuels generate around 14% of the pollution from stationary sources, while motor vehicle pollution represents 76% of the total atmospheric emissions in Mexico City (Table 3).

Thermal inversion is one of the elements that more directly contributes to the accumulation of atmospheric pollutants; these

occur practically every day of winter in the MCMA. Moreover, this season brings other meteorological phenomena that increase the concentration of

pollutants, like the presence of high pressure systems that further limit their dispersion. The main pollutants in the metropolitan area of Mexico City are carbon monoxide, sulfur dioxide, nitrogen oxides, ozone, suspended particles, and lead.

The standards by which these pollutants are measured (table 4) were established by the health sector through a decree published on November 29, 1982. This decree considers man as the foundation and objective of these standards.

In order to evaluate air quality in the MCMA, a system of monitoring stations has been implemented; they form the Automatic Network for Atmospheric Monitoring (ANAM) and the Manual Atmospheric Monitoring Network. The first of these has 25 stations that evaluate seven

pollutants and four meteorological parameters. The second comprises 19 stations that evaluate total suspended particles, or TSP (five), breathable suspended particles (BIP), SO<sub>2</sub>, NO<sub>3</sub>, and heavy metals (lead, cadmium, copper, zinc, and nickel). In order to enhance the ANAM's coverage, there is a financing project from the World Bank, to extend and reinforce the present network.

The SEDESOL published in 1986, the Metropolitan Index of the Quality of Air (IMECA in Spanish) on a daily basis, in order to inform on the levels of pollution in the MCMA. This index shows the relation to a standard of 100 for pollutants in each one of five metropolitan zones (northeast, northwest, central, southeast, and southwest).

The Environmental Contingency Program has been applied on several occasions since 1987. This program foresees critical situations for all pollutants; it's actions are directed towards reducing the emission from sources of ozone, thus reducing these pollutant's concentration in the short term.

ACTIONS. As a result of the information gathered on the main causes and processes that affect atmospheric conditions, several actions have been implemented at sectorial and inter-institutional level in order to prevent and control the impairment of the quality of air. Among these actions are: the creation of a regulating framework for the Motor Vehicle Emission Verification Programs, and their establishment in the MCMA with a mandatory nature; the application of the no circulation ("Hoy no circula") program in the MCMA for the winter season 1989-1990; compulsory use of the most advanced and accessible technology for the control of vehicle emissions of new automobiles; the improvement of

gasoline and its combustion by adding oxygenated compounds like methyl-terbutylic ether (MTBE); total substitution of heavy fuels by natural gas in both thermoelectric centrals; the implementation of the Program for the Control of Vapor Emission in PEMEX Storage Tanks and Distribution Vehicles; completion of 118 agreements with the industry for the installation of control devices for nitrogen oxide emission.

#### *Water Quality*

In Mexico, like in many other countries, the main water pollution sources have been grouped inside three sectors, according to their origin:

- Social origin, which correspond to domestic discharges and constitute municipal wastewater.

- Agricultural, generated by the runoff from installations for breeding and fattening of large and small cattle, and residual waters from agricultural farmland.

- Industrial, generated by discharges from resource extraction and transformation activities (into consumable goods).

EXISTING TREATMENT SYSTEMS. There are presently 361 municipal wastewater treatment plants, with an installed capacity of 29.10 mVs; there are also approximately 282 industrial wastewater treatment plants, with an approximate installed capacity of 20 m-Vs. This shows that, from the total municipal wastewater discharge of 105 mVs, only 24% can be presently treated; besides, approximately

Table 4	
Air Quality Evaluation Criteria	
Pollutant	Criteria (standard)
Carbon monoxide	13ppm in 8 hours
Sulfur dioxide	0.13 ppm in 24 hours
Nitrogen dioxide	0.21 ppm in 1 hour
Ozone	011 ppm in 1 hour
Particles (less than 10 microns)*	150 ug/m in 24 hours
Total suspended particles	275 ug/m3 in 24 hours
Lead	1.5 ug/m3 (3 month average)
Source: integral program against atmosphere pollution. Technical intergovernmental Secretariat, October, 1990	
*International criteria	

half of the treated water is for reuse, and not for pollution control. As to industrial wastewaters, with a total discharge of 79 mVs, only 25.3% is treated.

The existing municipal treatment plants mainly use processes based on stabilization containers and active mud, while the industrial treatments systems mostly use active mud processes with chemical coagulation.

HYDROLOGICAL BASINS. The hydrological basins where sanitation measures are being taken are: Lerma-Chapala, Balsas river, San Juan river, Blanco and Panuco river basins, as well as Patzcuaro lake and the border area. The need for keeping a continuous and systematic record of water quality in the main bodies of water of the country was determined as a result of specific studies, leading to the creation of the Water Quality Monitoring Network (which presently has 364 stations). With the help of this network, sampling and periodical analysis of superficial, underground and coastal waters has been carried out, including physical, chemical and bacteriological studies from strategic locations throughout the country.

In accordance with the National Environmental Protection Program for 1990-1994, laboratories for analysis are

being continually equipped, and pollution sources are being constantly inventoried. The SEDESOL has been developing and implementing a series of techniques and methods to determine the degree of toxicity of water in the fastest and safest way possible, with the intention of evaluating the presence of toxic pollutants in superficial and residual waters, as well as for establishing the potential threat these represent to the users of the resources and to aquatic ecosystems in general.

LEGISLATION. The ecological criteria for water quality were published on December 13, 1989, in the Official Journal of the Federation. These include a total of 24 parameters and 98 substances that, due to their negative effects on human health or the ecosystems, have been considered of top importance. These criteria establish the minimum quality required for use and consumption of water, and the technical ecological standards which establish the prerequisites that must be observed to guarantee the population's well being, as well as assure the preservation and restoration of ecological balance and the protection of all the country's water sources. Between 1988 and 1989, a total of 33 technical standards for the control of industrial wastewater discharges into the sewage and agricultural runoff reuse were published.

#### EVALUATION AND CONTROL OF TOXIC SUBSTANCES.

In 1989, a National Program for the Control and Evaluation of Toxic Substances in Superficial Waters was established, with the main objective of determining the degree of pollution in our superficial waters due to these type of substances, as well as for implementing the necessary policies for the prevention and control of pollution due to toxic substances. In coordination with

this program, studies are presently being conducted in the five main basins; these studies regard, among other aspects, both the degree of toxicity of the waters, as well as their metal and pesticide content. In the same way, the program coordinates studies that focus on the adequate technologies for their elimination from wastewaters. In order to confirm the absence of toxics in both industrial discharges and bodies of water, the SEDESOL has been devising the appropriate technologies (biotests) that will permit the detection of these types of compounds in a fast and safe manner. A laboratory has been created for this purpose, where acute toxicity tests are carried out under the methodology proposed by the Pan-American Center of Sanitation Engineering and Environmental Science, and the Latin American Regional Project for the Control of Toxic Substances.

#### *Municipal Solid Waste*

Solid wastes are classified according to their source in: municipal, industrial, hazardous, or non-hazardous. In the first two cases they are categorized depending on the source of generation, and in the third case, division is made according to the handling, treatment, and disposal requirements of this particular type of waste.

According to the last population census (National Statistical, Geographical and Informative Institute -INEGI-, 1990), the country has a population of 82 763 740 inhabitants, which generate 59 085 tons of solid waste a day, with a total of 21 566 025 tons generated every year.

The efficiency of the disposal systems is moderate, with an estimated 41 359 tons/day collected, (70% of the total),

adding up to 15 096 035 tons a year. Of these, 12 407 tons/day are deposited in landfills -30% of the collected waste- or 4 528 810 tons a year; the remaining 28 952 tons collected daily are disposed of in open dumps and reach a total of 10 567 480 tons a year.

As to standard setting, 17 official standards regarding solid waste disposal have been published in our country. Integral management of municipal solid waste disposal faces a difficult situation due to the need for establishing a self-supporting tax system, so that waste management may be efficient, punctual, and organized.

#### *Hazardous Wastes*

According to international terminology, Mexico has adopted the so called CRETÍ code for the categorization of hazardous wastes (corrosive, reactive, explosive, toxic and ignitable), besides the infectious wastes, generated in hospitals, clinical analysis labs, as well as research and higher education centers.

GENERATION. Industrial wastes generated nationwide amount to approximately 450,000 tons a day, of which 337,500 correspond to extractive mining and melting of non-ferrous metals; 81,000 tons correspond to processes from basic chemical, organic and inorganic, industries; 31,500 are due to agro-industrial wastes, among which the more important ones are the sugarcane industry, the coffee industry, and the juice and oil concentrating industries. All of the above generate a total of 164,250,000 tons a year of industrial waste. Of this figure, 14,500 tons a day (the equivalent of 5,292,500 tons a year), are wastes considered to be

hazardous, which are primarily generated in the chemical industry -both organic and inorganic-, as well as in the petrochemical industry. Heavy metals are produced by the smelting of ore, in the concentration of certain non-ferrous metals (like precious metals), and in the production of agrochemicals. Mexico City generates approximately 173,520 tons a month of industrial waste.

FINAL DISPOSAL OF HAZARDOUS WASTE. Mishandling of hazardous wastes, like their unauthorized disposal in abandoned dump yards or sites, in river beds, estuaries, or in the sea, causes substantial damage to the environment and its resources and, given the persistence of many of these pollutants, they can enter the human food chain, gravely affecting human quality of life.

The strategy adopted by SEDESOL for the control of toxic and hazardous substances establishes, in its first stage, the need for reducing their generation by recycling, their physical, chemical and biological treatment, as well as their incineration and controlled impoundment. Through concertation, the institution has convinced several private industries of installing plants for the treatment and disposal of the wastes they generate. Another fundamental measure of control in the future will be the exclusive authorization of new plants with clean technology within their processes, in order to reduce waste generation.

#### *Health and Safety*

ENVIRONMENTAL HEALTH. Human health is directly linked to environmental quality and conditions and, particularly, with the distribution of drinkable water, water management, the disposal of human and

municipal wastes, the presence of noxious organisms, and physical, chemical and biological pollution. All this is reflected in each society's health and death patterns.

Mexico presents an epidemic transmission phenomenon, where several transmissible diseases coexist, among them acute respiratory diseases and diarrhea, as well as those associated with modern urban and industrial life, like cancer; this emphasizes the need for facing both basic sanitation problems, as well as those derived from other activities that generate different factors that jeopardize human health. The above implies that traditional sanitation schemes must be expanded to evaluate a wider range of environmental effects on health, studying the adverse effect of physical and chemical pollutants on the population, an area that is still incipient in our country.

DRINKING WATER AND SANITATION. Dysenteric diseases are among the most frequent causes of illness and death in Mexico. The crucial lack of water in most of the territory has made it necessary to employ wastewater for irrigation, which has had a positive fertilizing effect in arid soils. However, such use poses a threat to human health, specially when used on vegetables, which are eaten raw, due to the presence of pathogen organisms like viruses, bacteria, protozoons, and helminth worms which are the cause of diseases considered a public health in Mexico. In addition to this risk, there is the hazard of human exposure to persistent materials that are subject to accumulation, like heavy metals; this risk is accounted for by industrial effluents that carry potentially toxic chemical compounds, which flow to water reserves used for irrigation.

Consequently, the Secretariat of Health (SSA) has issued sanitation criteria where the Technical Ecological Standard is supported, prohibiting the use of wastewater for the irrigation of crops that grow at ground level and that are eaten raw.

The importance water-related and basic sanitation problems have for the Mexican government is patent in the National Strategy for the Observance of Water Pollution Problems, and in the Clean Water Program, upheld by president Carlos Salinas de Gortari, who has pointed out that to act against pollution problems is to forestall health problems, for it would be illogical to channel extraordinary investments for hospitals and health care for the Mexican people if efforts were not also made to counter the origin of these health problems.

ATMOSPHERIC POLLUTION. Knowledge of the effects of atmospheric pollution on the population is a fundamental element in the definition of maximum permissible limits of pollutants in the atmosphere, as well as for optimizing actions that involve an intersectorial emergency response. The SSA is therefore carrying out studies and collating information to evaluate such effects on the inhabitants of urban areas like the MCMA. There are studies on: evaluation of the effects, and control of exposure to lead; arsenic and fluoride pollution; health risks due to exposure to hazardous wastes; danger of intoxication from pesticides; prevention and control of toxic related accidents; environmental health problems in the northern border, and; the importance of personal health care in the prevention of environmental hazards, among others.

Three fundamental elements have been emphasized for the safekeeping of human health



against negative effects from environmental pollution: implementation of an adequate regulative framework; the development of control measures, and; public education.

#### *Noise*

Noise is a characteristic pollutant of large urban centers. It can cause disorders and diverse disturbances like stress, and may even cause physiological damage. The main sources of noise pollution are industrial and commercial activities, besides air and land transportation. In order to reduce this type of pollution, different levels of government have included various actions in their programs. For example, different cities in the country have carried out noise reduction programs, consisting of obligatory engine changes to motor vehicles and control of exhaust systems, specially in diesel engines.

#### *Environmental Impact and Risk*

Evaluation of environmental impact is one of the most efficient means available to the State for the implementation of ecological policy and environmental planning for the country's development. It's importance is directly related to the damage that may be prevented to the direct ecological vicinity of it's action. The evaluation of a project or activity subject to an environmental impact study considers the magnitude and nature of possible environmental effects generated by it's own construction or activity. Roughly, the following aspects are taken into account: characteristics of the projected work or activity; chosen location for it's development; required input; general socioeconomic and natural environment conditions; relation with standards and regulations for land use; recognition of environmental

impacts; prevention and mitigation measures to be implemented, and; the environmental scenario after the conclusion of the work or activity.

The declaration of environmental impact must be made before SEDESOL by those responsible of all public or private works that lie within the legislative framework of the General Law of Ecological Balance and Environmental Protection, in effect as of march 1, 1988. The agendas of different productive sectors, like tourism, energy, transport and fishing have been looked into.

#### *Environmental Emergencies and Contingencies*

In broad terms, to talk about environmental emergencies and contingencies is to talk about technical criteria of classification, as well as measurement, prevention and control of incidents of water, air, land, and natural resource pollution, alongside their effects on human health.

ENVIRONMENTAL EMERGENCY AND CONTINGENCY PROGRAMS. Among the most important environmental emergency and contingency plans and programs in the country are: Joint Response Program for Hazardous Waste Spills in the Border Area (within the Mexico-USA treaty); National Contingency Plan for the Control and Containment of Hydrocarbons and other Noxious Substances in the Sea; Bilateral Agreement on Pollution of the Marine Environment by Hydrocarbon Spills and other Harmful Substances (Mexico-USA); Plan for the Tacana Volcano; External Radiological Emergency Plan; International Agreement for the Prevention of Hydrocarbon Sea Water Pollution; London Agreement on Prevention of Pollution of the Sea form Waste Spills and other Substances; Agreement for the Protection and Development of the Marine

Environment of the Greater Caribbean Region; the Contingency and Emergency Programs for Atmospheric Pollution Incidents in the MCMA.

CONTINGENCY PROGRAM FOR ATMOSPHERIC POLLUTION INCIDENTS IN THE MCMA. Agreed by all the involved sectors and within the framework of the National Civil Protection System, this program consists of the adoption of sectorial measures to decrease dangerous levels of pollution and, simultaneously, spread adequate and prompt information to the public as part of an emergency situation. The participating sectors are: government, private, social and the general public.

The Program considers, by means of the actions it establishes, the reduction of industrial and motor vehicle atmospheric emissions, which lead, with the objective of protecting the population, to a virtual interruption or suspension of activities. The Program may be enacted during any season of the year.

Measures have been divided into three phases, depending on the seriousness of the situation:

Phase I. If the level of pollution fluctuates around 250 points IMECA in large areas of the city, and atmospheric forecasts are unfavorable.

Phase II. Becomes active when pollution reaches 350 points IMECA, depending once again on how generalized the problem is and an meteorological forecasts.

Phase III. It would be enacted in the case of a critical situation, with over 450 points IMECA and an adverse atmospheric forecast. In this phase, there would be an additional suspension of activities, similar to a national holiday.

EMERGENCY PROGRAM FOR ATMOSPHERIC POLLUTION INCIDENTS IN THE MCMA. It will be applied in the unlikely, although not impossible event of a failure of the contingency program to produce satisfactory results in the reduction of pollutant concentration within a specific area of the city. Linked to the contingency program, it is designed to radically and immediately confront any serious pollution problem in the Metropolitan Area of Mexico City.

### **Environmental Promotion and Public Participation**

#### *Municipal Environmental Action System (MEAS)*

Solving the problems Mexico must face during the country's development process implies strong changes, ranging from modernization of the institutions themselves and the solidarity of it's people, to the decentralization of federal offices. From this point of view, the decentralization of the public sector may be understood as the process that in the midrange will allow the integral and sustainable development of the country. The inclusion of explicit environmental criteria within the Municipal Development Programs is imperative, as well as the precise definition of environmental actions that each entity -municipalities, states, and the Federation- must undertake to consolidate a Municipal Environmental Action System.

The MEAS's objective is to provide the municipality with the necessary elements to freely manage and operate it's own environmental protection and natural resource preservation programs, considered within their Municipal Urban Development Program.

#### *Public Participation and Sectorial Promotion*

The interaction of society and the environment is one of the central principles in facing the national challenges related to environmental protection. Such interaction has been therefore defined with three basic principles: to promote the adequate utilization of natural resources; to improve the quality of education, which shall include environmental topics in plans and study programs of the National Education System; and involve society in activities for the protection and fostering of natural resources. Based on these points, several projects that abet public participation were devised: ecological fostering, the improvement of ecosystems, public denounce, health, security, environmental sanitation of plants in the MCMA, and environmental education.

In the words of president Carlos Salinas de Gortari: "Environmental deterioration is a problem that concerns us all, both as nations and as individuals. It is a worldwide reality that directly involves the conscience of the citizens. There cannot be an ecological solution without social awareness and participation, without environmentally sound everyday behavior".

#### **International Cooperation on Ecology and Environment**

Mexico has played an international role of great scope and vision on different occasions. Environmental and ecological matters have taken up an important place in this activity, which has been bolstered, due to Mexico's efforts in solving its own internal problems, and because it is considered to be a convenient instrument for solving local manifestations of global environmental problems.

Although Mexico states that the country's priority is to its own people, environment, and natural resources, the nation has fully accepted its responsibility of environmental protection in international forums, recognizing that ecological problems may become a threat to humanity. For this reason, Mexico asserts that the solution to these problems require international cooperation, based on the principles of sovereignty, equity between nations, and equal responsibility and caution in the face of future problems. In such fashion, and in accordance to the goals of the PNPMA for 1990-1994, the country's presence in international forums will be preserved, renewing its commitments regarding control and prevention of environmental problems of international interest.

#### *International Agreements*

Mexico has participated in the negotiation, and the signature of various international agreements for the protection of the environment with different agencies of the United Nations' system and organisms. Among these are: United Nations Development Program (UNDP), United Nations Organization for Industrial Development (UNOID), United Nations Environmental Program (UNEP), United Nations Conference on Environment and Development (UNCED), World Meteorological Organization (WMO), International Maritime Organization (IMO), Pan-American Center of Health and Ecology, Organization of American States (OAS), European Community Commission (ECC), Economic Commission for Latin America and the Caribbean (ECLAC), Central American Commission on Environment and Development (CACED), and the United Nations Food and Agriculture Organization (FAO).

In recent years various scientific organizations have documented the fact that human activity is beginning to affect the delicate balances that allow life to be maintained on the planet; although a definite collective decision has not been reached about which are the truly global phenomena, the list tends to be limited to the following: destruction of the upper ozone layer, elimination of biodiversity, international water pollution, and others that affect the global climate.

Mexico's energy supply depends by 86.9% on fossil fuels (hydrocarbons used in basic petrochemistry and coke used in metallurgical processes must be subtracted from this percentage), and has therefore an energy activity with high carbon dioxide emission; on the other hand, it is a pioneer in the use of alternate energy sources, notably geothermal energy, in which it is fourth in the world. Per capita emission in the country is being researched simultaneously by the SEDESOL and the National Commission for Energy Saving; the most likely figure is about one ton of CO<sub>2</sub> equivalent a year, which is approximately what this research should yield. This figure also includes the effects of deforestation analyzed elsewhere in this summary. Mexico accepts its responsibility in global phenomena under the principle of proportional equity, and therefore also sustains that on self interest, it should increase measures that tend to lower thermoactive gas emission, by means of a greater effort in saving and rational use of energy, deforestation decrease, and more widespread reforestation efforts. The country plays an active role in scientific, technical, and economic research on climate change; it has organized scientific committees

and intersectorial work groups to reinforce these activities.

By November 1991, 48 international cooperation agreements had been signed, among them the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Diminish the Ozone Layer, having been the first country to sign this last agreement; actions defined therein having been achieved at considerably earlier dates than those scheduled in the Protocol. Mexico has had active participation in the actions of the Intergovernmental Panel for Climate Change, as well as in the initial negotiations for the establishment of an international legislative framework on the matter.

Additionally, Mexico takes part in international negotiations on biological diversity, having recently subscribed the Basil Convention on Transborder Movement and Disposal of Hazardous Wastes, as well as the Marpol Convention. It has issued a document that adheres it to the Convention on International Trade of Wild Plant and Animal Species, and is a part of the Convention of Significant Wetlands.

The country fosters and actively participates in all international efforts to commit the nations to the improvement of local and global environment, as well as to the sustainable utilization of natural resources. Mexico has an extensive scientific and technological bilateral cooperation program on environmental affairs. Within this program the agreements with the United States of America stand out, specially regarding the border area, as well as those subscribed with Japan for economic cooperation in the battle against Mexico City's pollution problems; finally there are several agreements on

environmental cooperation that have been signed or will be signed shortly, with other countries like Germany, Brazil, Canada, Chile, Spain, France, and the United Kingdom. Environmental cooperation has increased with Guatemala, Belize, Sweden and the European Community Commission.

#### *International Financing*

The recession of the eighties, the Mexican need to resort to external financing to complement it's own internal production and, above all, the urgent need of finding structural solutions to some environmental problems, have compelled the country to resort to international financing in order to complement it's own investments for the protection of natural resources and environmental improvement.

Such investment has a high priority, due to it's contribution to a structural change that shall generate a sustainable development, which will benefit not only the present generations, but the ones to come as well. Use of long term financial instruments will allow the distribution of the cost of those measures with the generations that will profit from them.

There are several international credits specifically dedicated to the protection of the environment. Many industrial financing credits have destined important amounts of money to environmental impact and arrangement, generated by large projects; these activities join those of the Inter American Development Bank on environmental matters. In addition to the credits from banks for international development, there are diverse private transactions that involve international commercial banks and, specially, co-investment between Mexican and foreign private firms for the

production of antipolluting equipment. This is an aspect that has recently been strongly considered and which has prompted exchanges and mutual visits from Mexican and foreign investors who wish to analyze co-investment and representation systems. It is also to be noted that OAS has collaborated with our country in matters, among others, related to ecological ordering of the territory and in training, inter alia.

In the case of Mexico City, there have been agreements with the Japanese Overseas Fund and with the International Reconstruction and Development Bank (World Bank). The later has authorized credits for the funding of the following activities: the improvement of solid waste disposal in several cities of the country; adequate and sustainable use of forest resources in various states of the Republic; implementation of drinkable water and sewage projects and those related to the environmental infrastructure of Lazaro Cardenas industrial port, and; the improvement of atmospheric conditions linked to urban transport and the environmental effects of agricultural development in the state of Chiapas.

MEXICO'S ENVIRONMENTAL PROGRAM. It is a project that began in 1991, partially financed by funds from the World Bank, whose goals are the strengthening, modernization, dispersal, and decentralization of the Federal Government's environmental action, through the Secretariat of Social Development.

At the same time, it seeks to increase analysis capacity and to establish environmental policies, linking them to other policies. The main functions that tend to be reinforced by the loan are: Monitoring and Control of Environmental Pollution;

Minimization of Negative Environmental Impact; Preservation of Biodiversity; Environmental Legislation and Standards; Modernization of Environmental Management Environmental Studies.

**Science and Technology for Ecological Balance and Environmental Improvement**

The National Development Plan 1989-1994 gives high priority to the support of scientific and technological activities, due to their contribution to the strengthening of the country's economic and social processes. This priority is consistent with the President's political agenda, for he has pointed to scientific knowledge as a condition for national progress and for the solution of many of our problems. President Carlos Salinas de Gortari has stated that: "If we want to advance towards a more just and democratic society, we must grant scientific research and technological development the prominent role they require in Mexico's development". The present development strategy in the country calls for both elements, fostering not only sciences like the exact sciences, natural, social, and others of the sort, but also those directly related to health, nutrition, agriculture, environment and ecology, to name a few. When emphasizing these last two terms, environment and ecology, it becomes clear that science and technology have increasing importance in facing problems generated from man's continuous disruption with nature. Accordingly, in Mexico the following activities need scientific and technological support: restoration and preservation of ecological balance; creation of plant, animal, and mineral inventories; use of natural resource exploitation techniques; installation of advanced air and

water pollution control methods; adequate municipal and industrial waste management.

Ecology-related scientific and technological activity is regulated by the national ecological policy, which is based on the principles that ecosystems are a public possession and that present, as well as future living and productive possibilities depend on their balance. This policy considers that ecosystems must be used in a way that insures their optimal sustainable yield, making their use compatible with their integrity and ecological balance. Responsibility for protection of ecological balance must be assumed by both public and private entities, and comprises all the present conditions that will determine the quality of life of future generations.

Deterrence of the causes that generate this unbalance is the most efficient way to confront it. Utilization of renewable natural resources must insure the upholding of their diversity and their regeneration, just as the use of non-renewable resources must avoid the generation of adverse ecological effects.

The national scientific and technological sector observes the following general strategy: to extend and reinforce scientific infrastructure, modernizing the technological infrastructure in support of ecological balance and environmental improvement actions.

The following specific strategies are defined: a national education, qualification, and diffusion system for environmental and ecological matters; interdisciplinary, interinstitutional, regional and national research lines for confronting the nation's ecological and environmental problems; development of co-

financing schemes between higher education and research institutions with government and private sectors for the development of ecologically and environmentally safe technologies; support for the creation and preparation of technical workshops specialized in ecological and environmental matters; fostering and implementation of scientific research and technological development projects in national and foreign institutions, for solving the most compelling ecological and environmental problems.

In the same way, the scientific and technological sector carries out research in the following priority areas: a) Environmental sanitation of hydrological basins and harbor areas; b) Environmental sanitation of cities with critical situations; c) prevention and control of land pollution ; d) Protection and preservation of wild and marine flora and fauna; e) system of national protected natural areas; f) pollution control of coastlines and ocean waters. It's lines of actions are: water, atmosphere, energy, natural resources, and health.

### **Environmental Perspectives**

The country faces a growing number of challenges related to the solving of it's environmental problems. The most important of them is, without a doubt, the fact that it recognized these problems tremendously late, from a historical point of view. This historical lagging is specially evident in the case of deforestation, depredation of wild fauna and flora, and solid waste disposal, including industrial waste.

This fact implies that prevention activities must be linked, for a considerable time span, to environmental control

and restoration activities. The assurance of survival conditions for plant and animal species, as well as the integrity of protected areas are also of great importance. This requires a national effort of shared responsibility between the individuals and the institutions that constitute the Mexican society.

This effort will demand considerable funding, which may not be postponed due to economic recession or other limitations. New productive projects and new public activities will inevitably have to include the required costs for an adequate environmental protection. Another related aspect is the establishment of the necessary industrial capacity for the production of equipment and techniques required in the control of wastewater and air pollution, and for the preservation of natural resources.

Modernization of the Mexican environmental system is seen, first of all, as the definition of the existing links between and different types of political instruments, particularly economic instruments; secondly, it implies a broader use of these instruments in order to apply the corresponding environment-related incentives or correctives. Consequently, it is expected that the different elements that make up the Mexican environmental sector accept their full responsibility, assigning a monetary value to society's environmental consequences.

As an important part of government action, ecological protection and preservation in the years to come will be directed to: increasing public participation in the solution of ecological problems; giving priority to pollution prevention and control, as well as to the preservation and restoration of

ecological balance; prompt complementary investment for clean technologies in state governments and federal companies, and; equitable distribution among the sectors involved of environmental damage and natural resource restoration costs, based on the "polluters-payers" principle.

The next two years are a crucial stage for assessing the reach of the goals presented in the NEPP 1990-1994. Actions taken will try to emphasize national ecological ordering, air quality improvement in large cities, and the supervision and control of the industrial substructure. A special concern will be the preservation and improvement of the amount and quality of water supply, as well as assuring the protection of and re-establishment of natural resources as a measure for reinforcing the legal framework.

A larger decision-making capability will be transferred to SEDESOL's state offices, strengthening the Secretariat's presence in the states and encouraging a greater participation of state and municipal governments, as well as from the general public. In view of the aforementioned historical lagging, it is acknowledged that solutions to environmental problems require mid and long term action. It is sought, for example, to induce behavioral changes in all sectors of Mexican society; difficult but necessary changes themselves. Such change will have to be induced by means of direct control measures and other appropriate incentives.

Although Mexico is increasingly an international leader in environmental protection measures, thanks to an internal effort and to the correct use of the international funding it has access to, it is necessary to

develop a national capacity for the production of goods and services required for the country's own environmental protection.

The globalization of ecological problems shall become more evident in the near future for these problems will surpass national borders with increasing haste and frequency. As to commercial competitiveness between nations, the tendency to link trade barriers to ecological balance and environmental preservation in different regions of the world will also increase in the years to come.