Chapter IV

POPULATION AND NATURAL RESOURCES

The relationship between population dynamics and ecosystems is decisive in achieving sustainable development.

1. Population, the environment and resources

Population is a resource –human capital– and at the same time the subject of development, and hence any topics related to the population should be dealt with from both points of view. This chapter will briefly examine the first of these: population as a resource. It also describes the current availability of other natural resources, including land, water, minerals and marine resources. Chapter V deals with population as the subject of development, and the relationship between poverty and sustainable development.

1.1 *The demographic variable*

Since the middle of this century, the Latin American and Caribbean region has experienced a change in its population and environmental profile. Changes in the composition of the population by age, occupation and residence have been accompanied by the tripling of its size, with the urban population moving from a minority segment to the point where it now constitutes the living and working environment of three out of every four inhabitants of the region. Therefore, although it may be possible to predict future changes in its composition, the speed and scale of these changes will be unlike those achieved in the period now drawing to a close, and the basic acquired characteristics will remain unchanged.

During the five-year period 1960-1965, and as a result of the combined effect of the transition to low mortality rates and the lag in the transition to lower fertility, the majority of countries recorded population growth rates on the order of a cumulative 3% per annum.[1]

As a result of an improvement in living conditions and in some aspects of the human environment (food and nutrition, progress in overcoming endemic diseases, coverage of health services, access to potable water), the region made progress in its transition to low mortality rates, reducing the still high infant mortality rates of the 1960s. Life expectancy at birth is now almost 70 years.[2]

The combined effect of demographic factors, development and the spread of family planning, accelerated the transition towards lower fertility rates from the 1970s onward, with the number of children per woman declining from six or more in the 1960s to slightly over three at the present time. The high rates of fertility at the start of the period and their maintenance in subsequent years led to a population structure that was characterized by a large proportion of youth under 15 years of age (40%) and, subsequently, to a heavy increase in the labour force (4% per annum). The size of the cohorts born in the years when fertility rates were high, in turn, has dampened the effect of the reduction in the number of children on the decline in the rate of population growth.[3]

Population growth was accompanied by changes in the rural- urban profile and in the occupational composition of the population. Ninety-four per cent of the total population increase in Latin America during the period 1960-1990 of 230 million was recorded in urban areas.[4] This increase was caused, often in similar proportions, by the expansion of the resident population and by rural-urban migration. Taken together, the Latin American and Caribbean region emerged in the 1990s with an urban population similar in proportion to that of the developed countries and more than twice that of Asia and Africa. In Asia, the proportion of inhabitants engaged in agriculture doubled, while it tripled in Africa.[5]

The rural population, following an increase of 10 million in the 1960s, remained stable from the mid-1970s onward at some 124 million. The main population pressure on natural resources in agriculture is of urban origin, whose dramatically expanding market favoured mechanization and the introduction of technology in the production of foods and fibres. Widespread mechanization of commercial agriculture and the expansion of large-scale livestock-raising led to an increase of the man/cropland ratio in marginal lands, which, however, continued to be the lowest in the developing world.[6] This pressure by the rural population on the land continued to be excessive in the traditional areas with small-scale farming ("minifundios"), exacerbated in many cases by the combined action of fragmentation by inheritance and the expansion of large export-oriented agroindustrial enterprises and the continuous expansion of livestock-raising activities.

The apparent contradiction between the low man/cropland ratio and the persistence of zones which are particularly exposed to deterioration, such as minifundio areas, is explained by the extreme levels of concentration of land ownership and use.[7] The region has the highest ratio of concentration of land ownership in the developing world and in those countries where the agricultural frontier has expanded over the last three decades, the high levels of concentration may persist or become even higher in the newly cleared areas.

The percentage of the urban population residing in the largest city increased in most of the countries of the region, where 14 cities of over two million inhabitants and two of over 15 million already existed by 1985.[8] The strain on the physical environment involved in sustaining some of these big cities has been growing; some are trapped between mountains, while others are situated on enclosed bays or on the banks of large rivers, all of which has aggravated air pollution, water pollution and the risk of floods. Even in cities located in valleys with abundant water supplies, increasing demand for water has necessitated huge investments in construction works, with severe consequences for the environment, in order to ensure adequate supplies (see box IV-1).

In these cities, the combined effect of a large population, its rapid rate of increase and the introduction of various technologies (such as stationary emission sources, automobiles and buildings that are crowded together), has exceeded the tolerance limit of the physical environment,[9] thereby requiring corrective actions which are very often unaffordable to the country in the short and medium term.

The countries which by 1960 had for all practical purposes begun their transition towards lower mortality rates and had made great strides towards the achievement of low fertility experienced, in later decades, only some of the challenges arising from population growth and urbanization (high rate of dependency of the labour force, explosive increase in urbanization and concentration of the urban population in one large city). This relatively better situation was more pronounced in those countries with agricultural frontiers than in those without, and in those with orderly demographic transitions (Barbados, Chile, Uruguay) than in those which underwent more dramatic changes along the way (Argentina, Cuba, Jamaica). The demographic causal factors behind the problems of environmental deterioration were marginal or local, with economic and technological factors predominating.

On the other hand, for those countries which will experience a demographic transition in the next three or four decades, a trend towards more

Box IV-1
EFFECTS OF INCREASED WATER DEMAND ON LARGE CITIES

In 1325 the Aztecs settled in a closed valley located 2 240 metres above sea level, where they founded Tenochtitlán, now Mexico City, on a plain surrounded by lakes. The area was frequently struck by floods and droughts, and large works were constructed to cope with them.

In this century, as the city expanded, it was necessary to dig wells for the collection of water. These depressed the water table and caused the ground to sink, which changed the surface and subsurface drainage system and led to floods. In 1958 the first project to transfer or import water from the Lerma valley was carried out for the purpose of reducing the exploitation of groundwater in the Mexico Valley and meeting the growing demand for water. This transfer caused ecological alterations in the Lerma Valley; in particular, it also depressed the Valley's groundwater table and dried up its lagoons. It also gave rise to serious political and social problems for the inhabitants of the Valley.

In 1950 Mexico City had five million inhabitants, whereas in 1984, it had three times as many, 60% of them in the Federal District. As a consequence of this growth, the demand for water grew exponentially. The water plate dropped even further, causing sinkings of up to nine metres in some parts of the city and changing the surface drainage system. The tapping of increasingly deep water tables ultimately changed the quality of the city's drinking water when fossil waters began to be extracted.

To meet the demand, a second transfer has been implemented in which water is brought into the city from the Cutzamalá river basin. Even so, more water is still needed. It is estimated that at the beginning of the next century water will have to be brought in from sources over 200 kilometres away and will have to be raised to a height of over 1 000 metres.

Source. Héctor Garduño, "Interregional water transfer in Mexico", *Large Scale Water Transfers: Emerging Environmental and Social Experiences*, Genady N. Golubev and Asit K. Biswas (eds.), published for the United Nations Environment Programme (UNEP) by Tycooly Publishing, Limited, Oxford, England, 1985, pp. 119-134.

severe environmental degradation may be expected. These are countries of less relative economic strength and management capacity (public and private) to deal with foreseeable environmental problems and to take the actions required to overcome them. The extreme case is that of countries without agricultural frontiers, which are already facing extensive erosion and loss of their water resources.

1.2 *Urbanization*

Urbanization, its conditions and characteristics, are the physical expression of the development styles adopted by society. Man occupies, exploits and transforms the natural environment, tailoring it to satisfy what he perceives as his needs; the result are human settlements, cities or a built-up environment. The process of urbanization in the region reflects the unsound economic and social development styles being adopted by the countries. Some of the characteristics of the process of urbanization in the region are not intrinsically negative and become so only when they constitute obstacles to the achievement of balanced and sustainable development; such characteristics include the following:

- Concentration of the population, production, services and decision-making in a small number of urban centres. In several countries up to 50% of industrial output (and the generation of industrial wastes) is concentrated in the main city.
- High growth rates of the urban population, which will convert Latin America into the most urbanized region of the world in the next century.
- High deficits in the provision of basic infrastructure and services, particularly in low-income urban sectors and rural areas.
- Limited control over disposal of waste from domestic and productive activities and over

the use of land resources. Only a small number of cities in the region have waste water treatment systems, and many of them have solid waste disposal systems which cover less than 50% of their waste production.

There are three key elements which determine the environmental sustainability of urbanization: its location and the use of land; the demand for inputs for maintaining residential and productive activities; and the waste discharge into the natural environment from urban activities. In order to guide these processes, there must be direct intervention in i) the form, growth and distribution of settlements, ii) the type and intensity of activities to be undertaken and iii) the way in which such activities are carried out (see box IV-2).

Box IV-2
RATIONALIZATION OF URBAN TRANSPORT IN MEXICO CITY

The global environmental control programme adopted by the Mexican Government for the nation's capital with the financial and technical co-operation of the United States, Japan, Federal Republic of Germany, France and the World Bank has an estimated cost of between US$2.5 and US$3 billion. In order to co-ordinate the efforts to combat the high level of pollution caused by the 2.5 million vehicles and 30 000 industrial enterprises of the Greater Mexico City area, which emit 4.8 million tons of pollutants per year, various interministerial committees were formed to prepare appropriate policies and supervise operations.

The measures which have been designed fall within the following five areas: rationalization of urban transport, production of clean fuels, use by industries and power stations of less polluting fuels, restoration of the vegetation of the Greater Mexico City area, and finally, modernization of industry. Only the first of these areas will be dealt with here.

The first actions taken, in the winter of 1989, concerned public and private transport, since it is estimated that 83% of the pollutants come from vehicles. In order to encourage the population to replace the use of private vehicles with public transport, the authorities decided to rationalize, improve and expand the latter. Thus, for example, the routes followed by 60 000 small private 14-passenger buses which travel between the suburbs and the centre of the city were either eliminated altogether or changed so that these vehicles only transport passengers to the metro stations or the main bus lines, thus reducing their presence in the city-centre area. The authorities are considering increasing the fares of private buses in order to spread the cost of the adjustment and compensate bus drivers for potential economic losses caused by the shorter routes.

At the same time, action was taken to improve the lines served by large buses, through measures such as the scrapping of old diesel engines and the adoption of emissions standards. The fares on these buses were increased by 300% in order to cover the cost of the new engines and expand underground railway construction work. The circulation of the new buses and the work to expand the metro began immediately, so that users would link the fare increase in their minds with improvements in the public transport service.

Other regulations designed to discourage the public from using private vehicles are the prohibition on parking in the city centre and in the main streets of the city, and the prohibition of private car use one day a week, depending on the last number in the license plate. Failure to observe these regulations is punished with heavy fines. A further measure to discourage the use of private transport was the 12.5% increase in the price of gasoline, which also helps to finance the environment programme.

In addition, automobiles must be tested in inspection centres twice a year, and these centres are punished with fines or total closure if cars which passed through them are later found to be polluting the environment in spite of having passed the test. It was also decided that new cars must be provided with catalytic converters, and once the new converters are installed the use of lead-free gasoline will be made compulsory. This latter measure is expected to involve a big adjustment effort, as 95% of the gasoline produced in the country contains lead. The refineries will have to be modified and lead will have to be removed from them and from the distribution system.

Finally, with regard to the replacement of polluting fuels, fuel oil has been replaced with natural gas in 40% of the power stations. As such gas is scarce and costs three times more than fuel oil, the price of electricity for industrial use was considerably increased, thus reflecting the higher cost of this resource.

The implementation of this first set of measures –the reduction of private automobile use, inspection of motors, replacement of bus engines and the use of natural gas instead of fuel oil– made it possible to reduce pollution by 15% in six months.

In order to avoid repeating the failed attempts of the past, the policies adopted should be aimed at overcoming some of the obstacles to the implementation of these activities. In practical terms, proper management of urbanization means that the objectives of national development and its priorities should be translated into specific physical actions. This requires the formulation, on a priority basis, of action strategies in the following areas:

Technological development, for the purpose of bringing the existing links between development, the natural environment and the attributes of settlements down to more operational and qualitative terms, since, for example, it is not always correct to assume that small or medium-sized cities are necessarily forms of settlement that are preferable to large metropolises.

The development of practical instruments and mechanisms for incorporating the criteria of sustainability and development (including changing production patterns and social equity) into the management of settlements.

Enhancing the legal framework and competence of local governments (municipal or regional) to enable them to intervene in aspects of development and environmental sustainability, thereby permitting effective complementation and application of the purely physical interventions which these authorities have traditionally carried out. This requires greater efforts towards the process of decentralization and deconcentration of decision-making, income distribution and investment allocation.

The processes of regionalization and municipalization under way in the region offer considerable opportunities for the development of institutional mechanisms (institutional capital), which allow for the co-ordination and reinforcement of the work of the various agents involved in environment-related activities. Local governments in particular, because of their proximity to the actual problems and because they act more directly under the scrutiny of the community, are institutions that offer greater possibilities for success in co-ordinating the application of environmental policies.

1.3 *Rural population, migration and the agricultural frontier*

Over the last few decades the rural population has had an extremely low overall growth rate, and this trend is expected to continue. While rural areas still have a higher fertility rate than urban ones, the low growth rate is due to the simultaneous occurrence of an equally high mortality rate and continued migration to urban areas, and in particular the selective migration of women of childbearing age. Demographic indicators point to a close link between the population's living standards and environmental quality. This relationship contributes to environmental deterioration by constraining recovery processes, in turn leading to heavy outward migration.

While rural-urban or inter-city migration are the most consequential, migration from one rural area to another has also increased. It has even been noted in some countries that rural-rural migration is as significant as rural-urban migration. Within this type of migratory movement, temporary migration has been acquiring greater significance, for it is associated with increasing opportunities for seasonal work as a result of the more intensive exploitation of land in the more modernized areas.

The colonization of agricultural frontiers is one type of rural-rural migration which, although dating back to the early years of the century, has only in the 1960s begun to be focused on as a means of resolving problems of employment, land access and soil degradation, although it also responded to the growth in demand from the more developed urban markets and to speculative land management. In this context, Bolivia, Brazil, Colombia, Ecuador, Mexico, Panama, Paraguay and Peru are some of the countries which have initiated efforts at colonizing and expanding their agricultural frontiers. This, however, does not seem to have been a solution to problems involving population redistribution, lack of jobs and inequitable access to land, and has had

negative ecological impacts, creating serious problems from the point of view of the human environment.

The rural population in frontier areas generally lives under very difficult conditions, with a low standard of living, makeshift dwellings and little access to education and medical care, all of which contribute to a low nutritional level and provide fertile ground for the spread of disease. One problem which has attracted attention, for example, is the resurgence of malaria and its spread into new areas, particularly in the new frontier regions such as the Amazon Basin. Other factors which have contributed to its expansion are –in addition to the resistance of the vectors to traditional control methods– the continued presence of makeshift housing and poor living conditions, lack of environmental sanitation and ignorance of preventive actions.

1.4 *Conclusion*

In brief, following a period of high population growth rates, the region has shown a downturn in these rates. This means, at least, that the pressure on the environment exerted by the mere increment in the number of persons is tending to lessen. The problems which persist, and which are perhaps worsening, are derived rather from the spatial distribution of the population and its dynamics and modalities (urban growth without infrastructure, depredatory expansion of the agricultural frontier), institutional conditions (concentration of land and minifundio-style farming) and production technologies in the countries where the population lives and reproduces.

2. Use of the region's natural resources

A presentation follows of the situation and prospects for the exploitation of the natural resources of Latin America and the Caribbean, with emphasis on those aspects related to sustainability. It should be pointed out, by way of introduction, that over the last two decades substantial changes have occurred in the region in terms of access to and use of resources. These are due both to small-scale activities carried out by many economic agents and to large-scale activities of a few individual agents. Examples of the former are activities engaged in by poorer sectors which result in urban sprawl or destruction of forests by slash-and-burn agriculture;[10] examples of the latter are mining and fishing.

The region has suffered from a significant and irreversible loss of its genetic biodiversity, soil loss due to erosion and the loss of native forests. In economic and social terms, the most serious environmental problems are associated with irrational urban expansion. These are followed by profound damage to coastal areas and some bodies of inland water. Without doubt the most direct harm to the population is caused by the contamination of water. The problems of air pollution, while serious in many cities, are relatively less pervasive despite their association with systems of production which can only be modified and controlled at high cost.

2.1 *Land use*

Land in the region is a resource which, from the point of view of its human exploitation, is continuously increasing. The expansion of the agricultural frontier, the profound changes in land use and the discovery of new mineral and energy deposits occur daily. This, however, takes place erratically because governments are poorly equipped to provide guidelines to users of the resource. This situation is even more complex if account is taken of the fact that more than 50% of the population is poor and to a large extent marginalized from State services and assistance.

Only about 7.5% of the total land surface of the region is arable. Of the rest of the land, 1.5% is used for permanent crops, 28.1% for grazing land, 48.2% for forests and the remaining 14.6% for other purposes (see table IV-1).

On the other hand, agricultural land has serious constraints on its use, so that the percentage of cultivable land is calculated at only between 8% and 16% of the total. Other projections expand the

possible cultivation area to as much as 27% and 32%. However, the cost of adding and managing new land is increasing daily. The incorporation of new land in desert areas, for example, costs more than US$20 000 per hectare, as against US$2 000 for the recovery of abandoned terraces in the high Andean regions of Peru and Bolivia. The cost of recovering salinized land is also US$2 000 per hectare. It would be even more profitable to increase productivity per hectare before seeking to extend agricultural frontiers [11] (see box IV-3).

During the period 1970-1987, land devoted to crops and grazing increased by 70 million hectares. This process took place spontaneously and independently, with the exception of a few specific projects. The expansion of pasture land was at the expense of native forests, with the result that almost 72 million hectares of wooded area were lost. In other words, 6.9% of the forested area that existed in 1970 disappeared. In Brazil and Mexico the largest relative number of hectares were destroyed. From the standpoint of surface area, however, the countries most affected by deforestation were Costa Rica, El Salvador, Nicaragua and Saint Lucia.

Much of the increase in land under cultivation (12.5 million hectares) was devoted to modern and high technology crops which have tended to create environmental problems in these areas owing to the indiscriminate use of pesticides, fertilizers and other chemical substances. Although these inputs are used in smaller quantities in the region than in the developed countries, ignorance of how to apply them or the fact that they are toxic substances or products which have been banned outright in the developed countries entails certain problems.

Livestock-raising is one of the activities with the greatest impact on the ecological system, particularly in tropical and hillside areas. Its main characteristics in the region are its low technological level and location in areas that are unsuited for exploitation. In 1989 the region had 317 million head of beef cattle, representing 25% of the world total.[12]

Erosion is a more widespread form of land degradation in the region. In hillside areas, this phenomenon is extremely common and has forced the abandonment of vast areas of land. The

Table IV-1

LATIN AMERICA AND THE CARIBBEAN: LAND USE

(Thousands of hectares)

Use	Estimated area (thousands of hectares)			Percentage breakdown	
	1970	1987	Difference	1970	1987
Cropland	120 258	150 720	30 462	6.0	7.5
Permanent crops	24 750	30 330	5 580	1.2	1.5
Grazing	529 646	563 542	33 896	26.4	28.1
Forests	1 038 975	967 144	-71 831	51.8	48.2
Other	290 960	292 853	1 893	14 5	14.6
Total	*2 004 589*	*2 004 589*	*0*	*100.0*	*100 0*

Source: ECLAC, *Statistical Yearbook for Latin America and the Caribbean* (LC/G.1606-P), 1989, pp. 600-607; United Nations publication, Sales No. E/S.90.II.G.1; and World Resources Institute and International Institute for Environment and Development, in collaboration with the United Nations Environment Programme, *World Resources 1988-89*, New York, Basic Books, Inc., 1988, p. 264.

Note: The information provided in this table refers to 25 countries in Latin America and the Caribbean.

Box IV-3
RECLAMATION OF SALINIZED SOILS IN PERU

Peru's experience with drainage and salinization problems, which had already affected over 30% of the best irrigated land along the Peruvian coast by 1970, illustrates the high cost of failing to take steps in time to forestall such problems, but it also indicates that the reclamation of such land is a good investment in comparison to the alternative of expanding the agricultural frontier.

The largest tract of irrigated land in Peru is found along its coast and covers an area of about 850 000 hectares out of an estimated total of 1 200 000 hectares. In all, approximately 2 600 000 hectares of Peruvian territory are under cultivation, out of a total area of 7 900 000 hectares of potentially arable land. Thus, as these figures demonstrate, a very significant portion of the country's land is affected by poor drainage and salinity problems.

Peru began to evaluate its drainage and salinization problems in 1968 with support from the Government of the Netherlands. More than 10 years of systematic work in this field made it possible to determine the magnitude and relative severity of these phenomena in each coastal valley, to experiment with various reclamation techniques, and to provide highly skilled technical experts with the necessary know-how to combat the problems that were identified. Armed with the information compiled by the project and a pool of experts and experience, the country was able to embark upon a number of large-scale land reclamation projects.

The cost of reclaiming these lands is estimated at US$2 000 per hectare, which is much the same as what it costs to reclaim a hectare of terraced land in the Sierra. Thus, the total cost of reclaiming the area affected by these problems alone has been calculated at around US$1.1 billion. During the past decade the Government of Peru and users have invested over US$200 million to reclaim 100 000 hectares. The reclamation of another 50 000 hectares is now under way, and projects to reclaim another 108 000 hectares have been designed. This initiative serves as an example of what can be done to control adverse environmental impacts when projects of the necessary duration and technical level are undertaken.

Source: Adapted from J.F. Alfaro, Assessment of progress in the implementation of the Mar del Plata Action Plan and formulation of a strategy for the 1990s (Latin America and the Caribbean), United Nations, UNDP, FAO, DIESA, DTCD, Agricultural Water Use Consultancy Project FAO/ITC/AGL/080, March 1990.

annual rates of erosion –measured in terms of sediment loads– in some parts of El Salvador and the Dominican Republic, for example, fluctuate between 190 and 346 tons per hectare (which means that the land probably will lose all possibility of economic use in less than one decade) while in well-managed zones barely five tons per hectare are lost annually. The State has been unable to put a halt to this situation because of the difficulties encountered in helping poor peasants. Moreover, soil erosion caused by low-income sectors reflects other phenomena such as the lack of job opportunities, *inter alia*.

Other phenomena also lead to soil loss. One of these is the loss of irrigated land located in semi-arid valleys, owing to competition for the use of water; another is soil salinization due to the use of inappropriate irrigation techniques. These processes, usually described as desertification, have been estimated to affect more than 33% of irrigated lands. Desertification alone affects more than 293 million hectares of productive arid land in Mexico and South America.[13]

If agricultural expansion were technically well managed, there is no reason why it should degrade the environment. Over the past 20 years, although public awareness of this problem has increased, the action taken has been inadequate. The State has not done enough to promote private activity and participation, nor has it undertaken large-scale initiatives. It has confined its efforts to the direct execution of a few pilot projects, in many cases thanks to the work of non-governmental organizations or to bilateral contributions, whose effect has been very limited in proportion to the magnitude of the task at hand. Moreover, only rarely has it provided the necessary support to enable users to fully accomplish the environmental management tasks which correspond to them. Little has been done to institutionalize public and private participatory action to resolve these problems. Encouraging

progress has been made, however, in some countries such as Brazil, Colombia, Ecuador, Peru and others, where, for example, steps are being taken to set up mechanisms for the management of river basins, the reclamation of agricultural terraces and salinized land and, in general, the promotion of rational natural-resource management activities involving public and private participation.

2.2 *Water resources*

The Latin American and Caribbean region is basically a humid area, although it also has extensive arid zones. Average rainfall in the region is estimated at about 1 500 mm, which is almost 50% higher than the world average. Surface runoff of rainwater amounts to some 370 000 m^3 per year, representing 31% of the freshwater reserves reaching the oceans.[14] Nonetheless, the region suffers from serious water-supply problems due to the distribution pattern of the population and to the fact that extensive agricultural zones are located in semi-arid areas or high mountain regions.

Significant progress has been made over the last 20 years in the provision of drinking water and sanitation services. In 1971 only 78% of the urban population and 24% of the rural population had access to drinking-water systems. Sanitation and sewerage services served only 38% of the urban population and 2% of the rural population. Seventeen years later, in December 1988, drinking water was available to 88% of the urban population and to 55% of the rural population,[15] while 80% and 32% of the region's population, respectively, had access to sanitation and sewerage services. Despite these advances, however, there are still 89.2 million people who do not have a supply of drinking water and 141.1 million who lack sanitation (excreta disposal) systems.[16]

The treatment of waste water is one of the region's major failings. Only between 5% and 10% of sewerage systems provide for some degree of waste water treatment before returning it to watercourses or the sea.[17] This percentage has not changed since 1960, and some of the systems having the greatest coverage treat the smallest percentage of the water they handle. This has created extremely serious problems of pollution in most receiving water bodies. It has been estimated that in 1980 South America alone dumped a total of 127 m^3/sec of municipal sewage into its rivers, lakes and the sea (a volume representing 4.2% of the world total), as compared to 29 m^3/sec in 1950 (3.9% of the world total) (see box IV-4).

Another issue is the growing dependence of some cities, such as Lima and Mexico City, on very remote sources of water. This engenders an unwelcome degree of vulnerability as well as having an adverse impact on the source areas.

Irrigation systems have a long tradition in Latin America and the Caribbean, and the region will no doubt carry on this tradition due to their value as an input for modern agricultural production. Irrigation expanded significantly between 1970 and 1987, with its coverage rising from 10 173 000 to 15 231 000 hectares. These figures, however, represent only 1.5% and 2%, respectively, of the total cultivated area in the region.[18] The countries which have made the greatest contribution to this expansion are Brazil and Mexico.

The high cost of building new dams and the difficulty of obtaining fresh loans are two of the reasons why the expansion of the area under irrigation has slowed during the past decade. In addition, the region has had to undertake large investments of other types in order to consolidate projects which are already under way. Some of the main problems associated with irrigation systems are salinization, the swamping of land, water pollution from pesticides and the destruction of wildlife habitats. Near the coasts, wastes carried by drainage water affect water quality in coastal lagoons and the breeding grounds of certain species.

Water management is also an important consideration in unirrigated zones. Such areas represent 98% of the cultivated land and are home to most of the poor rural population. It is important to recognize that the necessary attention has not been devoted to water use in rainfed zones. While irrigation is a very important means of increasing productivity, a wide range of activities can be undertaken to improve the productivity of the land in those areas where

Box IV-4
WASTE WATER DISPOSAL ALTERNATIVES

In 1985, only 41% of the urban population of Latin America had access to sewage systems, and over 90% of all waste water was discharged directly into other water without any kind of treatment. Furthermore, a decade of crisis and recession has reduced the amount of resources which the region can allocate to sewage and water treatment systems. In these circumstances, it is important to draw attention to a number of efforts being made to apply low cost technologies to cope with some of the problems related to the discharge of waste water.

Thus, in Cochabamba, Bolivia, a city with 240 000 inhabitants, an innovative integral sewerage project has been put into operation. New design criteria were applied in order to reduce diameters, gradients and deposits, with the result that costs were also lowered. Additional savings were also made by constructing modular pumping stations. For the future, thought is being given to increasing these savings even further by collecting waste water in stabilization wells, treating it and then using it for irrigation.

In Brazil a similar but simplified drainage system is being used and also a new type of latrine, which works with a smaller volume of water (4 to 5 litres each time instead of the traditional 15 litres).

There are other low cost projects which, although still at the assessment stage, provide useful lessons. For example, in some of the outlying districts of Guayaquil, where the construction of a sewerage system presents serious technical and economic obstacles, ventilated latrines have been built under the self-help system. These latrines operate with a very small amount of water (3 litres). These latrines are now being constructed in Brazil, Colombia and Peru and may become part of the normal sewerage system.

In north-eastern Brazil prefabricated latrines have been installed in rows and can be emptied by trucks using a suction device. In one such project, the user can amortize the cost of a latrine (about US$60) in five years, paying the water and sewerage company for cleaning and maintenance. It is also possible for one third of the payment to be made through contributions in the form of labour.

Even with a sewage system, however, the discharge of waste water may present problems. In this respect it is worth noting that satisfactory results in the treatment of waste water have been achieved by using waste stabilization wells, which are particularly appropriate in the tropics. They are usually economical and make it possible gradually to obtain water of practically any quality if a number of them are provided, thereby increasing the number of times the water undergoes the stabilization process. These wells have been used extensively in Cuba, Peru and Mexico. The largest series of wells in Latin America, which is located in Mexicali, covers an area of 180 hectares and makes it possible to treat a flow of 1.2 cubic metres of waste water per second.

In view of the inadequate waste disposal systems of the large number of cities of Latin America and the Caribbean which are located in coastal areas, it is common practice for waste water to be emptied into the sea without any treatment. Not only does this have adverse effects on human health and on the ecology, it also causes economic loss by reducing the number of tourists.

Using sewage systems which lead into the sea so that waste water can be discharged some distance from the shore along with limited treatment of waste products able to float, may be more efficient than traditional methods which include secondary treatment for water and the discharge of the waste extracted from it close to the shore. When waste is discharged some distance off shore, it may be dissolved at a ratio of 100 to 1 in a few minutes, thereby reducing the nutrient organic concentrations typical of waste water to levels at which they have no adverse ecological effects. In addition, killing bacteria in a hostile marine environment may reduce the concentration of pathogens to levels equal to or even lower than those achieved through the use of chlorine in secondary emissions.

Systems of this type may be found in Brazil, Mexico, Puerto Rico and Venezuela. The Ipanema system in Rio de Janeiro can process a flow of waste water of six cubic metres per second. Its length is 4 325 metres, its diameter is 2.4 metres, and it has a diffuser 400 metres long which discharges the contents at a depth of 28 metres. Continuous water quality control in the area has shown that a notable improvement has been achieved since the system was put into operation in 1975.

Source: Carl R. Bartone, "Water quality and urbanization in Latin America", *Water International*, No. 15, 1990.

rainfall is and will continue to be the only source of water. Integrated management of farming, forestry and livestock-raising activities, soil development and the selection of suitable seeds are some of the options in such zones. The percentage of budgetary resources allocated for such efforts, which involve, for example, the management of river basins, the control of soil erosion, and research on the adaptation of crops to rainfed areas, is equivalent to no more than 10% of the resources allocated to irrigation and drainage works in the region.[19]

The use of water for *industrial and mining* activities is another important issue in Latin America and the Caribbean because of the major implications such uses have in terms of the catchment and pollution of watercourses. In most countries of the region, water used by these sectors is discharged directly into watercourses without having undergone any form of treatment whatsoever. The total return flow from the industrial and power sectors in 1980 has been calculated at 254 m^3/sec, which is equivalent to 1.3% of the world total. Data for 1950 indicate that at that time only 70 m^3/sec were discharged.[20] The severest impact of the use of water for mining activities is felt in semi-arid zones owing to the very limited volumes of receiving water available in relation to the volumes of discharged toxic wastes.

Although **hydropower generation** does not involve the consumption of water, it does cause some degree of environmental deterioration. Dams regulate the natural flow of rivers and their ecosystems. While there was a decline in the number of dams constructed from 1980 onward in comparison to the preceding decade, the water storage capacity of the new dams increased considerably. Brazil and Argentina, for example, have 62% and 19%, respectively, of the total storage capacity of all the dams and reservoirs built in the region between 1970 and 1984.[21] The environmental impact of large-scale water works is currently one of the most controversial environmental issues, and a great deal of research remains to be done in this area.

The generation of hydroelectricity is a key factor in promoting development and in providing cities with a clean energy supply. The amount of power supplied by hydroelectric plants increased considerably between 1970 and 1987, and the percentage of total energy consumption covered by hydroelectricity climbed from 53.9% in 1970 to 60.3% in 1987, while the use of electricity generated by thermoelectric power plants declined from 46.1% to 37.3% during the same period.

The region's potential hydropower output, estimated at 805 792 mW, represents 35% of the world total. Today, it uses only 9.6% of the world total. This fact, together with the rise in petroleum prices, might be expected to lead to an upward trend in hydropower generation. However, the growth rate of installed capacity averaged 6.5% per annum between 1980 and 1987,[22] a figure considerably lower than the 10.2% average rate recorded during the latter years of the 1970s. The reasons for this decline are the high cost of these works and the economic recession experienced by the countries of the region. The environmental impact of such works should be evaluated in relation to the benefits they bring, such as electrification in urban and industrial areas. One of the environmental benefits derived from the construction of dams has been the greater attention devoted to the management of watersheds in order to control erosion.

2.3 *Mineral resources*

The known mineral **reserves** of Latin America and the Caribbean are located in an area amounting to less than 10% of the potential mineral-bearing territory,[23] whereas in other regions of the world most of the territory which might contain mineral deposits has already been explored and prospected. Even so, the region's known reserves of the principal non-ferrous metals and of iron ore represent a significant percentage of world reserves.

On the other hand, the rates of exploitation of known reserves are higher in Latin America and the Caribbean than in the rest of the world. In view of the long lead time involved in mining projects, resources need to be channelled into identifying new deposits, particularly of tin, gold, silver, bismuth, cobalt, chromium, manganese, mercury and lead. Nevertheless, according to the listing of new investment projects for the period

1988-1995, the region will continue to concentrate 75% of its resources in only three product lines: bauxite/aluminium, copper and iron/steel.[24] This allocation of investment resources indicates that the mining sector is becoming highly specialized. At the present time, mineral exports are concentrated in just eight metal products: bauxite, copper, tin, iron, nickel, silver, lead and zinc.

Most of the output is exported as raw materials, which means that the region provides a very small share of world production of metals, semi-finished and intermediate mineral-based products. Indeed, in 1986 consumption or industrial use in the region outstripped its production levels in the cases of antimony, bismuth, cadmium, chromium, lithium, manganese, mercury, molybdenum, gold, selenium, tungsten, uranium and vanadium.

Making greater and better use of the region's mineral resources requires greater knowledge of its metal resources; the introduction of new technologies to improve its competitiveness while at the same time reducing the pollution generated by its production activities; the development of greater production linkages in the mining, metallurgical and industrial sectors; and an expansion of intraregional trade based on the removal of barriers to trade and the enhancement of the region's international competitiveness.

2.4 *Marine resources*

As is well known, the marine areas of Latin America and the Caribbean contain a wealth of both living and non-living marine resources, as well as offering opportunities for harnessing water, currents and wind, among other sources, for the purpose of generating power. Fishery resources are the area which has been studied the most extensively so far, and a greater amount of information has been compiled on them than on other marine resources.

The harvesting of the oceans' fishery resources at both the world and regional levels has increased fairly steadily over the past two decades. Indeed, between 1970 and 1988, the nominal world catch rose by 38.3%. Slight declines in global levels were recorded in only two years during this period, and these were due mainly to a sharp drop in Peru's total catch in the early 1970s. The most recent figures made available by FAO indicate that the world's total nominal catch amounted to 84.6 million metric tons in 1988.

Chile, Peru and, to a lesser extent, Mexico are the principal fishing countries of Latin America, since they are endowed with some of the most productive fishing grounds in the world, mainly thanks to the effects of the Humboldt current. Together, Chile and Peru harvest between approximately 10 and 12 millions tons, which represents about 80% of the regional total. These two countries are also among the six top-ranking fishing nations in the world in terms of the volume of their catches and are the main suppliers of fish meal in the international market.

Chile's and Peru's catches are mainly confined to a limited number of pelagic species (anchovies, sardines, jurel and mackerel) which are harvested by the industrial and semi-industrial fleet and are used almost entirely for the production of fish meal. The unit value of the industrial sector's catch is therefore low in comparison to that of other fisheries which harvest species that bring a better price on the market (salmon, shrimps, tuna, etc.) (see box IV-5).

The non-industrial fishery sector, on the other hand, harvests a relatively small percentage of the total catch and concentrates on more highly-prized species which are sold almost exclusively on the market for fresh fish for direct consumption. The importance of this sector therefore lies in its contribution to employment levels and to the supply of fish products for direct consumption. In addition, because of the type of technology employed, it is more selective and efficient in terms of its use of inputs (petroleum, maintenance of equipment, etc.) and has less of a negative impact on stocks, since it harvests a smaller volume of fish and most of the fish caught are of adequate size. This sector is, however, the most severely affected by the pollution of the sea and the deterioration of coastal areas.

An analysis of the exploitation of fishery resources in the region requires an examination of

Box IV-5
DEREGULATION AND THE FISHERIES ACT IN CHILE

If fishery activity is left entirely to the free play of market forces, without any regulation, there is a risk of causing overfishing and the collapse of the small-scale non-industrial fishery industry, which is an important source of employment in coastal areas. The adoption of purely mercantile criteria in this sector will result in the long run in an allocation of marine resources which is inefficient from the social point of view, inasmuch as it will foster a degree of over-investment which may even endanger the survival of some species.

The limited and uncertain knowledge at our disposal on marine life, the natural fluctuations in the stock of resources –the natural capital–, and the need to conserve this capital are among the reasons why it is essential to regulate fishing by imposing regulations regarding such aspects as the minimum size of the species caught, close seasons, overall limits on catches, forms of fishing, and so forth.

Over the last twenty years, the Chilean fishery sector has registered explosive growth, with catches increasing sixfold between the early 1970s and the late 1980s. It is hard to see, however, how the main factor in the growth of the sector can continue to be increases in the catches, for there are signs of over-exploitation in the main fisheries, namely, coastal pelagic fisheries, demersal fishing for fine species such as hake, and the extraction of shellfish and crustaceans.

Two stages may be distinguished in the development of demersal fishing in southernmost Chile, in line with the degree of opening-up of marine resources to the intervention of the foreign fishing industry. The first stage –one of total openness– runs from 1977 to 1983 and corresponds to the period when industrial fishing was dominated mainly by foreign factory ships. The second stage –one of selective openness– runs from 1984 to the present and coincides with the installation on land of mainly Chilean processing and packing plants.

During the first stage, export markets were opened up in Japan and Spain for frozen products (mainly whole frozen gutted hake and cuskeel), and a fleet of about 11 factory ships was stationed in the area to serve the Japanese, Korean and Spanish trawlers. To begin with, these ships were authorized to operate in the open sea, from approximately the Island of Chiloé down to Cape Horn, under their respective national flags, subject to the payment of fishing licences whose cost was proportional to the size of the catch. After a little while, however, the requirement for payment of a licence was cancelled and the factory ships were assimilated to Chilean enterprises so that they only had to pay tax on their profits. At the same time, by way of conservation measures, maximum catches were fixed and standards were laid down regarding the minimum mesh size of the nets used.

For various reasons, the contribution made by the foreign fishery industry to the development of the area was frankly modest. The enterprises turned in accounting losses or showed barely any profits, so that they paid no taxes. Moreover, their main product (whole frozen fish) formed the raw material for a production chain located and ending in the final market. Thus, the whole preparation process whereby greater added value is given to the raw material took place outside Chile and brought it no benefits. Moreover, the direct employment generated by the factory ships was of little significance (a total of 735 persons), while as the investments were not domiciled in the country they had practically no impact on the economy of the area other than that due to the demand for fuel, shipyard and port services, and other inputs.

The second stage began when restrictions were placed on the entry of factory ships and encouragement was given to the installation of processing plants on land and the entry of other types of ships (refrigerated ships to serve the trawlers and factory ships to serve bottom-line fishing boats) to supply the plants with their raw material. These measures created a new situation, replacing the old policy with one that was fairer to Chilean investors. This new situation enabled the latter to give a fresh boost to the fishery industry, which now extended its activities even to the upper waters of the fiords and channels of the Aysén region.

During this stage, fishery technology became more diversified, especially through the entry of the new ships, and there was a significant expansion in small-scale non-industrial fishing, which became the main supplier of hake for the processing plants, for which it now provides as much as 75% of that input.

Even leaving aside the taxes they pay, the processing plants have made a considerable contribution to the development of the region. Since they submit the raw material to a higher degree of processing, they generate products of higher added value (fish fillets, for example). Furthermore, they provide direct employment for at least 4 000 persons and their demand for raw material maintains the activities of some 15 000 small-scale fishermen. This has been accompanied by the establishment of human communities in previously uninhabited areas and has strengthened economic activity in the region.

The new Fisheries Act, put before Parliament in 1990, provides for two different systems: one permitting free access, and the other permitting restricted access in cases where it has been established that a resource is already being fully exploited. The Act reserves the right of the authorities to impose restrictions on the size of catches and on fishing methods, as well as to impose periodic close seasons in certain cases. In general, it

eliminates controls over the level of activity in industrial fishing, but it established at the same time, in cases where a resource is already being fully exploited, a system of transferable individual permits which give the right to a certain proportion of the total annual catch fixed by the authorities during periods when access is restricted. Of these permits, 75% are granted on the basis of the catches made in the years before the state of full exploitation was decreed, while the remaining 25% are sold by public tender.

The inclusion of these individual permits in the Act has given rise to some controversy among specialists. Those in favour of them hold that they represent a system of regulation which prevents over-investment and limits the current administrative discretionality. It is also maintained that control over the size of individual catches will promote the use of more efficient technologies and permit better control of the size of the global catch.

Those who are against these permits adduce both legal and economic reasons for their attitude. Thus, they claim that the granting of exclusive fishing rights is unconstitutional, while from the economic point of view they say that these permits will favour the creation of monopoly rents which will adversely affect the social allocation of resources.

The Fisheries Act reserves a coastal fringe five nautical miles wide for the activities of small-scale non-industrial fishermen, and all vessels over 18 metres long are banned from fishing in this area. However, it is easy to see that this rule does not exclude from the small-scale fishery area vessels which, although not exceeding 18 metres in length, are so extensively endowed with advanced technological features that they do not fit into the category of "small-scale non-industrial vessel".

Source: Guillermo Geisse G., "Problemas y posibilidades de transformación productiva con conservación ambiental en cuatro sectores de actividad de la economía chilena", Santiago, Chile, December 1990, *mimeo* (document prepared for the ECLAC Division of Environment and Human Settlements), and Instituto Latinoamericano de Doctrinas y Estudios Sociales (ILADES), *Trabajo de asesoría económica al Congreso Nacional*, TASC, No. 1, Santiago, Chile, March 1990.

* Whereas in the late 1970s the new international marine legislation restricted the operation of factory ships off the coasts of most countries, in contrast Chile authorized this kind of ship to exploit high-value demersal fish in its Patagonian region.

different species and technologies as well as of regions or countries. FAO estimates indicate that catches in the most productive area in the region (area 87, which includes Chile and Peru), are higher than the maximum sustainable yield according to estimates of the biomass of pelagic species. Current levels of exploitation in that area range between 104% and 288% of the maximum sustainable yields, which clearly shows that a problem of overfishing exists. In point of fact, Peru suffered a collapse of its fishing industry in the early 1970s precisely as a result of overfishing, together with environmental changes produced by the El Niño current.

The non-industrial sector also shows signs of overfishing various species, although on a smaller scale. Some of the clearest cases are the harvesting of "locos" (a variety of abalone) in Chile and of shrimp larvae in Ecuador and Peru, and the overfishing of many coastal species in which a decline has been seen in the historic levels of catch per unit of effort.

Not enough is yet known about the behaviour (reproduction, migration, etc.) of many marine species, and many important questions therefore remain to be answered as regards the most appropriate levels of catch, closed seasons, the areas where fishing should be permitted and other aspects of their exploitation. In view of this lack of knowledge, it seems preferable to emphasize the conservation of these resources rather than their untrammelled exploitation. This requires international co-operation, and here again an important field is being opened up for negotiation and collaboration.

At the semi-industrial level, areas which have seen increasing development over the past decade include activities involving the cultivation of marine products, such as the planting and harvesting of algae, the cultivation of shrimp, and

the use of salmon-cage or ocean ranching production methods. These product lines (algae and salmon in Chile and shrimp in Belize, Colombia, Ecuador, Honduras, Mexico and Panama) are becoming quite important because of their high profitability and the large foreign exchange earnings they bring, despite the ecological and environmental problems associated with this activity.

3. Management of natural resources

The orientation of the use of their resources will constitute a major challenge for the countries of the region in the forthcoming decade. In order to meet this challenge it is imperative that they gear their management systems to the realities of the areas within their territories. The predominant tendency will be to harmonize traditional management systems, which are designed to direct development within certain political/administrative limits, with the other types of systems that are needed to manage components of the natural environment, such as ecosystems, river basins, coastal areas, lakes and oceans, and others. The sectoralized approach which took little account of environmental realities will give way to an integrated approach in which environmental and user needs are taken into consideration in the decision-making process.

There will also be a tendency to intensify the research effort already being made in some areas and to step up pilot projects in these fields. In addition to research on various technical aspects, economic analyses of the projects will be carried out, and a particular effort will be made to encourage the population to take an interest in these projects. These elements will lay the foundations for initiatives involving everything from managing the exploitation of the marine biomass right up to the reinforcement of legislation for the protection of native forests. This approach will also provide a sound basis for decision-making in respect of investments to provide protection against extreme natural phenomena.

The organized participation of the private sector will be crucial to this process, and in order to make such participation possible, it will be necessary to decentralize government action and strengthen public and private management capabilities. The continuity of State action is as important as its quality. Hence, the management of natural resources exclusively on the basis of investment projects will fail if such projects do not have the necessary institutional backstopping. This subject will be discussed further in chapter VII.

Ultimately, the purpose of natural resource management is to serve the population, which is the subject of development. Yet so far, despite the progress made in recent decades –with the exception of the 1980s, when the region took a step backwards– we have not succeeded in using the available resources to wipe out poverty. The existence of reciprocal effects between poverty and the environment creates a vicious circle which must be broken. This problem will be addressed in the following chapter.

Notes

[1] Latin American Demographic Centre (CELADE), *Latin America: Population Projections, 1950-2025* (LC/DEM/G.82), Demographic Bulletin series, No. 45, year 23, Santiago, Chile, January 1990.

[2] *Ibid.*

[3] See CELADE, *op. cit.*, and Regional Employment Programme for Latin America and the Caribbean (PREALC), *Empleo y equidad: desafío de los 90*, Documento de trabajo series, No. 354, Santiago, Chile, January 1990.

[4] CELADE, *op. cit.*

[5] United Nations, Department of International Economic and Social Affairs, *Prospects of World Urbanization, 1988* (ST/ESA/SER.A/112), Population Studies series, No. 112, New York, 1989. United Nations publication, Sales No. E.89.XIII.8.

[6] Inter-American Institute for Co-operation and Agriculture (IICA), *América Latina y el Caribe. Pobreza rural persistente*, Documentos de Programas series, No. 17, January 1990.

[7] See Food and Agriculture Organization of the United Nations (FAO), "Rural Poverty", *Potentials for Agricultural and Rural Development in Latin America and the Caribbean* (LARC 88/3), annex II, Rome, 1988.

[8] CELADE, "La población urbana y rural y sus condiciones de vida", January 1990, report prepared by the Pan American Health Organization (PAHO), and United Nations, Department of International Economic and Social Affairs, *op. cit.*

[9] It can be indirectly deduced that this limit has been passed when, for example, concentrations of pollutants in the air or water exceed certain standards, or when the average speed of motor vehicle traffic falls below a given threshold, occasioning traffic jams.

[10] FAO, *op. cit.*, annex IV.

[11] With respect to Andean systems, see ECLAC/UNEP, *Sobrevivencia campesina en ecosistemas de altura* (E/CEPAL/G.1267), 2 vols., Santiago, Chile, December 1983. United Nations publication, Sales No. S.83.II.G.31 (vols. I and II).

[12] FAO, *FAO Production Yearbook 1989*, vol. 43, FAO Statistics Series, No. 94, Rome, 1990.

[13] World Resources Institute/International Institute for Environment and Development/UNEP, *World Resources 1988-1989*, New York, Basic Books Inc., 1989

[14] ECLAC, *The Water Resources of Latin America and the Caribbean and their Utilization. A Report on Progress in the Application of the Mar del Plata Action Plan* (LC/G.1358), Estudios e informes de la CEPAL series, No. 53, Santiago, Chile, October 1985. United Nations publication, Sales No. E.85.II.G.16.

[15] Pan American Health Organization (PAHO), *International Drinking Water Supply and Sanitation Decade. Regional Progress Report*, Environmental Series, No. 6, Washington, D.C., 1987.

[16] PAHO, *The Situation of Drinking Water Supply and Sanitation in the American Region at the End of the Decade 1981-1990, and Prospects for the Future*, 2 vols., Washington, D.C., 1990.

[17] *Ibid.*

[18] ECLAC, *Statistical Yearbook for Latin America and the Caribbean. 1989 Edition* (LC/G.1606-P), Santiago, Chile, February 1990. United Nations publication, Sales No. E/S.90.II.G.1.

[19] ECLAC, *The Water Resources of Latin America and the Caribbean: Planning, Hazards and Pollution* (LC/G.1559-P), Estudios e informes de la CEPAL series, No. 77, Santiago, Chile, July 1990. United Nations publication, Sales No. E.90.II.G.8.

[20] *Ibid.*, note 4, p. 59.

[21] International Commission on Large Dams (ICOLD), *World Register of Dams*, Paris, 1984.

[22] United Nations, *Energy Statistics Yearbook 1987*, New York, 1989. United Nations publication, Sales No. E/F.89.XVII.10.

[23] Federal Institute for Geosciences and Natural Resources, "Regional Distribution of Mining Production and Reserves of Mineral Commodities in the World", Hannover, January 1982, *mimeo*.

[24] *Engineering and Mining Journal*, London, January 1988, and ECLAC, *Minería año 2000. América Latina: proyectos mineros y su financiamiento* (LC/R.807), Santiago, Chile, October 1989.