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Dominican Republic Environmental Assessment

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Environmental Assessment

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The EPIQ/IRG research team was composed of:

Dr. William Kaschak, Team Leader
Dr. John Warren, Policy and Organizational Network Coordinator
Mr. William McDowell, Technical Coordinator
Eng. Jehova Pena
Lic. Jose Almonte
Lic. Miguel Silva
Eng. Roberto Castillo-Tio
Eng. Hector Rodriguez
Lic. Nunilla Ramirez
Eng. Gilberto Gomez
Lic. Josefina Espaillat
Eng. Daniel Arias
Lic. Danny Pozo

Acronyms

ADN	Ayuntamiento del Distrito Nacional
APAP	Agricultural Policy Analysis Project
CAASD	Corporación de Acueducto y Alcantarillado
CEA	State Sugar Council
CEP	Country Environmental Profile
CIBIMA	Centro de Investigaciones de Biología Marina
CITES	Convention on International Trade in Endangered Species
CNA	National Agriculture Council
COENER	National Commission for Energy Policy
COGO	Governmental Committee on the Ozone
CONATEF	National Technical Commission on Forests
COP	Conference of the Parties
CORAASAN	Water and Sewer Corporation for the Municipality of Santiago
COSERENAMA	Environmental Sector Coordinating Commission
CRIES	Comprehensive Resource Inventory and Evaluation System
DGF	Forestry Directorate
DIRENA	Natural Resource Inventory Department
DNP	National Parks Directorate
DRP	Department of Fisheries
DTA	Department of Land and Water
DVS	Department of Wildlife
EC	European Community
FEPROBOSUR	Southern Region Forestry Production Federation
FIRENA	Investment Fund for Natural Resources
GODR	Government of the Dominican Republic
IBRD	World Bank
IDB	Inter-American Development Bank
INAPA	National Water Supply and Sewerage Institute
INDRHI	National Institute for Hydraulic Resources
INTEC	Technological Institute of Santo Domingo
ISA	Superior Institute for Agriculture
JBN	National Botanical Garden
JUNTA	Development Association for San Jose de Ocoa
LMD	Liga Municipal Dominicana
MARENA	Ministry of Natural Resources and the Environment
MNHN	National Museum of Natural History
NGO	non-governmental organization
NIBE	Ibero-American University
OAS	Organization of American States
ONAPLAN	National Planning Office
PUCMM	Madre y Maestra Pontifical University
UASD	Autonomous University of Santo Domingo
UICN	World Nature Union

UNDP	United Nations Development Program
UNICA	Inter-American University
UNPHU	Pedro Henriquez Urena National University in Santo Domingo
UTESA	Technological University of Santiago
SEA	Secretariat of State of Agriculture
SEOPC	Secretariat of Public Works and Communications
SOEBA	Ecological Society of Barahona
SOECI	Ecological Society of the Cibao
STP	Technical Secretariat of the Presidency
TDS	travel document system
TNC	The Nature Conservancy
USAID	US Agency for International Development
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
WWF	World Wildlife Fund
ZOODOM	National Zoological Park

Executive Summary

Introduction

In 1981 USAID sponsored the first Country Environmental Profile (CEP) in the Dominican Republic. For the last two decades that seminal study has been the only comprehensive analysis on the state of the Dominican environment. The object of this current research effort is to update, on the basis of secondary data sources, the 1981 work. This update will provide a point of comparison for the 1981 CEP. In so doing, it will demonstrate major trends that have occurred in key environmental areas—soil, land use and vegetative cover, water quantity, quality and use, institutional structure for environmental management, policy—in the last 20 years.

This study also provides recommendations on the country's most pressing environmental problems. These recommendations, along with their underlying rationale, are offered to Dominican environmental sector decision-makers, their partners in the private sector and the non-governmental organization (NGO) community, and international donors as an action agenda for the conservation and sustainable use of the country's natural resources and for the reduction of vulnerability.

The comparison between the state of the environment in the Dominican Republic between 1981 and 2001 was carried out against the backdrop of a society that has changed significantly during that period of time. The population of the country increased by almost 50% to a current level of 8.5 million people. Agriculture, once the mainstay of the economy, has declined, while other sectors, most notably tourism, light manufacturing, and financial services, have grown in importance. In fact, tourism has become the most important sector of the economy for generating revenues. Finally, the Dominican Republic has become an urban country (about two-thirds of the population now live in urban settings as compared to one-third in 1970). This poses new challenges for environmental management.

Major Environmental Trends

The changes in the Dominican social and economic makeup have had significant impact on nearly every aspect of the environment. With respect to soil and land use, this impact is seen in a series of important trends. The 1981 study noted that erosion was one of the environmental sector's major problems. By 2000 the area of land classified as eroded, arid, or barren had increased by 400% (UNDP 2000). On the surface, these data clearly demonstrate that the problem has grown and become more acute. However, much of the increase in erosion took place in the 1980s. Beginning in the mid-1990s there is the suggestion that the rate of erosion began to slow—and that perhaps the negative trend was starting to reverse.

Vegetative cover, particularly forest area, is closely associated with erosion. Differences in the methodology among the tree cover studies between 1980 and 1998 make it difficult to assess the real forested land area in the country. However, it seems evident that the loss of forests noted in the 1981 CEP continued through the 1980s. That said, by the end of the 1990s there is evidence that the land area under forest cover was greater than that of 1980, suggesting that deforestation had abated and some recovery was occurring. Important contributing factors to forest recovery

include concerted government efforts at reforestation (e.g., the Plan Sierra project, FEPROBOSUR), expansion of the national protected areas system, and migration patters.

The agricultural sector evolved significantly in the period between the two studies. In 1980 the predominant systems were plantation sugar cane production and hillside subsistence farming. Over time the system has become much more diversified. Irrigated rice production has expanded substantially, as has the area dedicated to such high-value export crops as tomato, banana, plantain, and yucca. The use of processed fertilizers and other chemical inputs to improve production and productivity has expanded in lockstep with agricultural diversification.

Land affected by salinization has increased dramatically. This trend is a byproduct of the rapid growth in irrigated agriculture and deficiencies in the technology used to do such farming. It is most prevalent on coastal plains and in the lower reaches of watersheds. In addition to salinization, the growth in irrigation works over the past 20 years has reduced normal dry season water flows in major watersheds (e.g., Yaque del Norte, Yuna). The change in the water flow is, in turn, affecting downstream fresh water habitats.

Other major trends regarding water resources include continued sedimentation of the reservoir network, a substantial increase in the demand for water, and a decline in water quality. Sedimentation of reservoirs was a concern of the 1981 CEP. Research in the intervening years indicates that this problem has persisted and perhaps become more acute. The storage capacity of all the country's reservoirs has been reduced. The reduction in capacity of the reservoirs used principally for agricultural purposes ranges from 10% to 25%. Such natural disasters as hurricanes have been an important cause of the reservoir sedimentation problem. But soil erosion and landslides in upland watersheds are also major contributing factors.

In keeping with the country's overall population growth, there has been a notable increase in the demand for water. Demand for water for household use has risen more than sevenfold to more than 1.45 million cubic meters per year. Water requirements for agriculture, driven mainly by the expansion of irrigation works, have increased more than threefold to almost 8 million cubic meters per year. The amount of water used for industrial purposes has also risen considerably in response to the growth of light manufacturing.

Few studies have been carried out in the last two decades on water quality, but the incidence of water-borne diseases suggests that water contamination is a serious problem that is growing worse. A major source of contamination is the seepage of nutrients into groundwater owing to inadequate sanitation infrastructure (principally sewerage wastewater systems). Between 1990 and 1998, the national government invested RD$22 million a year in potable water and sewerage infrastructure. But this figure represented only 3% of the national budget. The fact that the country consumes more than 1,000,000 cubic meters of bottled water per year is a reflection of overall deficiencies in water quality. Runoff of agricultural chemical products and discharges from mining and manufacturing industries are other growing sources of contamination.

The status of the country's biodiversity has been impacted by the changes in Dominican society over the past two decades. Since 1981 at least 10% of all of the species in the country—and perhaps as much as one-third of the vertebrates—have become endangered. The decline in biodiversity is associated principally with the reduction of forest habitat during the 1980s. But

the stabilization of the country's forests in the last decade is apparently easing the rate of biodiversity loss.

Growth in tourism is a second major threat to biodiversity, especially in ecological coastline niches. To illustrate, the hospitality industry (hotels, restaurants, and bars), most of which is located near the beach, expanded at a rate of 13% per year during 1994–98. This growth in hotel construction and the volume of tourists—2.5 million visited the country in 1999—is placing extreme pressure on existing flora (sea grasses beds, mangroves) and fauna (coral reefs, sea turtles) in coastal habitats.

Over the past 20 years, the institutional structure for the environmental sector has expanded significantly. The largest growth has taken place within the NGO community. Beginning in the 1980s and accelerating in the 1990s, a plethora of local NGOs (PRONATURA, Plan Sierra, Progresses, FEPROBOSUR, The Jaragua Group) were established to deal with specific watersheds, parks, and community areas and participate with the government on environmental issues such as education, community awareness, and sustainable management of natural resources.

The academic community has also become more involved in environmental study, research, and projects. The Autonomous University and the Pedro H. Enriquez National University (UNPHU) in Santo Domingo and the Center for Urban and Rural Studies (CEUR) of the Madre y Maestra Pontifical University (PUCMM) in Santiago have been leaders in raising the public's consciousness on environmental issues and conducting research on specific natural resource questions. The Technological Institute of Santo Domingo (INTEC) established a graduate program in environmental education in 1988, and the Superior Institute for Agriculture (ISA) launched a forestry school.

Public institutions grew in number over the past two decades, but, before 2000, without a corresponding increase in effective environmental policy. The CEP reported in 1981 that public institutions involved with natural resources were characterized by parallel functions, inefficient use of human and financial resources, and a lack of coordination. This situation persisted for most of the last 20 years while the number of public institutions increased to more than 20. Major government entities involved in the sector included the National Hydrological Institute (INDRHI), the Agricultural Secretariat (with a number of its dependencies), the Forestry Directorate, the National Parks Directorate, and the National Agricultural Council. The establishment of the Secretariat of the Environment and Natural Resources in 2000, as the single public institution responsible for environmental oversight, was a significant step toward rationalizing public sector activity regarding the environment and natural resources.

Water user associations are recent additions to the Dominican environmental sector. The movement began in the late 1980s as an initiative of INDRHI to improve the efficiency of water use in rural areas. This experiment has been successful. The number of water user associations in the country, while still small, is growing rapidly—there were 10 such associations in 1999. Institutionally, they represent another important presence in the management of natural resources (in this case water). On average the local associations are collecting four times the user fees generated by the traditional government-managed system. Money generated by the associations is invested in technology and training of local association members to improve water management efficiency.

Urbanization has been an important phenomenon in Dominican society over the past two decades. Correspondingly, the appearance of urban or "brown" problems has been a major environmental trend. In addition to water quality and the related deficiencies in sanitation infrastructure, growing air and noise pollution and shortcomings in solid waste management are the most serious threats to the urban environment.

Public policy, like the other areas of activity, has evolved considerably since the original assessment was carried out. In 1981 the CEP noted that that there was a defined policy regarding agriculture, but that there was no explicit policy for natural resource management. The CEP also noted that the legal basis for environmental management was ambiguous and resulted in overlaps, gaps, and confusion among cognizant institutions.

In the 1980s the national government issued 60 environmental policy initiatives. In general, these actions—Law 355 of 1983 prohibited the use of lime on tree trunks and Decree 1026 of 1986 established the La Caleta Underwater Park—tended to control or prohibit the use of natural resources. In the 1990s, under the influence of the Worldwide Environmental Conference in Rio de Janeiro, Brazil, the policy process was characterized by expanding awareness and public dialogue on environmental issues. Policy legislation and decrees focused on the sustainable use of natural resources. The culmination of this process was the passage of the General Environmental Law (64-00) in August 2000. This law not only reorganized the institutional structure for managing the environment, but also raised environmental awareness in the public sector planning process and required public consultation on environmental issues with legal implications.

Major trends in the environmental sector over the past 20 years, while showing some signs of progress, reveal the persistence of serious problems. An action agenda to address these challenges should include:

- Amplification and refinement of the Law 64 to establish a comprehensive policy regime that will promote protection and sustainable use of the country's natural resources.
- Strengthening of the institutional structure, including local units and local private organizations put in place to manage the environmental sector.
- Aggressive programs to, among other things, promote reforestation, curtail soil salinization, manage watersheds, and protect fragile ecological niches such as the coastal marine environment.
- Aggressive environmental protection public awareness program.
- Research on such important issues as water quality, bathometry, and trends in vegetative cover.
- Increased investment in sanitation and potable water infrastructure.
- A proactive program of consultation and consensus building with all relevant sectors (private entrepreneurs, NGOs, academia, local government) on the design and implementation of a national environmental program.

Chapter 1. Introduction

1.1 Objectives of Assessment

Environmental issues in the Dominican Republic span a wide range. Watershed degradation, soil erosion, solid and liquid waste disposal, water and air pollution, deforestation, biodiversity loss, and pesticide contamination are serious concerns. The matter takes on added importance given the close link between the country's natural resource base and its economy. The Dominican Republic has had, and will continue to have, an economy dependent upon its natural resources. Accordingly, the prospects for economic expansion are inextricably linked to the remediation, protection, and prudent use of the country's natural patrimony.

In 1981 USAID sponsored the first environmental assessment carried out in the country. Clearly, significant social and economic change has taken place in the intervening twenty years, and it is reasonable to assume that this change has had an impact on the environment. The objective of this study is to establish a point of comparison for the 1981 analysis by providing a snapshot of the state of the environment in the Dominican Republic at the beginning of the twenty-first century. It updates the areas addressed in the 1981 analysis—vegetative cover and forestry, water quantity and quality, land use, erosion—and highlights the trends that have taken place in the areas over the past two decades. Simultaneously, this assessment will give consideration to environmental matters—policy, institutional regulatory and service delivery network, air and noise pollution, and water contamination—that have arisen since the 1981 report was produced.

1.2 Methodology

At the request of the Secretariat of State for the Environment and Natural Resources, USAID/Santo Domingo developed the scope of work for this study. The contents of the scope of work were discussed with, and agreed to, by the Secretary of the Environment and Natural Resources. USAID and the secretary also agreed on the methodology to be used in carrying out the research—a review of existing secondary sources.

The reliance on secondary sources posed certain limitations. In some cases it limited the ability of the researchers to demonstrate precisely the status of given environmental sub-sectors. To illustrate, the body of information available on forestry consists of a series of different studies conducted with separate methodologies, particularly regarding classification criteria for types of forests and ground cover. Because of these methodological differences, there are wide variances in the studies' conclusions. These variances make it difficult to document precise trends regarding forest and other ground cover over the past twenty years.

In other cases, the dearth of secondary data limited the team's ability to draw definitive conclusions. For example, very little research has been done recently on dam sedimentation. This virtual absence of information inhibited efforts to refine estimates of actual water storage capacity.

Despite these limitations, the methodology was adequate to draw a comparison on the state of the country's environmental resources between 1981 and 2001. The methodology also permitted the

identification of major trends in key environmental sectors over the past two decades, as well as the identification of research and other programming priorities.

1.3 Socioeconomic Overview

The Dominican Republic has a land area of slightly less than 50,000 square kilometers, and occupies about two-thirds of the island of Hispaniola. The country's population is estimated at 8.5 million, resulting in a population density of approximately 170 people per square kilometer. In 1990, the population growth rate was measured at 2.3%—a figure that demonstrated a continued decline from its high of 3.62% registered in 1960.

After stagnation—and in some instances contraction—during the 1980s, the country's economy flourished during the 1990s. Between 1995 and 1999, the economy grew at a yearly rate of more than 7%, and inflation never exceeded 10% per year. In 1999, the gross national product was $17.6 billion—an increase of almost 100% over 1993.

During the 1990s, the agricultural sector's participation in the economy contracted by 30% (from 17.5% in 1991 to 12.4% in 1997). The sugarcane production and processing industry, which is included in the industrial economic sector, was once the mainstay of the economy. In the two decades since the 1981 profile, land in sugarcane has been reduced by about 12%, and the sugarcane industry now represents only about 1% of all economic output.

Although the sector has declined as a whole, there has been modest growth in crop production. The increase in crop production is concentrated in high-value commodities—tobacco, industrial tomatoes, and bananas. Livestock growth has also been modest, with only a slight increase in the area dedicated to cattle grazing.

During the 1990s industry (including sugar production, mining, construction, and utilities) expanded from 26% to just over 32%. Manufacturing, led by the introduction of free zone *maquila* operations, grew at 3.8% per year between 1994 and 1998. Mining also increased substantially over the same period.

The service sector (commerce, tourism, transport, communications, finance, and government) remained even, contributing about 55% of the economy during the 1990s. Tourism (hotels, restaurants, and bars) showed impressive growth (13% per year between 1994 and 1999), as did communications (17.5% for the same period). Within services, government was the principal area of economic contraction.

While there has been a continuing trend of reduced population growth, the labor force, as a result of high population growth rates in the 1960s and 1970s, has expanded by more than 3% annually since 1980. A parallel demographic trend is the marked urbanization of Dominican society: between 1965 and 1997, the portion of Dominicans living in urban settings rose from 35% to 67%, while the rural population declined by a concomitant amount.

1.4 Development Policies and Resource Management

In large part, the demographic shifts (especially increased urbanization) over the last two decades (certainly throughout the 1990s) were related to changes in the country's economy. The growth of the urban-based industrial and service sectors has drawn people to the cities to fill available

employment niches. A growth-oriented economic policy facilitated the impressive growth of the 1990s, but this regime was adopted with little concern for environmental consequences. The passage of the Environmental Law (Law 64-00) and the creation of the Secretariat of the Environment in late 2000 were initial steps to developing a new policy regime to join environmental protection and sustainable natural management with economic expansion.

Chapter 2. Soils, Land Use, and Agricultural Development

2.1 Land-Use Capability and Soils

The Organization of American States published a Land-Use Capability classification for the Dominican Republic based on 1977 soil studies (CEP 1981). This work indicated that approximately 12.6% of the Dominican Republic's soils (classes I-III) have good potential for intensive cultivation with only moderate limitations, while over 55% of the land area has soils that are so steep, rocky, or shallow (classes VII-VIII) that they have good potential only for forestry or protected areas (table 2.1). Much of the remaining soils have limited capability to support intensive agriculture, though some can be used effectively for perennial tree crops (coffee, cacao) and pasture.

Table 2.1 USDA Land Use Capability Classification for the Dominican Republic

Land Class	Km^2	Percentage of National Territory	General Characteristics of Land Class Unit
I	537	1.1	Excellent for cultivation, high productivity potential.
II	2,350	4.9	Very good for cultivation, few limiting factors.
III	3,122	6.6	Good for cultivation, some limiting factors, medium productivity potential with good management.
IV	3,639	7.7	Limited potential for cultivation, appropriate for pasture or perennial crops, with severe limiting factors. Low to medium productivity with management.
V	6,071	12.7	Limiting factors severe, especially drainage. Can be used for pasture, or for rice with intensive management.
VI	5,611	11.8	Cannot be cultivated, except for certain perennial crops (such as coffee), pasture, or forestry. Limiting factors include topography, soil depth, rocky soils.
VII	25,161	52.7	Cannot be cultivated, only appropriate for forestry uses.
VIII	1,202	2.5	Cannot be cultivated, appropriate for protected areas or wildlife uses.
Total	**47,693**	**100.00**	

Note: Does not include 588 km^2 of lakes, islands, and other areas.
Source: OAS Survey of Natural Resources of Dominican Republic 1967, cited in 1981 CEP.

2.2 Actual Land Use

Data that allow a definitive comparison of land-use patterns in 1980 to present land use are not available due to different study methodologies. But some general trends can be detected (table 2.2):

- Loss of broad-leaf forest cover has slowed significantly or stopped.
- There is some suggestion that coniferous forest area expanded slightly.

- Intensive agriculture, particularly steep slope cultivation of subsistence crops, has declined in some areas.
- Sugarcane land has been reduced, perhaps by as much as 12%.
- Intensive pastures have increased only slightly.
- Urban areas are rapidly expanding.
- Eroded or barren land has expanded significantly.
- Area dedicated to tree crops has increased.

Table 2.2 Changes in Land Use in the Dominican Republic, 1980–98 (km^2)

Type of Land Use or Cover		OAS 1967	CRIES 1980	DIRENA 1998	OAS %	CRIES %	DIRENA %
Broad-leaf forest	Humid	2,580	6,518	6,306	5.3	13.7	13.1
	Dried, mixed, and others	835		3,889	1.7		8.0
Coniferous		2155	311	3,025	0.64	4.0	6.2
Sugarcane			4,025	3,682		8.8	7.6
Tree crops (coffee, cacao, etc.)				3,414			7.1
Intensive pastures			2,325	2,636		4.9	5.5
Others: marginal agriculture/pastures/ matorral/tree crops/other forests, etc.			27,417	17,595		57.6	36.5
Urban areas			292	394		0.6	0.8
Arid, barren, or eroded land			402	1,306		0.8	2.7
Total			**47,657**	**48,224**			

Source: Adapted from UNDP 2000.

2.3 Changes in Agricultural Production, 1980–2000

Agricultural production in the Dominican Republic has been subject to a series of changes driven by, among other things, agricultural policy, national and international markets, and economics. In the last 20 years, the Dominican agricultural sector has adapted to these forces by modifying cropping and land use patterns, as well as technology. Table 2.3 allows a comparison of acreage per crop and production levels for the most important Dominican agricultural products.

Changes in sugar production are among the most significant to have taken place in the agricultural sector. Before 1980, the sugar industry was organized into large production and processing centers (*ingenios*). The majority of the *ingenios* were controlled by the national government—a few (three) were privately owned and operated. During this period sugar production emphasized use of large areas of land. Little concern was given to the application of technologies that would enhance productivity and production in smaller areas. With the decline of the international sugar market in the 1980s, the government faced the difficult problem of controlling large expanses of underused land. A privatization program was initiated in the late 1980s to address the problem. This effort has made some progress—the former Esperanza *ingenio* was converted into a successful irrigated rice and banana operation—and the private owners have emphasized modern technology and operational efficiency for enhanced productivity. But the success is limited. Large areas of former sugarcane have been either abandoned or are underused.

Table 2.3 Comparison of National Crop Acreage and Production, 1979 and 1998

	1979		1998	
Crop	Crop Area (hectares)	Production (metric tons)	Crop Area (hectares)	Production (metric tons)
Rice	106,408	245,437	106,138	382,199
Red beans	54,853	37,927	40,523	38,559
Black beans	10,355	11,883	7,535	8,539
White beans	11,205	9,928	2,463	2,525
Maíze	36,581	48,177	37,679	59,614
Yucca	22,933	119,556	23,680	176,270
Sweet potatoes	6,659	5,495	10,200	60,248
Plantains	30,580	204,250	56,987	380,627
Bananas	7,058	71,626	24,975	234,725
Ñame (root crop)	2,707	17,274	2,511	20,125
Potatoes	897	8,987	2,951	39,500
Tomatoes	615	7,131	1,634	14,406
Industrial tomatoes	5,082	100,969	10,070	324,452
Onion	1,447	10,248	2,355	n/a
Pepper	911	3,624	2,359	23,661
Garlic	651	3,452	873	16,012
Coffee	**155,000**	**63,000**	**125,000**	**6,944**
Cacao	94,000	43,850	147,674	60,875
Tobacco	29,402	33,931	27,516	73,834

Source: Annual Plans, Secretariat of Agriculture Economic Planning Unit 1979–98.

The following changes in crop production over the last 20 years, as outlined in table 2.3, may be important to national environmental quality:

- Area in basic cereals (rice, maize) is not increasing, but productivity is considerably improved, due to increased application of fertilizer and other inputs.
- Dry beans and other staple crops of hillside farmers have declined in area under cultivation.
- Traditional root crops (yucca, sweet potatoes, ñame) have increased in area, and yields have significantly improved.
- Plantains and bananas, perennial crops, have increased in acreage, especially under irrigation.
- Export crops such as industrial (canning) tomatoes and tobacco—crops requiring intensive inputs—have increased in productivity dramatically.
- While overall area of rice cultivation has remained constant, rice grown under irrigation has increased significantly. The productions and productivity increases are attributable to enhanced technology, such as irrigation and application of chemical inputs.
- Vegetables grown in the mountains (Constanza, Valle Nuevo, Arroyo Frio) have increased.
- Use of chemical inputs for vegetable production has increased.

2.4 Animal Production

The livestock production sector has grown dramatically over the past two decades. Table 2.4 demonstrates the expansion.

Table 2.4 Animal Production, 1979 and 1998

Category	1979	1998	Change
Poultry (hundred weights)	77,700	168,966	132%
Pork (tons)	0*	27,530	–
Beef (tons)	54,500	76,780	86%
Milk (millions of liters)	302	443	46%
Eggs (millions of units)	316	901.7	185%

*Pork production was temporarily eliminated due to African swine fever.
Source: SEA Operating Plans for 1980 and 1998.

Dramatic increases in the production of poultry, pork, and eggs, and more modest increases in the production of beef and milk, are driven by local demand. This demand is largely urban-based and a result of population shifts from the countryside to the cities in response to the growth in the service and industry sectors. The increased production of animal products poses a challenge in environmental management, especially for water quality, owing to the concentration of fecal matter at larger poultry and hog operations, and the food processing wastes created in preparing these products for market. This is a key area where appropriate land-use planning and environmental regulation can protect environmental quality.

2.5 Soil Erosion

In 1981, the Country Environmental Profile identified soil erosion as "the most serious problem affecting the natural resources of the Dominican Republic." This problem was attributed in large part to deforestation and small farm agricultural practices on steeply sloping lands, which make up a large proportion of the nation's interior. It was noted that these widespread erosion problems degraded soil fertility, decreased the life span of critical water reservoirs used for hydroelectric generation and irrigation, and exacerbated flood risks.

In the past two decades, the erosion problem continued and, in some senses, became more acute. Data demonstrate that in 1998 land area classified, as "arid, barren, or eroded" was four times larger than the levels reported in 1980 (see table 2.2).

But it appears that most of the erosion since the CEP occurred in the 1980s. Beginning late in the decade, the Dominican government launched a concerted effort to respond to this problem with a series of national and local programs. The most notable of these programs include the Quisqueya Verde campaign for reforestation of the 1990s; Plan Sierra's government–private sector efforts to replace annual crops with coffee and promote reforestation and economic development in the north-central portion of the country; and the efforts of numerous NGOs on watershed, soil conservation, and reforestation projects in the uplands. These and similar efforts appear to be having some impact on water retention—an important contributing factor to erosion control.

Economic policy of the late 1980s also played a role in slowing erosion. Data on agricultural output indicate that the production of dry beans, the staple crop of hillside farmers, has declined (see table 2.3). The latter part of the 1980s also witnessed economic policies to promote free zones and light manufacturing. The free zones became a vital source of jobs for rural dwellers (especially small hillside farmers) faced with a declining demand for beans and other traditional commodities. Accordingly, opening markets to competitive imports and establishing trade regimes that favored high-value export commodities, cheaper imported beans, rural out-migration, and other economic pressures on small farmers in recent decades may be as responsible for this change as conservation programs.

Anecdotal evidence suggests that the stagnation of population growth in rural provinces actually masks significant depopulation of remote uplands once involved in slash-and burn agriculture (J. Pena 2001). A demographic shift, as younger people from former hillside agriculture zones move to local municipal centers or emigrate to Europe and the United States, may relieve some of the agricultural pressure on steep, remote watersheds. Limited field trips by this team in 2001 in the Nizao watershed noted neither significant use of uplands for annual crops (most land was in unimproved pasture, matorral, or coffee), nor significant cropland soil erosion problems.

While more research must be done on erosion rates, and different types of erosion under various land uses, as overall rate of erosion slows, upland erosion and sedimentation of reservoirs continue to be problematic.

Table 2.5 Sedimentation Rates in Reservoirs in the Dominican Republic through 1995

Reservoir	Years of Operation	Sedimentation Observed (M^3/km^2/year)
Tavera	20	2,284
Valdesia	17	3,218
Sabaneta	12	1, 963
Sabana Yegua	13	2,644
Rincón	16	4,442
Hatillo	12	4,575

Source: UNDP 2000, J. Rodríguez 2001.

Sedimentation rates in reservoirs reported in Ottenwalder (UNDP 2000) for several reservoirs of 2,000–4,000 m^3/km^2/year exceed what can be expected from overland flow on croplands, and especially on the pasture and matorral land uses common in the upland watersheds, even with high sediment delivery ratio (most sediment eroded in a given year does not make it downstream for many years). The sources of the sediment accumulating in reservoirs include cropland erosion, but landslides (many triggered by hurricanes), poor road construction, erosion of riverbanks during floods, and mobilization of river bed sediments deposited over the past decades have been significant sources of reservoir sediment.

In general, land uses that emphasize perennial tree crops, minimize road construction, and lower population densities in steep upland watersheds are critical to addressing the serious existing soil erosion problems. Promotion of soil conservation practices for hillside agriculture are important,

but in the current economic and demographic situation of the mountainous provinces of Dominican Republic, alternative perennial crops and appropriate municipal economic development alternatives like those promoted by Plan Sierra and FEPROBOSUR will be a more important part of any long-term solution.

2.6 Salinization of Irrigated Soils

About 13% of the Dominican Republic's cultivated land is under irrigation. From 1980 to 1998 irrigated area increased from approximately 178,000 hectares to 265,000 hectares (H. Rodriguez 1998). Much of the irrigated land is concentrated on the nation's best soils located in the Cibao (Yaque del Norte–upper Yuna), Yuna, and Yaque del Sur watersheds. Salinization of soils due to poor irrigation practices (often overuse of water raising local water tables), lack of adequate drainage, or simply intensive re-use of tail water for downstream irrigation, poses a distinct threat to the future use of some of these high-quality soils.

An example of the extent of the salinization problem can be seen in table 2.6. There are clearly relatively greater degrees of salinization in the Lower Yaque del Norte valley—an area where irrigation systems are supplied from tail water that has already been used for upstream irrigation. It is also an area with insufficient drainage infrastructure.

Table 2.6 Salinization of Soils in the Upper and Lower Yaque del Norte Valley (hectares)

Location	Not Saline	Slightly Saline	Moderately Saline	Strongly Saline	Very Strongly Saline	Total Hectares
Upper Valley (Santiago–Hatillo Palma	56,167	4,090	3,687	–	3,345	67,289
	84%	**6%**	**5%**	**0%**	**5%**	**100%**
Lower Valley (Hatillo P.–Montecristi	7,520	16,780	6,070	4,275	675	35,320
	21%	**48%**	**17%**	**12%**	**2%**	**100%**
Total	**62%**	**20%**	**20%**	**4%**	**4%**	**100%**

Source: Plan Nacional de Ordenamiento de los Recursos Hidráulicos (PLANORHI), OEA/INDRHI 1993.

Efforts to address the problem of soil salinization can be extremely costly when drainage structures are required. Several major projects have worked on improved irrigation water management in Azua and Cibao, but major deficiencies remain.

2.7 Environmental Impacts of Irrigation Projects in the Dominican Republic

Among the best-documented cases in the Dominican Republic of irrigation projects' negative impacts on the environment is the salinization of the Yaque del Norte river by high levels of water withdrawal (lowering flow in the river) and contaminated irrigation return flows.

Table 2.7 Salinization of Water in Yaque del Norte, 1970–93, as Evidenced by Conductivity Measurements Upstream to Downstream (microsiemens/cm)

Year	Santiago	Estancial del Yaque	Esperanza	Jibon	Hato del Medio
1970	170	300	560	410	570
1993	180	420	620	740	1000

Source: Juan Antonio González 1999, Valle del Cibao: Ecología, Suelos y Degradación, Santo Domingo.

2.7.1 Water Quality Impacts

These data indicate that downstream surface water in Hato del Medio is 10 times more saline than water in Santiago, and that much of this degradation occurred in the last 30 years as more irrigation projects have come on line. The salinization of water supplies by irrigation tail water is almost certainly accompanied by significant runoff of nutrients and sediments from agricultural fields to surface waters.

Two of the most important irrigated valleys in Dominican Republic, Yaque del Norte and Yuna, discharge to important wetlands and estuary systems: Monte Cristi and the Samana Bay, respectively. Both areas are experiencing changes in salinity, sediment loads, turbidity, nutrients, and other contaminants—concentrations of mercury have been detected in Samana Bay (UNDP 2000). A recent study conducted in small drainages below the Hatillo Reservoir revealed the presence of elevated levels of cadmium, chromium, and other heavy metals. (USGS 2000). Clearly, these contaminants can have major negative effects on estuary and reef ecosystems, especially in partially closed estuaries like the Samana Bay.

2.7.2 Alteration of Water Flows

Another major impact of irrigation is the reduction of dry season flows in the rivers themselves due to irrigation diversions, reducing and degrading the habitat available to freshwater aquatic life. Improving irrigation efficiency to leave unneeded water in the river is often a great benefit, but no evidence of studies on this issue in the Dominican Republic was encountered. Another impact on aquatic systems is the considerable ecological damage caused by large reservoir projects altering hydrologic and geomorphic processes in large river systems. These issues are apparently not yet being considered in water development projects in the Dominican Republic.

2.8 Key Issues in Land Use and Soil Management

- Most increases in crop production are attributable to intensification of the use of fertilizers and other inputs on available good soils. Efforts to optimize fertilizer management will save costs and reduce the potential for water pollution.
- Livestock production is intensifying, especially medium- and large-scale poultry and pork operations, which can pose threats to water quality from manure and processing wastes.
- Annual cropping of fragile uplands, especially with dry beans, apparently is declining significantly.
- Soil erosion continues to be a serious problem. It is critical to determine whether annual cropping on hillsides is really the principal source of eroded sediments, or whether landslides, dirt roads, and stream bank erosion are more important at a watershed level.

- Salinization of high-quality irrigated lands will continue to require substantial investment if these lands are not to be permanently lost for production.
- Salinization of surface and groundwater is at risk from saline intrusion in large areas of the Dominican Republic. This problem is especially serious on the south coast, the fastest growing region of the country.

Chapter 3. Water Resources and Watersheds

3.1 The National Water Budget—Components of the Water Cycle

The Dominican Republic's climate varies from humid in the northeast and high western mountains to semi-arid or arid in the southwest and northwest. The average annual precipitation nationwide is approximately 1,500 mm. This provides a gross annual national water budget shown in table 3.1.

Table 3.1 National Water Cycle for the Dominican Republic

Component	Water Volume (millions of m^3)
Precipitation	73,000
Evaporation-transpiration	51,000
Runoff (surface water)	20,000
Recharge to aquifers	1,510

Source: PLANIACAS 1983.

Total annual surface water runoff is approximately 20 billion cubic meters per year from the country's six major watersheds. The Yaque del Norte and the Yuna-Canu watersheds are the largest, supplying about 25% and 20% of the runoff. The balance of the water is drawn from the Azua-Yaque del Sur, Ozama-Nizao and other watersheds. Detail on the runoff supplied by each of the key watersheds is presented in table 3.2.

Since total flows include large flood surges (water not available for human use) the base flow (or dry season flow) is used to estimate available water supplies. The total available water supply can be estimated as the surface water base flow (371 m^3 per second) plus the available groundwater, which has been estimated at 47.5 m^3 per second (PLANIACAS 1983). This is equivalent to 1,610 cubic meters per capita for the Dominican Republic's present national population of 8.5 million. Compared to other countries, this water availability level is adequate for domestic, industrial, and agricultural uses—but has potential for shortages.

3.2 Groundwater Resources

Estimates by PLANIACAS in 1983 put potential groundwater resources at approximately 1,610 million cubic meters per year. Recently INDRHI, with international technical assistance, completed an intensive 42-volume field study of groundwater resources. This study focused on the southern portion of the country, where the majority of groundwater resources are located (hydrographic basins of the Ozama-Nizao, Yaque del Sur, etc.). Research findings indicate that recharge only in the south coast areas alone is more than 2.2 billion cubic meters per year. Therefore, the estimates of current available groundwater must be considerably higher for the country as a whole than the 1983 figures.

Table 3.2 Annual Runoff from Major River Basins in the Dominican Republic

River Basin (includes various rivers)	Rivers	Mean Base Flow		Mean Annual Flow	
		m^3 per second	10^6 m^3 per year	m^3 per second	10^6 m^3 per year
Yaque del Norte and others	Total	109	3,440	181	5,700
San Juan	San Juan	25	785	293	900
	Artibonito	18	575	32	1,015
	Total	43	1,360	61	1,915
Azua	Various	4	125	7	220
Yaque del Sur	Yaque del Sur	14	430	40	1,250
	Others	20	630	39	1,240
	Total	34	1,060	79	2,490
Yuna-Camú	Yuna	54	1,700	100	3,150
	Camú	24	770	52	1,630
	Total	78	2,470	152	4,780
Ozama—Nizao and other south coast rivers	Nizao	19	610	30	945
	Ozama	45	1,410	89	2,810
	Haina	14	440	22	685
	Chavón	6	190	13	420
	Others	19	590	33	1,030
	Total	103	3,240	187	5,890
National Total	**All Surface Water**	**371**	**11,695**	**667**	**21,995**

Note: INDRHI is organized into three water districts: Northern Region (Baja Yuna, Yuna Camu, Alto Yaque del Norte, Bajo Yaque del Norte), Eastern Region (Este, Ozama-Nizoa), and Southern Region (Valle de Azua, Valle de San Juan; Yaque del Sur, Lago Enriquillo).

The INDRHI study also detailed the extent of groundwater contamination with salts from seawater—which can be a serious problem in coastal aquifers. Where extensive use is made of coastal aquifers, their water table (or piezometric) level declines, which can allow seawater to move in to fill the void created by over pumping. This problem, known as saline intrusion, is widespread in the south coast of the Dominican Republic.

3.3 Water Use and Efficiency—Domestic, Agricultural, Industrial

According to table 3.3, water demand in 1980 was 2.3 million cubic meters per year—2.123 cubic meters per year for agricultural purposes, 287 million cubic meters per year for household consumption, and 82 million cubic meters per year for industrial use. Table 3.3 lacks a figure for industrial sector water demand for the year 2000 (the data were not available at the time of the study). Nonetheless, given the increases in the domestic use and agricultural sectors, and assuming that there has been a significant increase in industrial sector in accordance with the

growth of industry, one can estimate that the total current water demand is at least 10 million cubic meters per year—a four to fivefold increase over the 1980 level.

The efficiency of water use technology is a critical variable in water demand. As discussed below, there are serious efficiency questions regarding the two major uses of water—irrigated agriculture and household consumption.

Table 3.3 Total National Water Demand (millions of m^3 per year)

Type of Use	Source	1980	1983	1998	2000
Urban and rural domestic use	A	287		1,450	
Agricultural use	B	2,123			7,700
Industrial use	C	82	305		

Sources: A—Mott-McDonald 1998, B—G. Méndez 2000, C—PLANIACAS 1983.

3.4 Irrigation Water: Environmental Issues

Irrigated agriculture is responsible for more than 85% of national water use in the Dominican Republic, and has a major impact on water quantity, water quality, and aquatic habitat, all of which are important environmental issues.

Table 3.4 Expansion of Irrigated Area, Dominican Republic, 1980–2000 (hectares)

Area	1980	1990	1998–2000
Planned irrigation expansion	178,294	234,350	319,302
Actual area under irrigation	178,294	241,838	275,000

Sources: PLANIACAS 1983, INDRHI 2000, Mendez 2001.

Irrigation water supplies in the Dominican Republic include storage reservoirs, other surface water diversions, and groundwater. Some of the largest irrigation projects are supplied by major multi-purpose reservoirs (irrigation, hydro-electric generation, domestic water supply).

Table 3.5 Major Irrigation Storage Reservoirs in the Dominican Republic

Dam	Dam height (m)	River	Storage capacity (millions of m^3)	Irrigation service area (hectares)
Las Barias	22	Nizao	3	5,628
Sabana Yegua	76	Yaque del Sur	560	20,505
Sabaneta	70	San Juan	77	4,860
Hatillo	50	Yuna	700	17,718
Rincon	54	Jima	75	2,000
Tavera	80	Yaque del Norte	170	11,903

Note: A number of other dams (Chauey, Maguaca, Jiguey, Aguacate, Rio Blanco, and Bao) are part of the water storage system. They are not included in the discussion here because their principal use is provision of potable water of production of energy, not water storage for irrigation.
Source: INDRHI 2000, in Rodríguez 2001.

3.5 Irrigation Efficiency and Administration

Irrigation efficiency is a measure of the proportion of irrigation water provided that is beneficially used in crop production. Irrigation efficiency reflects the status of the infrastructure used to deliver water, the evaporation rate of the climate, the management of water deliveries, the system for applying water (e.g., flood irrigation, furrow irrigation, sprinkler irrigation), and the skill of the irrigators. In the Dominican Republic, a large part of irrigation water is delivered by surface canals, and applied either in furrows or as flood irrigation, both of which are low-efficiency systems.

Total water use efficiency is estimated to be low, about 18–25% (Rodriguez 2001). The environmental impacts of low efficiency in water can include raised groundwater levels, salinization of cropland soils, erosion of croplands and waterways, greater than necessary draw-downs of rivers and streams, and excess tail water carrying salts, fertilizers, and sediment into downstream waters.

Improvements in irrigation efficiency can require overhaul of water management and administration systems, investments in infrastructure (e.g. lining earthen canals), investments in water application devices (e.g. sprinklers, pipe, drip systems), and changes in pricing of irrigation water. Several projects have been carried out in the Dominican Republic to review and improve irrigation and water management practices.

One of the primary conclusions of irrigation management work in the Dominican Republic, as well as in many other countries, is that the systems are operated more effectively when their management is transferred from national government agencies to local agricultural water users association, or *Juntas* (Rodriguez 2001). To illustrate, over the past decade, INDRHI has led a program to assign management of the irrigation systems to local farmers. Those systems under local management demonstrate water fee recuperation rates of 60–85%. In contrast, the average rate of fee recuperation for systems still under central management is about 15%. The increase in fee collection under Junta-run systems is providing secondary water management benefits. Some Juntas are investing the money from water fees to purchase state-of the-art water management technology. Others are providing scholarships to water-user association members to study modern methods of water management. Both types of investment are contributing to enhancements in water use efficiency.

The government recently attempted to promote increased efficiency of water use by Presidential Decree 79-2001, which requires pricing water by volume, regardless of whether it is for energy, domestic, or irrigation use.

3.6 Effects of Sedimentation on Reservoir Storage

The sedimentation of major reservoirs in the Dominican Republic was a major concern of the 1981 Country Environmental Profile. Sporadic studies carried out in the intervening years by INDRHI have documented that those concerns have been borne out in reality. Table 3.6 explains what was known about reservoir sedimentation through the mid-1990s.

Table 3.6 Reservoir Sedimentation

Date	Reservoir	Reservoir storage capacity (millions of m^3)			Storage capacity lost due to sedimentation (%)		
		Active	Dead	Total	Active	Dead	Total lost
Dec-91	Valdesia	130	56	186	11.1	60.7	**26.1**
Dec-92	Sabana Yegua	446.9	33	479.9	9.6	45	**12**
Feb-93	Tavera	165.4	7.6	173	17.1	100	**20.7**
Dec-93	Rincon	58.4	16.1	74.5	15.4	33.4	**19.3**
Apr-94	Hatillo	416	25	441	15.2	10.4	**14.8**
May-99	Sabaneta	65.6	10.9	76.5	10.8	57.6	**17.5**

Source: M. Espinal/INDRHI/2000.

The sediment accumulation in these reservoirs has reduced total storage from 10% to 25% in only a few years or decades. Undoubtedly, in some cases, natural disasters like hurricanes David and Georges played an important role in delivering large sediment loads. However, in many cases, larger sediments derived from overland erosion, landslides, and bank erosion in upper watersheds take many years to arrive at a downstream location, so even with improvements in the watershed the sedimentation process will continue, and may in fact be significantly worse than during the last measurements.

3.7 Water Quality Issues

Water quality information for rivers and streams is scarce. Scant data of this type is collected regularly except at intakes for public water supply systems. Evidence collected on the South Coast, from the mouth of the Soco to the mouth of the Haina rivers in November 2000 by the USS Peter Anderson (a US Environmental Protection Agency research vessel), coupled with general trends in land use and sanitation, indicate that elevated levels of organic matter, fecal coliform bacteria, nutrients, and in some cases salinity, pesticides, and other contaminants are likely in many surface waters passing through agricultural and urban areas.

A recent study above the Hatillo reservoir, in small drainages below the El Rosario gold mine, indicated that elevated levels of cadmium, chromium, and other heavy metals were present (USGS 2000). Other studies have identified high levels of mercury in near-shore coastal waters of Samana Bay, and bio-accumulating pesticides and organic compounds, such as DDT and PCBs, in estuary mollusks (UNDP 2000).

The relatively few studies carried out to date indicate that there are many potential water quality problems in rivers, streams, and estuaries in the Dominican Republic. The lack of good data on water quality problems is troublesome, because human health, aquatic life, and ecosystem integrity are potentially all at risk. It is imperative that environmental authorities begin to develop a program to monitor and analyze water quality parameters in areas at risk (ports, urban rivers, rivers in agricultural zones, key estuaries), as well as in areas where relatively little human activity is taking place to establish baseline water quality information for the nation.

An exception is the INDRHI Water Quality Program. Launched in 1997, its objective is to systematize water quality measurement. While it is too early to note definitive results, this applied research effort holds promise for generating reliable data for future programming.

3.8 Key Issues in Water Resources

Issues are of critical importance to water resource management in the Dominican Republic include:

- *Salinization of Surface and Groundwater*—Groundwater is at risk from saline intrusion in large parts of the Dominican Republic, especially the south coast, which is one of the fastest growing areas of the country. Surface water has been degraded by salinization in certain intensive agricultural areas.
- *Access and Efficiency Issues in Public Water Supply*—A high proportion of Dominicans, especially in rural areas, still have no access to domestic water, which causes this part of the population to pollute public waters to meet the basic human needs of bathing, laundering clothes, and so on. Most existing public water supply systems are emphasizing conservation and efficiency measures critical to environmental quality.
- *Integrating Supply Protection into Policy*—Protecting key supply reservoirs and aquifers from sources of contamination is a key justification for land use planning and should be the focus of investments in the water sector.
- *Administration of Irrigation Water Supplies*—The traditional "public institutional management model has proven to be ineffective for managing irrigation water systems. Privatization of irrigation systems, and realistic pricing for water, both of which have been initiated by INDRHI, needs to be further promoted and put in place.
- *Documenting Water Quality Threats*—A gigantic lack of data on ambient water quality conditions threatens to obscure various threats to human health, aquatic life, and ecosystems from agricultural, industrial, mining, and urban development sources.
- *Access to Sedimentation Information*—There is relatively little information available on dam sedimentation. Bathometric studies to analyze rates and levels of sedimentation, and the associated loss of dam storage capacity need to be given high priority.

Chapter 4. Forests and Forestry

4.1 Forest Resources of the Dominican Republic

The Dominican Republic has a wide variety of forest cover. Broad-leaf forests, including high-elevation cloud forests, as well as humid forests, and semi-humid forests, are widespread in the steeper and less accessible areas of the northern, central, and eastern parts of the country. Conifer forests, made up almost entirely of the indigenous *Pinus occidentalis*, are found at very high elevations, principally in the Cordillera Central. Dry forests are widespread in the south, southwest, and eastern tips of the country. Many of the best remaining forest stands are in protected areas (see section 4.2).

Before 1980, forests that once covered 70% of the country were drastically reduced by logging and agricultural invasion. Between 1980 and 1998, several studies were carried out to measure forest cover. The fact that these studies used different methodologies makes it difficult to compare, in quantitative terms, the status of forested land area. What can be concluded from the CRIES (1980) and DIRENA (1998) studies is that the total area under forest cover increased by about 550 square kilometers in the intervening 18 years (table 4.1). Furthermore, it appears that coniferous forests have recovered the most—the DIRENA study indicates that land area under broad-leaf dry forests has expanded significantly. But, again, the differences in definitions in forest categories between the two studies make it impossible to draw a definitive conclusion. However, at least the data indicate that broad-leaf forests have more or less stabilized in the past 20 years compared to the trend in the period before the 1981 CEP.

Table 4.1 Land Area with Forest Vegetation as Quantified by Various Studies, 1967–98 (km^2)

Type of land use or cover		CRIES 1980	DIRENA 1998
Broad-leaf forest	Humid	6,518	6,306
	Dried, mixed, and others		3,889
Coniferous		311	3,025
Sugarcane		4,025	3,682
Tree crops (coffee, cacao, etc.)			3,414
Intensive pastures		2,325	2,636
Others: marginal agriculture, pastures, matorral, tree crops, other forests		27,417	17,595
Urban areas		292	394
Arid, eroded, bare land		402	1,306
Total		47,657	48,224

Source: CRIES 1980, DIRENA 1998.

The reasons for the stabilization and incipient recovery of forests include:

- Economic policies that (1) reduced taxes on the importation of low cost food commodities which, in turn, contributed to a reduction in steep slope subsistence agriculture, and (2) subsidized bottled cooking gas which, in turn, had a direct impact on the dramatic reduction of the charcoal-making industry.
- The growth of the urban-based industrial (e.g., free zone manufacturing) and service (banking and tourism) sectors that helped fuel a migration of rural residents, especially hillside agriculturalists, to the cities.
- Government-sponsored reforestation and natural resource management programs.
- Natural regeneration of former agricultural hillside land.
- Expansion in the number and size of protected areas.

4.2 Forest Management Initiatives

In 1988 CONATEF emitted Resolution 3-88 that started a Program of Certification of Plantations with Rights to Harvest. This program has contributed to a number of private forest plantation efforts by establishing the legal right "to use trees planted trees planted on one's own land." Between 1988 and 2000, this program issued almost 6,000 certificates resulting in more than 16,000 hectares planted in forest. Furthermore, the program has been gaining momentum steadily. In 1991 only 400 hectares were planted under the program. In 2000 the area planted was more than 2,000 hectares.

Several notable forest management activities have been initiated in the past 20 years, two of which—Plan Sierra's La Celestina Project, and the Zambrana Agroforestry project of Enda Caribe—are highlighted in brief case studies below.

4.2.1 Case Study: Zambrana Agroforestry Project

In 1984 an NGO named Enda Caribe launched a pilot agro-forestry project using participatory methods in coordination with the Federation of Campesinos of Zambrana-Chacuey in Sánchez Ramírez Province.

The project did field trials with 88 species of native and exotic trees, among which *Acacia mangium* showed the best results, and generated enthusiasm among the campesinos that wanted to attempt reforestation projects.

The success of *Cassia mangium* extended into neighboring areas, and hundreds of small farmers showed interest in planting this exotic tree. In 1992 the Association of Agroforestry Producers of Zambrana was formed with 600 members. The planting rates rose to several hundred thousand seedlings a year. A small sawmill was installed to process the first harvests from the farmers' plots.

The early results in Zambrana encouraged small and medium-scale producers to establish *Acacia mangium* plantations in other low-elevation areas of the country.

4.2.2 Case Study: Plan Sierra La Celestina Project

Plan Sierra began the La Celestina management project in 1983 to test the development of a forest management plan on a degraded natural forest. The project was funded in part by the government of Sweden.

The project area is 3,860 hectares, of which 57% is covered with native pine forests mixed with some broad-leaf forest. Initially, the native forest was so degraded that the plan called for substituting plantations for the natural forest. A second part of the project is the installation of a modest, but modern, sawmill. This mill is operated by local project participants and is the commercial, income generating dimension of the project.

This project has been through several difficult periods, but has succeeded in conserving a natural forest in the area. It also has demonstrated the economic feasibility of sustainable, locally managed wood harvesting, and established a land market for mountain areas with forest industry potential.

4.3 Government Reforestation Efforts

Since 1981, the national government has launched a series of large-scale reforestation campaigns. Most notable among these efforts is the Quisqueya Verde initiative that began in 1997. Quisqueya Verde was an ambitious undertaking that set as a goal the planting of 30 million trees in three years. Despite a heralded launch, the project's success is debatable. It has suffered from the difficulties similar to those experienced by other reforestation efforts in the Dominican Republic. To illustrate, government land available for reforestation has not been clearly identified, private landowners fear that land reforested will be lost to productive uses, and commercial operators fear that, given current policy, they will be prohibited from harvesting their trees.

4.4 Forest Protection Issues

4.4.1 Charcoal-Making

In 1981, when the CEP was published, charcoal production for urban cooking fuel was a large rural industry that impacted dry woodlands and forests in the Dominican Republic. In 1985 the consumption of wood for charcoal, used for cooking by nearly two-thirds of the entire population, was estimated at 4,172,700 m^3 of wood per year (JACC 1988, Gomez 2001). Beginning in the mid-1980s a government policy of subsidizing propane gas and cooking stoves, suggested by the National Commission for Energy Policy (COENER), was set in place. While perhaps a distortion to the economy at large, this policy was a boon to forest protection efforts. The gas subsidy measure virtually eliminated the demand for charcoal in less than 20 years. According to DGF, charcoal consumption dropped from 1,596,000 sacks in 1982 to 26,465 sacks in 2000 (Gomez 2001).

The decline in the charcoal-making industry has had a significant impact on the rural economy. Many poor households lost an important source of income. However, while quantifiable data are not available, it is believed that this loss was offset by the movement of farmers to urban jobs, especially in the free zone light-manufacturing sector.

4.4.2 Forest Fires

As a matter of course, significant numbers of forest fires break out in the dry season in Dominican Republic. The DGF has tabulated information on forest fires and reports that during 1981–2000 there were 1,365 recorded forest fires affecting 72,796 hectares. The years 1990 and 1997 were particularly bad fire years, with 15,269 hectares and 13,075 hectares respectively burned. Commonly, 1,000–5,000 hectares are affected annually. The DGF has trained fire-fighting brigades and provided some specialized equipment and training.

Table 4.2 Forest Fires in the Dominican Republic, 1981–2000

Year	Number of Fires	Total Affected Surface (hectares)	Average Surface (hectares)
1981	14	4,849	346
1982	25	1,998	80
1983	43	4,746	110
1984	88	3,079	35
1985	49	1,299	27
1986	60	835	14
1987	41	1,339	33
1988	32	525	16
1989	51	808	16
1990	74	15,269	206
1991	83	6,247	75
1992	52	1,485	29
1993	45	5,118	114
1994	170	5,080	30
1995	19	860	45
1996	55	674	12
1997	234	13,075	56
1998	55	1,061	19
1999	61	1,144	19
2000	114	3,304	29
TOTAL	**1,365**	**72,796**	

Source: Department of Forestry Planning, Sub-Secretariat of Forestry Resources, Dominican Secretary of State for the Environment and Natural Resources

4.5 Importing Forest Products

The Dominican Republic continues to be a net importer of wood products, as well as paper. Data on wood product imports alone indicates that the country spent an average of US$50 million a year of foreign exchange on sawn wood, both pine and fine hardwoods. And 85%–90% of imported wood volume is made up of American and Chilean pine (Gomez 2001). In 1981, the CEP indicated that the Dominican Republic was importing US$30 million a year of wood products.

4.6 Key Issues in Forestry

- *Absence of an Industrial Forestry Sector*—The forestry sector has stagnated in the Dominican Republic as a result of government policies to restrict wood harvest. No viable commercial timber industry exists. Most legal forest plantations are young and of small size (less than 5 hectares). It is unclear whether standing timber would be available to support a viable industry.
- *Negative Incentives for Private Land Forestry*—Despite the limited success of the Certification of Plantations Program, few private landowners in the Dominican Republic are planting tree crops owing to negative incentives for reforestation.
- *Silvicultural and Forest Management Models*—Little research is being done on forest management, and most attention has been given to exotic species (*Cassia mangium* and *Pinus caribea*) or the indigenous pine. Numerous native broad-leaf hardwoods exist (including local species of mahogany *Sweitenia*), and it is likely that much reforestation could be rapidly accomplished by natural regeneration if the right incentives were there.
- *Future Uses of Public Lands and Sugar Council Lands*— It is important to look at what role national government land, and land now controlled by the State Sugar Council (CEA), could be available for use in large-scale reforestation, perennial crop production, or other uses. It is imperative that the new uses on any large-scale government tracts be based on sound research, including silvicultural studies and market research.
- *Forest Cover Stability*—The loss of forest cover appears to be stabilizing; there is some suggestion of forest recovery.

Chapter 5. Coastal and Marine Resources

5.1 Coastal and Marine Waters in the Dominican Republic

The Dominican Republic is surrounded by the Atlantic Ocean on the north, the Caribbean Sea on the south, and the Mona Passage to the east, comprising, in total, 238,250 km^2 of in-shore and offshore waters within the Exclusive Economic Zone. Of this total, approximately 3% (7,600 km^2) is part of the island shelf, defined as waters less than 180 meters deep. Another 2% of the oceanic waters form the Banco de la Plata and Banco de la Navidad, which are important reef areas off the north coast.

5.2 Critical Coastal Ecosystems in the Dominican Republic

The Dominican Republic's coast is made up of a combination of rocky coastlines and headlands, mangroves and other wetlands, dunes and beaches. Below the surface of shallow coastal waters, sea grass beds and coral reefs are critically important resources for marine productivity.

- *Rocky coastlines* are primarily of limestone (coraline) origin. They are widespread ecosystems, and often intermixed with sand beaches.
- *Mangrove forests* are made up of four major tree species: *Rhizophora mangle, Avicennia germinans, Conocarpus erectus,* and *Laguncularia racemosa*, each tolerant of salt water and adapted to different conditions of submergence. These are ecosystems of high biodiversity, highly productive in biomass, important for rearing of many juvenile and adult fish, crustacean and mollusk species. They also protect coastal areas from erosion, remove sediments from rivers discharging to the estuaries and shallow coastal waters, and improve the quality of coastal waters.

The most important mangrove ecosystems in the Dominican Republic are at the mouths of the Yuna and Yaque del Norte rivers and are part of the national protected area system. No trends in mangrove forest conservation have been established, but with the end of charcoal-making in the 1990s, exploitation of mangrove forests is not currently a major concern (Silva personal communication 2001).

Table 5.1 Mangrove Forest Distribution in the Dominican Republic

Coastal zone	Total mangrove area (km^2)
North Coast	193
East Coast	75
South Coast	57
TOTAL	**325**

Source: CEPNET/IDB, 1998.

- *Dunes and beaches* are dynamic ecosystems, constantly changing form in response to wind, tides, and coastal erosion. There are a number of endemic plant species found on coastal dunes in the Dominican Republic (N. Ramirez personal communication 2000). Important coastal dune systems exist at El Estero in Montecristi Province, Bahia de Calderas in La Altagracia Province, and Salinas in Peravia province. Sand beaches are widespread but sporadically located along the Dominican coast. They are a major attraction for the large tourist industry, and beachfront properties are highly valued for hotel investments. They are also important ecosystems for a number of birds, sea turtles, and other marine and coastal species.
- *Sea grass beds* are highly productive ecosystems characteristic of clear, shallow coastal waters, often found in close proximity to coral reef ecosystems. Major sea grasses in the Dominican Republic are *Thalassia testudinum*, *Syringodium filiforme, Halodale, Holophila*, and *Ruppia maritima*. These areas can be important in biomass production, and are favored habitat for various commercial conch species, but are also easily damaged by increased turbidity or other water quality degradation in coastal waters.
- *Coral reefs* are well known to be among the most biologically diverse ecosystems on the planet, as well as the most highly productive of subtropical marine waters. Principal reef formations in the Dominican Republic are included in table 5.2. These reefs include many of the important fishing grounds in the Dominican Republic.

Table 5.2 Principal Coral Reef Areas in the Dominican Republic

Zone	Location	Province
North Coast	Bahía de Icaquitos a Punta Rucia	Montecristi
	Punta Balandra	Samaná
East Coast	Punta Icaco a Cabo Engaño	La Altagracia
	Canal de Catuano	La Altagracia
	Isla Saona	La Altagracia
South Coast	Isla Catalina	La Romana
	Guayacanes–Juan Dolio	San Pedro de Macorís
	La Caleta	Distrito Nacional
	Puerto Viejo	Azua
	Isla Beata	Pedernales

Source: CEPNET/IDB 1998 (http://grid2.cr.usgs.gov/cepnet/rep_dom/submenu.htm).

5.3 Marine Fisheries

Marine fisheries in the Dominican Republic are primarily coastal and exploited by a low-technology artisanal fishing industry. The marine fishing fleet was estimated in 1979 (CEP 1981) and estimated in 1991 (PROPESCAR-Sur 1991), using methods that may not be strictly comparable. The data are reported in table 5.3.

Table 5.3 Marine Fishing Fleet in the Dominican Republic

Vessel	1979	1991
Cayuco: Dugout canoes of 3–5 meters	420	1,418
Yola: Open boats of 4–6 meters with outboard motors	830	2,136
Bote, Pivote, Barco: Larger motorized craft (>6 meters)	150	198
Total	**1,400**	**3,752**

Sources: CEP 1981, PROPESCAR-SUR 1991, Comprehensive Census of the Coastal Fishery in the Dominican Republic.

The fishery is primarily exploited using bottom-fishing techniques, with heavy emphasis on hand lines. Production was estimated for 1976–80 total landings as 7,000 tons a year (CEP 1981). Production in 1992–99 is presented in table 5.4.

Table 5.4 Marine Fishery Landings in Metric Tons, Dominican Republic 1992–99

Year	1992	1993	1994	1995	1996	1997	1998	1999
Production (tons)	13,169	12,949	13,027	18,662	13,192	14,536	10,069	8,517

Source: Department of Fisheries 1999, Silva 2001.

The inference to be drawn from these data is that the size of the fishing fleet has grown significantly in the last two decades, and that marine fish landings have been correspondingly higher in most years. The particular significance of lower landings in 1998/99 is not clear. An Inter-American Development Bank study reported in the 1981 CEP estimated the potential sustainable production of 10,454 tons per year from accessible island shelf and offshore bank areas (0.8 tons per km^2). Localized studies have indicated a drop in production from the Samana estuary, of 1.86 tons per km^2 to 0.48 tons per km^2 from 1980 to 1994 (Silva and Aquino 1994).

The PROPESCAR-SUR survey published in 1990 included 226 species of bony fishes, 12 species of cartilaginous fishes (sharks, rays), 9 species of crustaceans, and 11 species of mollusks for a total of 258 species in the catch figures. Catch surveys published by the national Department of Fisheries (DRP) report a much lower diversity—the 1999 survey mentioned 68 marine species. This is probably not so much a reflection of changes in species catch as a reflection in the distinct level of detail in the survey techniques. With these discrepancies in the type and quality of data, it is not known whether particular stocks are at risk of over-exploitation.

Anecdotal evidence suggests that over-fishing of certain high-value species, particularly spiny lobster (*Panulirus argus*) and conch (*Strombus gigas*), both of which are exported as well as consumed locally, is occurring in certain near-shore waters (Silva 2001). In general, the quality of the available data is insufficient to judge whether the marine fishery is sustainable at the current levels of harvest on a national scale; however, certain areas and species are being over-fished and are apparently poorly regulated.

5.4 Freshwater Aquaculture

Aquaculture in the Dominican Republic is focused on freshwater production of fish, primarily Tilapia (*Oreochromis*) and *Macrobrachium rosenbergii*, a large shrimp. There are 22 private aquaculture ventures, most of which produce fish and shrimp (table 5.5).

Table 5.5 Production of Freshwater Fish and Shrimp in Commercial Facilities, 1994–98 (metric tons)

Product	1994	1995	1996	1997	1998
Shrimp	121	41	96	212	169
Fish	56	11	66	127	80

Source: F. Richardson and M. Nicolas, "La aquaculture en la Republica Dominicana: Presente, pasado, y futuro," forthcoming.

5.5 Coastal Tourism Development

The tourism industry in the Dominican Republic is a fast-growing and important part of the national economy. In the Dominican Republic tourism is strongly focused on beach-oriented international hotels, many of which have been built by foreign investors. The hotel, bar, and restaurant industry grew consistently at an average of almost 13% annually in 1994–98, and the tourism industry contributes to many other aspects of the national economy, including construction, communications, and so on, as well as being an important source of new employment (Central Bank 1999).

Table 5.6 Increase of Hotel Rooms in the Dominican Republic, 1993–98

Year	1993	1994	1995	1996	1997	1998	1999
Rooms	26,801	29,243	32,846	36,273	40,453	44,665	49,623

Source: National Association of Hotels and Restaurants, Inc. (ASONAHORES) 2000.

Almost all of the new hotel construction is in coastal environments, especially on the north, east, and southeast coasts.

Table 5.7 International Tourists Arriving in the Dominican Republic

Year	1996	1997	1998	1999
Arrivals	1,925,565	2,211,394	2,309,139	2,649,418

Source: National Association of Hotels and Restaurants, Inc. (ASOHONORES) 2000.

5.5.1 Environmental Impact of Coastal Tourism

The rapid growth of tourism is placing significant pressure on coastal ecological niches in a variety of levels. Constant destination resort construction and ever-increasing volumes of tourists are threatening the coastal marine biodiversity. Simultaneously, the tourism industry is demanding increases in essential services (potable water, public sanitation facilities). The demand for basic services is, in the long run, beneficial. In the short and medium-term this demand is levied on a system (at the national and local levels) unprepared to meet it. In sum, the key environmental issues raised by coastal tourism development include:

- Increased discharge of sediment and wastewater into coastal waters (degrading water quality, sea grass and coral reef communities).
- Urbanization, population growth, and public sanitation problems in beach communities due to new hotel work forces.

- Alteration of natural geomorphic processes (beach erosion, migration) due to construction of hotel infrastructure.
- Degradation of beach, mangrove, or wetland habitat for sensitive species such as sea turtles, waterfowl, and other species.
- Conflicts in use between tourists, commercial fishermen, and shipping interests.
- Danger of over-exploiting coastal aquifers and saline intrusion in groundwater.
- Damage to reefs and other fragile environments by over-use (anchor damage to popular reef areas, etc.).
- Encroachment into protected areas.

Areas of potential conflict between tourism development and sensitive coastal environments are, geographically widespread. For example, a number of critical resources, including important sea turtle nesting beaches, coastal lagoons critical to waterfowl, and high-quality sea grass beds/fishing zones are concentrated in the northeast Altagracia Province, also designated a tourism development zone. Appropriate tourism development may be able to proceed or adapt, with minimal damage to these resources, or even contribute to their protection, but the commitment to do so must come from the government, and be accepted by the development interests.

5.6 Ports and Shipping Infrastructure

Major ports in the Dominican Republic include Haina, Puerto Viejo de Azua, Barahona, Santo Domingo, San Pedro de Macoris, La Romana, Duarte, Santa Barabara de Samana, Puerto Plata, and Puerto Libertador. Haina handles a large portion of the commercial and industrial cargo, while Puerto Plata, Santa Barbara, Duarte, La Romana, and Santo Domingo handle commercial and tourist traffic, including large cruise ships. The five largest ports (including Haina, Puerto Plata, and Santo Domingo) handled 15,803 ships and nearly 42 million tons of cargo in 1990–94 (UNDP 2000).

The potential for contamination of coastal waters from these vessels is significant. Large ships discharge fuel, wastewater, and solid waste, which can cause damage to coastal waters or place a major disposal burden on coastal communities. The risk also exists that cargo ships carrying toxic or noxious substances, such as petroleum, could wreck in Dominican waters.

5.7 Urban Development

The coastal areas of Dominican Republic include most of the largest, fastest-growing urban areas, including Santo Domingo, which will soon encompass a third of the entire Dominican population, and many heavy industries are located in the port areas. This development pattern means that all environmental risks created by growing urbanization (see chapter 8) concentrated in coastal environments.

5.8 Key Coastal Issues

Coastal management is a complex inter-disciplinary field, which integrates economic and social development with environmental sustainability in fragile coastal areas. The Dominican Republic's coastal management issues are central to national development, not only because the majority of the population and demographic growth is in coastal areas, but because one of the

most dynamic sectors of the economy, the international tourism industry, is almost entirely concentrated in a few coastal areas, and demands a high degree of sanitation and environmental integrity to remain viable.

- Coastal marine fisheries are increasing pressure on the resource, but current data collection and analysis do not allow appropriate planning to conserve critical stocks.
- The dynamic international tourism industry is having a detrimental impact on certain coastal resources and needs appropriate environmental evaluation and planning.
- Future coastal tourism growth, if not integrated into environmentally sound urban and rural planning, will degrade the very resources—coastal scenery, high water quality, biodiversity—on which it is based.
- Shipping, ports, and harbors are a critical sector for potential environmental contamination.

Chapter 6. Biodiversity and Protected Area Management

6.1 Definition of Biodiversity in the Dominican Republic

The diversity of native flora and fauna in the Dominican Republic is an important part of the country's rich natural resource patrimony. That said, it is important to note that biodiversity in island settings has two predominant characteristics: (1), a high level of endemism (species found nowhere else in the world) and (2) high vulnerability of extinction. The Dominican flora and fauna are typical of this pattern.

Table 6.1 Definition of Biodiversity for the Dominican Republic

	Definition
Diversity of ecosystems	The number of distinct habitats and biological communities
Diversity of species	The variety and relative abundance of different species present
Genetic diversity	The internal genetic diversity of each species, or the sum of genetic information contained in the plants, animals, and microorganisms

Source: Global Strategy for Biodiversity 1992.

6.2 Description of Terrestrial Ecosystems

The wide majority of native terrestrial ecosystems in the Dominican Republic were forests or matorral. While over time there has been a steady decline in forests, as recently as the middle of the 20th century about 70% of the original cover remained in tact. Since the 1950s the rate of forest loss accelerated markedly. Current estimates place only 36% of the country's land area in forests, and much of that is found in protected areas and national parks (Tolentino et al. 1998).

6.2.1 Forest Types, Typical Species

The principal native forest types, with typical species, and sample localities are as follows:

- *Conifer forest*. Dominated by the native pine, *Pinus occidentalis*, this forest is found in elevations between 800 and 3,085 meters. Most significant conifer forests are in Armando Bermudez, Jose del Carmen Ramirez, Valle Nuevo, Sierra de Bahoruco, and Sierra de Neiba national parks.
- *Broad-leaf cloud forest*. Found in very humid mountain zones between 600 and 2,300 meters in elevation, typical species include *Didymopanax tremulus*, *Brunellia comocladifolia*, *Magnolia pallecens*, *Magnolia hamori*, and *Prestoea Montana*. This forest type is restricted to the Cordillera Central and Cordillera Septentrional and the Sierra Bahoruco and Sierra Neiba.
- *Broad-leaf humid forest*. This forest type is widely distributed in mountainous areas between 500 and 1,500 meters. Typical species include *Ocotel Sloanea berteriana*, *Tabuebuia berterii*, *Mora abbottii*, and *Cyathea arborea*. This forest type can be found in Reserva Científica Ebano Verde, Loma la Humeadora, and Lomas Quita Espuela y Guaconejo. It is commonly found mixed into traditional coffee and cacao plantations.

- *Broad-leaf semi-humid forest*. This is a low-elevation forest found on lower mountain slopes and in coastal areas, including karst terrain and many soil types now dedicated to agriculture. Typical species include *Coccoloba diversifolia, Guaiacum sanctum*, and *Swietenia mahagoni*. Examples of this forest type persist in Parque Nacional del Este, near Bávaro, and on the southern flank of the Sierra Bahoruco.

6.2.2 Other Vegetative Communities

In extremely dry areas of the south, southwest, and extreme east the dominant ecosystem is a Dry Matorral, or thorn brush ecosystem. Typical species include *Tabebuia berterii, Sweitenia mahagonia*, and *Acacia macracantha*, as well as various species of cactus and other xerophytes. This habitat is found in the Lake Enriquillo area, Azua Valley, and other areas of the southwest. Other minor ecosystem types, in terms of area covered, include various mangrove ecosystems, fresh and saltwater wetlands, and savannas.

6.3 Floral and Faunal Diversity and Endemism

The Dominican Republic has an exceptionally high rate of endemism. Island habitat endemism is particularly fragile and subject to extinction. Accordingly, aggressive conservation is required to preserve the country's rich biodiversity. The fact that neighboring Haiti has little native terrestrial habitat left gives added importance to conserving the Dominican Republic's biological uniqueness. Table 6.3 identifies the variety and rate of endemism of native species. Almost all the reptiles and amphibians are endemic, and more than a third of the Dominican Republic's flora is endemic.

Table 6.3 Species-Level Biodiversity in the Dominican Republic

	Number of species	Number of endemic species	Percentage of species that are endemic
Flora			
Plantas vasculares	5,600	1,800	36
Algas	168	unknown	unknown
Fauna			
Mamíferos	48	2	10
Aves	296	26	9
Reptiles	146	138	94.5
Anfibios	65	63	97
Peces	399	–	–
Molusco	311	–	–
Artrópodos/Crustáceos	164	–	–
Cnidarios	111	–	–
Equinodernos	67	–	–
Poliferos	39	–	–
Annelidos	6	–	–

Sources: CIBIMA 1994, SEA/DVS 1990, UNDP 2000, CEPNET IDB, Liogier 1978, CIBIMA 1994.

6.4 Species Threatened and at Risk of Extinction

The biodiversity of the Dominican Republic faces numerous threats, especially due to the loss of a major portion of the terrestrial forest habitat. At least 10% of the species in the Dominican Republic and 33% of the vertebrates (mammals, birds, reptiles, amphibians, and fish) are endangered or threatened with extinction (table 6.4). By any standard, this is an extremely high rate of potential loss of biodiversity.

Table 6.4 Threatened Species in Dominican Republic

Species group	Total species	Percentage of total species in this class	Number of species threatened or endangered	Percentage of class or group threatened with extinction
Plants	5,600	75.4	442	8
Algae	168	2.3	Unknown	–
Vertebrates	954	12.8	204	33
Invertebrates	698	9.4	117	17
Total	**7, 420**	**100**	**763**	**10**

Source: N. Ramirez 2001.

Marine species, including a diverse array of marine mammals (whales, dolphins), are poorly known and not well represented in this analysis. Although marine species are mobile and not as often endemic it is noteworthy that the near-shore banks of the Dominican Republic are the most important wintering area for humpback whales in the Atlantic Ocean.

6.5 Key Issues in Biodiversity Conservation

- Threats to biodiversity in the Dominican Republic include the continuing degradation of forest habitats by land-clearing, human-caused forest fires, and mining; the illegal hunting and capture of certain species for the pet trade (birds, reptiles); and the introduction of alien species that are particularly pernicious in island environments.
- The scientific knowledge of biodiversity in the Dominican Republic is quite incomplete. Improved knowledge of the conservation status and ecology of many little-known species will improve the ability to conserve them. This requires an investment in education and research.
- Many terrestrial species probably owe their continued existence to the substantial national park and protected area system being developed in the Dominican Republic.

Chapter 7. Protected Areas of the Dominican Republic

Over the past two decades, the Dominican Republic has dramatically expanded its protected area network. In 1980 there were only 9 protected areas. By 2000 that number had grown to 70 (table 7.1). The part of the protected area network that is completely land based accounts for 16% of the country's total area. In addition, there are parts of protected areas (Jaragua and Montecristi) that are marine niches, while there are other parks (Banco del Plata Marine Sancturary) that are complete marine environments. The marine parks and the aquatic parts of the predominantly land reserves add over 27,000 km^2 to the protected area network (table 7.2). This significant expansion reflects a conscious effort on the part of government, and the growing interest of the public, in protecting the country's natural resources. It also reflects the increasing emphasis on biological and natural science education, and the political influence of the conservation stakeholders.

The protected area system in the Dominican Republic is rapidly improving, but obviously still quite deficient in management infrastructure, staff, and visitor infrastructure. Political will must be generated to adequately fund the government entities responsible for patrolling and managing 16% of the Dominican land surface. A number of NGOs are assisting in the task of managing the national parks in the Dominican Republic, using several co-management models. Much work remains to be done in the area of strengthening relationships with local organizations, including not only NGOs, but also communities and municipalities.

Table 7.1 The Increase in Protected Areas by Decade

Protected areas	To 1980	1981–90	1991–2000
Scientific reserves	1	6	10
National parks	8	12	22
National monuments			9
Anthropology reserves			2
Fauna refuge			7
Fauna sanctuary		1	
Wildlife refuge		1	
Panoramic view		1	10
Ecological corridors			6
Recreation areas			3
Special ecological reserves			1
Total	**9**	**21**	**70**
Percentage of national land surface included	**4.2**	**11.2**	**18**

Sources: Mores 1980, Valdés and Mateo 1992, Ramirez 2001.

Table 7.2 Size and Status of Protected Areas by Category

UICN category	Number of areas	Total area (km^2)	Surface area (km^2)		Manage-ment plans	Areas with visitor infrastructure	Areas with management infrastructure	Area with staff
			Terrestrial	Marine				
Scientific Reserves	10	639	546	94	2	2	2	2
National Parks	22	8,485	6,359	2,126	8	6	14	17
National Monuments	11	246	155	98	–	–	3	5
Wildlife Refuges	7	25,577	273	25,303	–	–	2	2
Other	20	546	513	33	–	–	–	0
Total	**70**	**35,494**	**7,844**	**27,646**	**10**	**8**	**–**	**26**
Percentage			16%	12%				

Sources: UNDP 2000, Sub-secretary of Protected Areas and Biodiversity (consultant) Bonnelly de C. 1996, Bibliography for *Management and Development of the Marine Protected Areas in the Dominican Republic*.

Table 7.3 Protected Areas and National Parks

	Local tourists	Foreign tourists	Total visitors	Fees collected
Parque del Este	–	143,199	143,199	RD$4,506, 626
Isla Catalina	318	44,735	45,053	RD$1,327
Los Haitises	2,333	8,291	10,624	RD$442,655
Isla Cabritos	8,149	1,996	10,145	RD$284,500
El Choco	0	6,813	6,813	RD$181,780
La Isabela	2,001	2,379	4,380	RD$151,770
Montecristi (Cayo arena)	895	1,610	2,505	RD$86,950
Armando Bermúdez	1,348	147	1,495	RD$72,670
Loma Isabel de Torres	617	1,088	1,705	RD$49,010
Cuevas del Pomier	2,652	42	2,694	RD$28,775
Estero Hondo	0	1872	1,872	RD$27,830
La Vega Vieja	1,111	61	1,172	RD$15,740
Parque Nacional Jaragua	613	156	69	RD$21,655
Laguna Cabral	8	22	30	RD$1,260
Sierra de Bahoruco	0	24	24	RD$1,200
Laguna Redonda y Limón	15	–	15	RD$300
Valle Nuevo	0	3	3	RD$150
Total	**20,060**	**212,435**	**232,495**	**RD$7,200,408.00**

Source: DNP Annual Report 1999.

7.1 Tourism in the Protected Areas

Tourism development in protected areas is largely in an incipient stage. Fees are charged for national and foreign visitors, which generates some income. But only a part of the revenue from visitations is retained for park maintenance. Park managers sense that operational budgets are far

below needed requirements. An aggressive revenue generation campaign or increase in transfers from the national treasury is needed to maintain, at a minimum, and hopefully upgrade it.

It is clear from this summary that the visitor use potential of the national park system, and its potential for generating fee income, is very underused. Parque del Este is responsible for more than half of all visitors and fees generated.

7.2 Key Issues in Protected Area Management

Many important issues constrain the national protected area system. Some of the most prominently mentioned issues according to high-level staff are:

- *Budget and Financial Management*—The dramatic expansion in number and size of national protected areas has not been accompanied by a corresponding budget. Of particular concern is the possibility that private property included in new parks might be subject to financial compensation.
- *Physical Demarcation and Patrol*—Many of the protected areas have no physical demarcation of boundaries, signs designating their borders, or staff to patrol and educate local communities about the parks.
- *Development of Tourism Facilities*—Absence of appropriate infrastructure for tourist use hampers the access to many parks. In some cases, private investors are interested in helping develop park infrastructure, especially coastal areas, but this issue is a two-edged sword, and potentially controversial.
- *Invasion of Protected Area Lands by Agricultural and Recreational Users*—Some remote parks suffer from agricultural invasions, a continuing problem in Parque Nacional los Haitises. In Dunas de las Calderas mangrove and dune areas are being eliminated for construction of private recreational residences.
- *Natural Resource Damages*—Deforestation, poaching (for meat or pet trade), off-road vehicles (on dunes/beaches especially), and forest fires are all serious problems in some protected areas.
- Community relations, participation in management, and compensation to local communities who have lost some traditional uses of protected areas are all major issues for the national park service.
- It is also advisable to carry out economic valuations of protected areas in order to provide environmental and economic bases for investment.

Chapter 8. Environmental Quality in the Urban-Industrial Sector

8.1 Urbanization of the Dominican Republic

Only a few decades ago the Dominican Republic was an agriculturally based nation. It is now rapidly evolving into a primarily urban society. A nation with 65% of its population in rural areas in 1965 became a nation with the same amount in urban areas by 1997. This urbanization of Dominican society has put huge pressures on municipalities to provide infrastructure and services to maintain acceptable environmental quality in the booming urban centers. These pressures will only increase in the immediate future.

Santo Domingo is the center of the urbanization process. Over half of the nation's urban residents live in Santo Domingo, which in 2001 has 2.7 million people, 2,600 kilometers of roads, 700,000 vehicles, and covers over 300 square kilometers. In 1980 by comparison, Santo Domingo had 1.3 million inhabitants and covered 161 square kilometers (Castillo-Tio, 2001).

8.1.1 Case Study: Santo Domingo's Marginal Neighborhoods

A worst-case scenario for environmental management in a rapidly urbanizing setting exists in the marginal neighborhoods along the canyons leading to the Isabela River in the northeast part of Santo Domingo. One example is La Zurza, where thousands of mostly one-room homes are perched precariously on the steep slopes of a canyon. Population density is 80,000 people per km^2; potable water supplies are leaky homemade pipes of electrical conduit; sewage disposal ranges from open drains to bottomless latrines perched over a stream. Huge quantities of garbage are accumulated in the canyon bottom, where they are washed downstream to the Isabela River by a combination of industrial wastewater, raw sewage, and storm water. The local population traverses dirt paths on the steep canyon slopes and crosses this effluent stream to reach nearby homes. Heavy rains and hurricanes flood out all the low-lying homes at the canyon's outlet.

Local community and municipal organizations are working to tackle these enormous problems and have made progress on housing improvements, garbage pickup (a locally run private operation), and storm water drainage. In one community near La Zurza, a massive covered storm drain in the bottom of the canyon has provided physical separation from the raw sewage and industrial effluents, as well as some flood relief. The flat top of the storm drain provides a valuable secondary use as a walkway for access to all homes. Large infrastructure investments need to be made simply to control storm water runoff, and protect homes from being flooded with polluted water. Safe potable water, sewerage, and wastewater treatment are far more expensive long-term goals.

8.2 Municipal Infrastructure Investment

Municipal governments, which are responsible for basic environmental sanitation in urban areas (garbage collection, street cleaning, road repair, maintaining sanitary and storm-water drainage networks), among other duties, received only 2.5% of the national revenue in 1998, equivalent to 0.4% of the gross national product (Castillo-Tio 2001). The capital investment needed in this sector is also substantial, but establishing financial mechanisms for maintenance budgets for

municipalities in environmental quality work is a key need for the future. The government invested an average of RD$22 million annually from 1990–98 in potable water and sewer infrastructure, representing approximately 0.3% of the national budget during that period (Castillo-Tio 2001). This rate of infrastructure investment will need to rise substantially to improve the national access to potable water and sewage facilities.

8.3 Potable Water Supply for Urban Areas

Nationwide, 54% of urban people had access to domestic (piped) water in 1979, while in 1998 80% of the urban population has access to domestic water supplies—a significant improvement (CEP 1981, H. Rodriguez). Nonetheless, 850,000 urban dwellers still have no access to domestic water supplies.

Unmet demand for high-quality potable water is evident in the consumption of more than 1,000,000 cubic meters of bottled water per year. The cost borne by the consumer is reflected in the fact that the cost of water provided by the Santo Domingo aqueduct is RD$4/$m^3$ and the cost of bottled water is RD$900/$m^3$. In 1991, the percentage of the urban population consuming bottled water was 13.9%, while in 1995 the proportion using bottled water had already increased to 40% (Castillo-Tio 2001). This substantial increase in the use of bottled water took place in spite of a dramatic price differential between the water supplied by the Santo Domingo aqueduct system (RD$4/$m^3$) and the processed bottled product (RD$900/$m^3$).

8.4 Domestic Wastewater Management

Appropriate wastewater management is critical to both human health, to the quality of the urban environment, and to water quality in rivers, streams, aquifers, and coastal areas. Sanitary sewers served approximately 15% of the urban population in 1979, while estimates for the entire nation were about half that (CEP 1981).

Table 8.2 Coverage Of Sewer Connections in Different Urban Areas

	Small urban areas (INAPA)	Santo Domingo (CAASD)	Santiago (CORAASAN)	National
Number of connections	47,500	63,000	52,200	162,700
Number of homes	47,500	94,500	52,200	194,200
Population served	185,350	378,000	261,000	824,300
Total coverage	4.00%	16.20%	38.20%	10.70%

Source: Consultant's Report on Economic and Financial Analysis, December 1996.

In 1997, INAPA provided sanitary sewer service to 4% of the rural and smaller municipal center population, CAASD provided such service to 16% of the Santo Domingo population, and CORAASAN provided sanitary sewer service to 38% of the population of Santiago. Accordingly, the total national rate of sanitary sewer coverage is 10.7% (Castillo-Tio 2001). The combined rate of coverage in the major urban centers of Santo Domingo and Santiago is about 21%, which may indicate a slight improvement over 1979. Further improvements were made in 1997–2000.

Approximately 19% of the national population is estimated to use septic systems, 53% use latrines, and 17% of the population has no wastewater disposal at all (Castillo-Tio 2001).

The wastewater treatment system in Santo Domingo consists of 600 kilometers of tubes which discharge variously into marine waters, into the Isabela and Ozama rivers, and into 13 small wastewater treatment plants which then discharge into the same two rivers. The wastewater treatment plants are reported to have "serious deficiencies in operation and maintenance" (Castillo-Tio 2001). It is not known what proportion of effluent is treated before discharge.

The municipal government of Santo Domingo has done a feasibility study of master planning and construction of comprehensive wastewater collection and treatment for the city. The initial estimated capital cost for this project is RD$12,000 million (Castillo-Tio 2001).

At the municipal level (smaller urban areas), 15 wastewater collection and treatment systems were constructed in 1968–78. These systems have been expanded since that time, and a few additional projects have been built, but the rate of investment in this infrastructure has declined in the last 20 years. At least 80 municipal areas are in need of major investment in wastewater collection and treatment, among a total of over 150 smaller urban centers in Dominican Republic that have no sewer systems (Castillo-Tio 2000).

The inadequate sewer and wastewater treatment infrastructure, combined with deficiencies in potable water supply, quality control, and source protection among existing water systems, result in a continuing vulnerability to water-transmitted diseases in the Dominican Republic. Table 8.3 below indicates that several water-borne diseases continue to be common.

Table 8.3 Incidence Of Water-Borne Diseases in the Dominican Republic, 1994

Disease	Number of cases nationally	Rate per thousand
Acute diarrhea	133,932	180.86
Typhoid fever	1,714	15.82
Hepatitis	2,364	3.14
Paratyphoid fever	1,758	2.37

Source: First National Seminar on Water Quality in the Dominican Republic. Lina Hotel, August 30, 1994.

8.5 Urban Storm Water Management

Rainfall runoff in urban areas washes many different contaminants from streets, buildings, construction sites, and industrial areas, forming a major source of non-point water pollution. These contaminants include nutrients, sediment, heavy metals, bacteria, oils, grease, rubber, and organic matter, which originate from automobile traffic, garbage, and other sources. Both street cleaning and the construction of storm sewers with treatment facilities can be used to combat this problem. In Santo Domingo, the City Council has discussed the development of an improved and expanded storm water sewer system, based on studies by the World Bank for the Secretary of Public Works and Communication (SEOPC/IBRD Nº 01-97—Master Rainwater Drainage Plan for the Dominican Republic).

8.6 Industrial and Commercial Wastewater

There are more than 7,000 registered industries and large commercial operations in Dominican Republic, with approximately 70% of them in the Santo Domingo area. Industrial development has been most rapid in the free-trade zones, but that growth is reported to be slowing. The total discharge of organic matter into rivers and coastal waters, primarily in the south coast area, by these industries and businesses is estimated to be 600,000 tons per year of biological oxygen demand, compared to 125,000 tons per year of biological oxygen demand from domestic wastewaters (Castillo-Tio 2001). To illustrate, a chemical analysis carried out by INTEC in 1993 revealed elevated contamination levels in the Ozama. Levels of chloride, lead, iron, and nickel were above the international norms for rivers and lakes. The main causes of this contamination were industrial discharges.

Despite the probable magnitude and impact of industrial wastewater discharge, relatively little data is available concerning the topic. The sector is characterized as follows (Castillo-Tio 2001):

- Clear norms and standards for industrial wastewater treatment and discharge do not exist, and sampling programs for wastewater are underdeveloped. The Commission on Ecological Sanitation (Comision de Saneamiento Ecologico) takes samples of wastewater effluents at 550 industries, usually 3 samples per year.
- Financial resources for industrial wastewater monitoring are scarce.
- Some of the most dangerous contaminants are not being analyzed.
- It is estimated that 90% of the industries discharge wastewaters to water bodies or sewers without any treatment. Industrial wastewater treatment plants are few.

8.6.1 Case Study: Water Pollution at Thermo-Electrical Generation Plants

A USAID–funded study of the energy sector made the following observations about coal- and petroleum-fired electrical generation plants:

- Rainfall runoff control appears to be oriented only towards controlling flooding, not minimizing contact of rainfall runoff with materials, which can contaminate waterways.
- Runoff from all electrical generation plants was observed to be oily, indicating contamination from petroleum products stored at the plants was discharging to rivers and coastal waters.
- The coal-fired plant at Itabo allows rainfall runoff from the stored coal piles to flow directly into coastal waters. Coal pile runoff is usually acidic, high in suspended solids, and may contain traces of heavy metals, all potentially damaging to coastal ecosystems.
- Thermal pollution of receiving waters by generation plant cooling water is prevalent, posing a severe hazard to coral reefs which are extremely sensitive to water temperature variations.

(See Goldberg Associates, "Energy Sector Management Plan for the Dominican Republic," November 18, 1997.)

8.7 Water Pollution in Natural Surface Waters

Very little data exists in the Dominican Republic regarding the quality of surface waters and coastal waters. Due to the intensive use of the existing rivers, the intensification of crop and

livestock production in rural areas, and the character of industrial and domestic wastewater management, it is expected that significant water pollution problems may exist.

Table 8.4 Surface Water Quality, June 2000

Parameters								
River, Location	**EC (uS/cm)**	**pH**	**TDS (mg/1)**	**PO4 (mg/1)**	**NO3 (mg/1)**	**Class**	**Colifoms Totales (MPN/100ml)**	**Coliforms Fecales (MPN/100ml)**
Río San Juan, margen derecha (Puente) San Juan	432	7.9	267	0.4	10.6	C2S1	>110,000	>110,000
Río San Juan, aguas abajo Planta Tratamiento	627	7.2	204	0.9	11	C2S1	>110,000	>110,000
Río San Juan en el Puente Rosario	718	8	449	0.7	10.6	C2S1	9,300	9,300
Río San Juan, El Ingenito, aguas arriba de la Presa	176	8.1	110	0.3	11.4	C1S1	910	>2.2
Toma del Acueducto, El Hatico	772	7.1	472	0.4	49.3	C3S1	>2.2	
Río San Juan, aguas debajo de la Presa de Sabaneta	179	7.3	304	0.2	9.2	C1S1	360	360

Source: PRODAS Project 2000.

Although these waters are low in salts and potentially good to excellent quality for various uses, they are severely over-laden with phosphates and nitrates, and contaminated by fecal coliform bacteria. This is indicative of environmental sanitation problems throughout the study area, including human and livestock excreta reaching surface waters, and probably runoff of fertilizers, sediment or other nutrient sources. Nutrients at these concentrations, which reach coastal waters or reservoirs, can cause major algae blooms, sometimes including species that are toxic to aquatic and marine life. These algae blooms can also severely reduce water clarity and reduce dissolved oxygen in receiving waters.

This type of water pollution can pose a serious threat to the quality of coral reefs, sea grass beds, and all associated marine life in shallow coastal waters, and are incompatible with sustainable tourism and commercial fishing uses.

8.8 Solid Waste Management

Management of solid waste, especially urban garbage is a high profile environmental issue in the Dominican Republic. The major institutions that are involved in this issue are:

- Office of the President of the Republic: S.T.P–ONAPLAN–SESPAS–L.M.D.–A.D.N.
- Executive-Level Bodies: Secretariat of Environment and Natural Resources, Secretariat of Commerce and Industry
- Other Public Institutions and Private Entities: City Councils (*Ayuntamientos*), private institutions, and NGOs.

In Santo Domingo the solid waste collection services are 95% privatized. This process was initiated in 1984. Eighteen municipalities out of the nation's 105 now have a privately contracted garbage collection service, or are in the contracting process.

8.8.1 Characteristics and Volume of Urban Solid Waste

Solid waste has changed in composition in Santo Domingo in the last 20 years. In 1980 it was estimated that 80% of the waste was organic material (50% food waste, 30% garden waste). In 2001, the organic fraction has declined to 52%, while plastics now make up 8%, paper and cardboard 15%, and glass 3% (table 8.4).

Table 8.4 Composition of Solid Waste from Various Sources

Sources	Resident, high income	Resident, low to medium income	Resident, low income, area #1	Resident, low income, area #2	Public markets	Hotels	Mean
Plastic	14.0	14.3	6.4	13.8	1.5	–	8.3
Paper	23.0	17.1	12.0	13.8	–	23.3	14.9
Clothes	2.2	9.3	8.2	10.6	–	3.8	5.7
Glass	1.9	6.2	1.7	4.3	–	2.8	2.8
Metal	3.3	7.5	6.3	4.0	–	1.5	3.8
Food wastes	11.6	19.4	18.3	23.3	95.0	22.1	31.6
Garden waste	41.3	26.2	5.5	7.2	3.5	39.4	20.5
Soil, other	2.7	–	41.6	23.0	–	7.1	12.4
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Humidity (%)	40.0	53.4	–	–	60.1	–	51.2
Specific weight (kg/m^3)	364.2	523.8	474.0	357.5	412.9	402.1	422.4

Source: Castillo-Tio 2001.

Note the high content of paper from all sectors except public markets, the very high proportion of garden wastes from high and medium-income residential areas, and the preponderance of food wastes from public markets. These differences present interesting possibilities for sorting waste and recycling by collection zones. Garbage collection in Santo Domingo is accomplished by a private fleet of trucks, including 205 compactors, 68 dump trucks, and various other vehicles. In 20 other municipalities there are 76 compactors and 72 dump trucks, with the necessity of at least doubling these numbers to give adequate service in the municipalities (Castillo-Tio 2001).

Table 8.5 Solid Waste Produced in the Dominican Republic

Year	Santo Domingo, average value, tons per day	Remainder of country		Total tons per year
		Tons per day	Tons per year	
1999	2,688.26	–	–	973,916
2000	3,570.16	2,030	740,950	1,409,200

Source: Castillo-Tio 2001.

8.8.2 Status of Disposal Sites

Approximately 98% of the solid waste collected in the Dominican Republic is deposited in open, unlined dumps. San Francisco and Moca are attempting to bury garbage at their disposal sites, and Puerto Plata has been financed by the World Bank to develop a comprehensive collection and disposal system with high standards. Open-air disposal in unlined dumps or pits can create serious environmental health risks, including serious groundwater contamination. This is a major risk in southern coastal plain areas where depth to groundwater is shallow and limestone aquifers have high rates of transmission of contaminant plumes.

8.9 Air Quality Issues

Major sources of potential air pollution in the Dominican Republic include motor vehicles, thermal power plants, and other industrial sources. The vehicle fleet has increased rapidly, requiring large investments in highways, but also caused locally serious air quality problems, especially in Santo Domingo. Leaded gasoline was banned in the Dominican Republic only as recently as 1999. The principal air pollutants affecting the Dominican Republic include: particulate matter, carbon monoxide, lead, sulfur dioxide and nitrous oxides. Other gases such as methane and carbon dioxide, affect the ozone layer or global greenhouse phenomena. These originate from the transport/industrial sector as well as the agricultural sector. The cities most affected by air pollution are Santo Domingo, Santiago, San Pedro de Macorís, La Vega, Bonao, and San Cristóbal.

Table 8.6 Vehicle Fleet in the Dominican Republic

Type of vehicle	1992	1993	1994	1999	2010 (projected)
Automóvil privado	119,519	152,063	221,000	359,655	654,213
Jeeps and SUVs	11,678	14,230	14,350	35,627	53,984
Private buses	9,304	10,199	14,833	27,050	40,988
Cargo trucks	79,147	92,318	111,178	177,653	269,188
Motorcycles	237,334	302,411	506,000	689,398	1,044,610
Other vehicles	24,956	40,402	43,710	43,651	49,810
Total	**481,938**	**611,623**	**911,071**	**1,333,034**	**2,112,793**

Source: Castillo-Tio 2001

Growth in private automobiles is approximately 7% annually, with the rest of the fleet increasing at about 4.5% annually. Motor vehicle exhaust is the source of 85% to 95% of the carbon monoxide in urban areas. Carbon monoxide levels have recently been measured in several cities in Dominican Republic, as reported in table 8.7. A 1991 study carried out by INTEC in Santo Domingo revealed carbon monoxide levels considerably higher than internationally established norms (Mendoza de Cid et al. 1991), thus demonstrating the growing air pollution problem in the country's capital. Similar trends are taking place in other urban areas.

Table 8.7 Carbon Monoxide Air Pollution Levels

Location	Average carbon monoxide (ppm)[a]	Peak carbon monoxide (ppm)[b]
San Pedro de Macoris, Zona Franca	105 ppm	439 ppm
San Pedro de Macoris, Puerto	89 ppm	239 ppm
Santo Domingo, Av. 27 de Febrero/Lincoln	34 ppm	63 ppm
Santo Domingo (1997), Centro	17 ppm	28 ppm

a. The US Environmental Protection Agency allows an 8-hour average for CO to equal 9 ppm.
b. The US Environmental Protection Agency allows a 1-hour concentration for CO to equal 35 ppm.
Source: Castillo-Tio 2001

8.9.1 Greenhouse Gases

From 1980 to 1995, the production of carbon dioxide (CO_2) per capita increased from 1.1 to 1.5 tons per person per year (UNDP 2000). In 1998 the Dominican Republic ratified the Convention on Climate Change and began to put effort into diminishing its emissions of greenhouse gases.

8.9.2 Petroleum Importation and Use

The total consumption of petroleum-based fuels, for automobiles and industrial use, has increased dramatically in the last 20 years in Dominican Republic. Table 8.8 outlines the changes in consumption from 1972 to 2000.

Table 8.8 Comparison of Petroleum Fuel Consumption, 1972 and 2000

	1972	2000
Barrels per day of petroleum products	35,000	137,000

Consumption of gasoline is approximately 7.8 million barrels per year, gas oil is 14.8 million barrels per year, and fuel oil is 5.9 million barrels per year. The fastest growing sector is gasoline consumption (Castillo-Tio 2001).

8.10 Key Environmental Issues in the Urban and Industrial Sector

The environmental issues presented by the rapid urbanization and increasing industrialization of the Dominican Republic are at present, quite evident, but poorly documented. Data on water quality degradation by urban runoff and sewage effluent, as well as by industrial and agricultural activities, are still extremely scarce. This situation was noted in the 1981CEP, and still holds true today. The same situation pertains to air pollution, where there is an extreme dearth of data.

One of the primary priorities at this stage is to begin a diagnostic process to examine the actual quality of the surface waters, ground water, and air sheds in critical areas of the Dominican Republic. This is not simply a matter of collecting and analyzing samples, but requires experienced personnel to design reasonable, cost-effective, but statistically sound monitoring programs oriented towards very specific objectives. Experience has shown that careful design of

environmental monitoring programs can save vast amounts of time and expense often wasted on hastily organized data collection.

Given that many of the sources of urban environmental degradation are known, the general issues are clear, despite the lack of abundant quantitative documentation:

- Large investments in public water supply and sanitation are urgently needed, including potable water, sewer, wastewater treatment systems, and storm water runoff throughout the urbanizing areas of the country. Santo Domingo lags behind Santiago—and perhaps some other secondary cities in this area. This is a national issue with major public health, economic, and environmental consequences.
- Industrial wastewater is a serious concern, but little data is available. Environmental audits of thermal electric generating plants have revealed wastewater management problems, including thermal pollution of sensitive coastal waters.
- A case study in Rio San Juan drainage indicates that nutrient pollution of rivers and streams is a major problem, especially where these rivers discharge into shallow coastal bays and coral reef areas.
- Privatization of solid waste collection has helped some municipalities move forward effectively in this area of sanitation, but other municipalities lag behind. Highly visible garbage collection/disposal problems on the south coast threaten not only public health and welfare, but threaten to degrade the tourism potential of the entire area.
- Air pollution issues are not well documented in Dominican Republic, but some recent analysis has confirmed that air pollution from motor vehicles (particulates, carbon monoxide) are a serious issue is some large cities. Automobile numbers are rising rapidly in the urban centers.

Chapter 9. Environmental Institutions and Regulatory Framework

9.1 Historical Perspective

9.1.1 The 1981 Country Environmental Profile

As indicated in the preceding sections, the 1981 CEP provided a comprehensive treatment of most physical aspects of the natural resources and environmental sectors, as well as a relatively thorough coverage of the institutional factors at the time. However, environmental policy was not a high priority in 1981, and little emphasis was given to it. Policy was essentially treated in a minor descriptive piece in the introductory section, and in brief descriptions of legal bases in some of the subject matter sections. Nevertheless, almost all of the 48 major recommendations generated in the CEP are at least marginally policy-related, and the editors of that document did identify as an urgent necessity in 1981 the formulation of a natural resources policy, and the linking of that policy with the developmental objectives of the country. In the intervening years, the institutional structure for dealing with the environment has undergone profound change, while the people of the Dominican Republic have managed to make meaningful progress toward an environmental policy approach that can help transform the way natural resources are managed in this country. It is useful at this point to review the institutional dynamics and the major policy actions that have contributed to—and continue to help formulate—this country's environmental management regime.

9.1.2 Environmental Institutions 1981–2000

The institutional structure for the environmental sector has expanded significantly. Substantial growth has occurred in the public sector institutions whose responsibilities include management of the resource base, and within the universities. However, the greatest growth has taken place in the NGO community. In the private industrial sector, participation and commitment have continued to lag.

The CEP identified 26 institutions involved in the sector in 1981, of which 18 were public sector agencies, including most importantly the Agriculture Secretariat (SEA). Another of the 18 was Plan Sierra, which at that time was considered a crossover institution with both public and private participation. There were eight other private institutions, including universities, and notably only three of what would be considered environmental NGOs. Similarly, the international donor community was not active in this sector before 1981.

On the private sector side, production, construction, and extraction industries have typically shown very limited interest in managing the environment in a sustainable way. The tourism industry, which has grown dramatically since 1981, has in general also shown a surprising lack of interest. Improving cooperation from these industries will be a continuing important challenge.

Beginning in the 1980s, and accelerating in the 1990s, in this country as elsewhere, interest in environmental matters began to manifest itself in a growing proliferation of local NGOs established to deal with specific watersheds, parks, community areas, or other sites of local or

regional interest. Some of these organizations quickly established relationships with donors and the international environmental community (for example, the Nature Conservancy—TNC, the World Wildlife Fund—WWF, and others), and have become major players in the institutional framework for the environment. Examples of active environmental NGOs established or becoming very active during the period include:

- *PRONATURA* was a pioneering coalition of private organizations with environmental interests, and was instrumental in bringing TNC to this country. Once a joint venture, TNC now has separate representation.
- *Plan Sierra,* another pioneering Dominican environmental institution, has had profound impacts on natural resources management in the northern central highlands.
- *The Ecological Society of the Cibao (SOECI)* and the *Dominican Society of Ecology* were two early NGOs that were formed by interested individuals in Cibao and Santo Domingo, respectively.
- *PROGRESSIO,* an NGO, partnered with the Dominican government in the administration of the Ebano Verde nature reserve.
- *The Jaragua Group,* an NGO, cooperated with the DNP for research in the Jaragua National Park.
- *The Quita Espuela Foundation* cooperated with the DNP in administration of the park of the same name.
- *The Ecological Society of Barahona (SOEBA)* administered environmental education campaigns in Jaragua and Sierra de Bahoruco National Parks.
- *The Development Association for San Jose de Ocoa (JUNTA)* actually began sponsoring natural resources activities in the southern central mountains as early as the 1970s, and was active throughout the period, administering the USAID–funded Investment Fund for Natural Resources (FIRENA).

These organizations—and many others too numerous to mention here—have made major contributions in environmental education, public awareness, and sustainable management of natural resources, in what has become a major trend since 1981. In addition, the academic community throughout the nation became more and more involved in environmental study, research, and projects over the last two decades. It was in the academic community and among NGOs that the environmental movement began in this country in the 1970s. From initial conferences on the subject at the Pedro Henriquez Urena National University in Santo Domingo (UNPHU) in the 1970s, to the offering of a graduate degree in environmental education by the Technological Institute of Santo Domingo (INTEC) in 1988, university faculty members have been at the forefront of the environmental movement. The Superior Institute for Agriculture (ISA) in Santiago, had established a forestry school in the late 1970s.

Public sector institutions also grew in number during the past two decades, but in many ways without a corresponding increase in effective environmental policy before the year 2000. The CEP reported that in 1981, the public institutions that were directly related to natural resources were often characterized by parallel functions, inter-institutional interference and conflict, inefficient use of human and financial resources, and a lack of coordination. This situation persisted and worsened for most of the last 20 years, while the number of involved public institutions increased to 21. Public institutions with major roles in the sector during the 1980s and 1990s included the following:

- *The Dominican Hydraulic Resources Institute (INDRHI)* was given the specific mandate for managing hydrographic regions. However, there were overlapping responsibilities with other institutions, such as SEA and DGF.
- *The Agriculture Secretariat (SEA)*—particularly through its dependencies for natural resources *(SURENA)*, fisheries *(DRP)*, wildlife *(DVS)*, land and water *(DTA)*, and linkage with *Plan Sierra*—was increasingly active in environmental areas during the period. Several other SEA units also involve themselves in some environmental matters. These would include the departments of plant protection, research, and natural resource inventory, the livestock directorate, and others.
- *The Forestry Directorate (DGF)* had the primary responsibility for oversight of the nation's forest resources, although other agencies also had minor roles, and the overall system was confused by a series of laws and decrees, a lack of incentives, and the absence of coordinated sustainable use planning.
- *The National Parks Directorate (DNP)* was created in the 1970s to conserve, protect, and develop recreational areas.
- *The National Agriculture Council (CNA)* was set up as an agriculture and natural resources advisory board under the SEA, but with both public and private representation.
- *The National Environmental Commission* was created by decree in 1987 as a government body with 16 specific objectives, including the coordination of institutional activities related to the environment.
- *The National Zoological Park (ZOODOM)*, the *National Museum of Natural History (MNHN)*, and the *National Botanical Garden (JBN)* all either conduct research or execute activities related to the environment.
- *The Secretariat of Environment and Natural Resources*, established in 2000, is now the only public institution responsible for environmental oversight and activity.

9.1.3 Legal and Policy Actions and Precedents for Current Environmental Law

Since 1981, there has been an evolution in the way public policy deals with the environment. The CEP reported that in 1981 there was a well-defined national policy regarding agriculture and development planning for agriculture, but that there was no explicit policy for managing natural resources. The CEP further stated that solutions to environmental problems were only sought once such problems became serious enough to warrant immediate attention. It found that the legal bases for environmental management were relatively ambiguous, and that much of the relevant legislation, having been created to deal with problems on an individual basis, resulted in overlaps, gaps, and confusion among responsible institutions.

Clearly, this situation changed dramatically over the subsequent two decades. Change, however, has been incremental during the period. It is meaningful to consider several of the watershed events that have characterized the evolution of public debate and guided the official actions affecting the environmental climate in recent years.

- *Rio 1992.* In the case of the Dominican Republic, preparations for the United Nations Conference on Environment and Development did indeed serve as a catalyst in focusing attention on the plight of the environment. The national report issued at the conference indicated, with respect to a policy and legal framework, that "measures to protect natural spaces, create environmental organizations and commissions … ratify international

agreements … had been the form through which the Dominican Government had demonstrated its preoccupation with accelerated degradation of the natural resources of the country." It added, "Mechanisms for conserving natural resources and the environment … are not backed up by an environmental policy that orients actions and facilitates the operational effectiveness of the responsible organizations" (Government of the Dominican Republic).

- *Sustainable Tourism Development Policy*. In 1996, the State Tourism Secretariat adopted this policy, in compliance with an agreement with the World Tourism Organization. Implementation of the policy has fostered the beginnings of economically and environmentally viable tourism development with respect to use of coastal and marine resources. However, the policy has fallen short of its original goal of bringing about a fundamental change in the tourism industry to make it environmentally friendly.
- *Agricultural Policy Analysis Project (APAP).* An APAP study prepared a policy inventory in 1992, which focused on watersheds, forestry, biodiversity, and sustainable agriculture. Coming in the same year as the Rio Conference, this study provided Dominican policy makers with a useful basic document for considering some aspects of environmental policy (Nunez et al.).
- *Rio +5 yrs*. Five years later, in 1997, the success of the country in achieving the targets agreed to in Rio in 1992 was evaluated. It was determined that "if the Dominican State had indeed taken actions for the protection of resources and the environment in its search for sustainable human development, it has done so in an isolated and fragmented manner, with old institutional structures." The report put forth the important idea that the Dominican government should establish a high-level institution to guide and integrate environmental policy (Almonte).
- *Environmental Strategy, 1994–2003*. The 1994 document entitled, "A Strategy for the Conservation of Biodiversity in the Dominican Republic: 1994-2003," made the case that ecological damages also caused significant economic and social costs, and reiterated the necessity to adopt integrated environmental policies. (Almonte)
- *National Nutrition Plan 1998–2005*. This plan recognized the important links between the environment and other sectors of society. It also recognized the importance of integrated participation by civil society and the NGO community in programs on nutrition and environment.
- *National Sustainable Development Council*. This report of the national commission set up to review follow-up actions from the Rio conference affirmed a lack of attention to the environment, and observed, "Development of economic activities in the Dominican Republic, including development of the tourism industry and the duty free zones, has been brought about, in the majority of cases, without contemplating [environmental] preservation."
- *National Environmental Dialogue*. During the mid-to-late 1990s the national government encouraged a broad public dialogue on environmental issues, and a commission was formed to identify environmental problems and define remedial actions. This dispersion and legal inefficiency that characterized the sector. The plenary of the National Dialogue placed priority on adoption of an environmental agenda that included the formulation of a national environmental policy and the adoption and execution of a supporting legislative agenda. Direct results of this commission included the creation of the Environmental Sector Coordinating Commission (COSERENAMA), and the approval of the 1999 Forestry Law, which created the National Forestry Institute, replacing the old DGF. These actions also led

directly to the conceptual steps needed to reorganize the environmental sector via a new environmental law (Almonte).

- *INDRHI Action Plan 1999*. In its 1999 Action Plan, the National Water Resources Institute articulated a new emphasis on water resource management as its mission. The same document noted a vision for the institute based on fundamental policy changes, including improved institutional development, modernization and restructuring, decentralization, and the management and conservation of natural resources, particularly water and soil. The actions in the INDRHI Plan were oriented toward: (1) organization of agricultural water user associations into boards; (2) an increase in the area under irrigation; (3) a bottom-up review of the institute's role; (4) provision of basic data for integrated resource management; (5) community-based water resource education; (6) development of a national system of natural disaster alert network; (7) implementation of bilateral activities with Haiti; and (8) institutional modernization.
- *Seminar/Workshop Toward Formulation of a Solid Waste Policy for the Dominican Republic*. This event held in April 2000 publicly affirmed the need to "design and install a Dominican Government policy that establishes the legal and institutional framework for managing solid waste."
- *2000 Human Development Report*. This UNDP study evaluating human development in the country found that "the focus of environmental policy had been characterized by a proliferation of decrees, laws, resolutions, norms, institutions, commissions, agreements, and treaties that had as results temporary solutions that did not provide fundamental problems with definitive solutions." It added, "In the Dominican Republic linkage between the economic and environmental policies has not existed" (UNDP).

To set the stage for the eventual enactment of a new environmental law in 2000, it is instructive to accompany the preceding list of influential events with a chronology of the major environment-related policy dispositions issued during the period.

Examples of laws passed during this decade include Law 355 of 1983, which prohibited the application of chemical lime to tree trunks, and Law 258 of 1985, which approved a national plan for forestland use. Importantly for environmental education, Law 295 of 1985 incorporated environmental education in public and private school curricula. Similarly, there was considerable variety among the many decrees passed, from the routine to the significant, such as a series of decrees that declared a number of national parks (for example, Decree 1026 of 1986, establishing the La Caleta Underwater Park).

Table 9.1 summarizes over 60 policy acts that tended to control or prohibit certain uses of natural resources during the 1980s, while totally inadequate financial resources were dedicated to the institutions responsible for executing these same public policies. In addition, these actions were, for the most part, disconnected, and without any coordinating mechanisms. It is also worthy of note that, during the 1980s, the Dominican Constitution was modified, but was still without any direct reference to the environment.

During the 1990s, while fewer environmental actions were generated, laws and decrees passed were generally more focused on impacts. Decree 226 of 1990 prohibited the discharge of raw chemical and organic wastes into waterways; Decree 531 prohibited cutting of mangroves; and other decrees were directed at coral reef preservation, environmental contamination, limiting destructive agricultural practices, and creating a green belt for major cities.

Table 9.1 Environmental Policy Dispositions, 1980–90

Sub-Sector	Laws	Decrees	Resolutions	Total
Forestry	7	17	1	25
Protected areas	0	13	0	13
Coastal/marine	0	5	0	5
Pollution	1	4	0	5
Wildlife	0	3	0	3
Mining	0	0	0	0
Water	1	2	0	3
Fishing	0	8	0	8
Soils	0	0	0	0

Source: Jose Almonte.

Table 9.2 Environmental Policy Dispositions, 1990–2000

Sub-Sector	Laws	Decrees	Resolutions	Total
Forestry	1	6	0	7
Protected areas	0	11	1	12
Coastal/marine	0	3	1	4
Pollution	1	4	2	6
Wildlife	0	0	1	1
Mining	0	1	0	1
Water	0	1	0	1
Fishing	0	0	0	0
Soils	0	0	1	1

Source: Jose Almonte.

In 1981–2000, environmental policy and the institutional framework that functions within policy parameters suffered through a series of dramatic changes. This perspective suggests that in the environmental sector, the last 20 years can conveniently be considered as two distinct periods. During 1981–91, policy actions were defined by traditional views including prohibitions and strict controls. There was little understanding of fundamental links between the environment and other sectors of the economy (for example, watershed management, downstream silting, and power failures; contamination, water quality, and public health; pollution and tourism).

The beginning of the period 1992–2000 is marked by the development of a national environmental position for the Rio Conference. It can be characterized as a period of rapidly expanding awareness and vigorous public dialogue on environmental issues. There was still a basic lack of an integrating entity for the sector, but a process was underway through which this shortcoming would be addressed.

9.2 The Current Situation

On entering the twenty-first century, the Dominican Republic faces its myriad environmental problems with tools and resources that are very different from those in 1981. Public awareness of and interest in the environment have increased, and this growing constituency is reflected in the dynamic institutional situation and the new policy environment described in subsequent sections of this profile. Nevertheless, there are aspects of human resource and environmental education that warrant review, as discussed below. A critical assumption of the environmental movement is founded on the principles of geographic interrelationships and the environmental agreements and donor arrangements in which the Dominican government is a participant form an important component of the current environmental profile of this country. Of course, the strengthened institutional framework and promising new policy regime must be the fundamental elements with which the Dominican people will effectively manage their environment in the near term.

9.2.1 Public Perceptions on the Environment

Historically, the development of an aware and interested public constituency has been a necessary condition for achieving change in the environmental policy arena. In an economic context, it is analogous to creating demand for a product. There are many aspects to this process. Development of workable environmental education programs requires core individuals with formal training to conduct research, report on results, and impart both technical information and the ability to pass information on effectively to others. There are now numerous sources in the Dominican Republic and other countries for these kinds of formal education. Informal environmental education at the neighborhood or community level is commonly facilitated via outreach programs provided by both NGOs and government. The best of these often involve a heavy element of community or municipal participation, because natural resources management is essentially a social act. As such, it requires a high level of common—rather than individual or familial—commitment, which initially may be a relatively unfamiliar sentiment. In such fundamental attitudinal change is found a key challenge for environmental educators. In addition to person-to-person outreach, communications media are often utilized as effective elements for reaching large numbers of people, and print, radio, and television programs are used effectively in this regard in the Dominican Republic.

- *Environmental Education and Public Attitudes.* Since the 1980s the formal education sector has attempted to incorporate, with mixed success, environmental education in both basic and middle school curricula. More recently, Law 300 of 1998 expressly mandates the inclusion of environmental and natural resource studies in all levels of education on a national scale. On the informal side, decades of environmental education and awareness campaigns carried out by a broad range of NGOs throughout the country have undoubtedly changed the perceptions and attitudes of thousands of Dominicans, and have prepared many thousands more to manage their own lives in manners much more friendly to the environment.

- *Human Resources for the Environmental Sector.* While execution of a directed human resource demand and availability study was not within the scope or budget of this analysis, observations and discussions imply that demand for trained professionals will continue to grow in many subject matter areas related to the environment. Intuitively, with environmental oversight apparently becoming more extensive and intensive, an increased demand for practitioners for the public sector would be expected. However, with probable continued

availability of donor assistance to the sector, resources should be available to provide for near-term needs in academic and technical training through more efforts in the regulatory area, private demand will also grow. Typically, the scenario in such cases has been that the private sector hires individuals already trained by the public sector, and if this approach is repeated here, it could put pressures on the availability of trained personnel for the public sector and NGO community. In any event, additional investments in human resource development can be expected. Fortunately, sources for such training are available locally, and more specialized or advanced graduate training can be obtained offshore. The following Dominican universities conduct research activities and offer technical and academic degree programs in varying fields of environmental studies:

- Department of Natural Resources, Pedro Henriquez Urena National University (UNPHU), Santo Domingo
- Department of Natural Resources, Superior Institute of Agriculture (ISA), Santiago
- Environment Department, Northeastern University, San Francisco de Macoris
- Faculties of Agronomy, Sciences, or Economic and Social Sciences, Autonomous University of Santo Domingo (UASD)
- Technological Institute of Santo Domingo (INTEC)
- Pontifical Catholic University Mother and Teacher (PUCMM)
- Technological University of Santiago (UTESA)
- Dominican O&M University
- Catholic University of Santo Domingo
- University of the Caribbean
- Naval Academy of Superior Studies
- Inter-American University (UNICA)
- Ibero-American University (NIBE)

9.2.2 International Environmental Agreements and Donors

Agreements. International environmental agreements have become a critical tool for rationalizing natural resource use among nations on a regional and global scale. Indeed, ratification of (and compliance with) specific agreements is now often a condition to approval of funding for projects from international donor groups, governments, and NGOs. The Dominican Republic is signatory to a number of these agreements (table 9.3).

Donors. Significant donor investments in the environment, beginning in the 1980s, grew substantially throughout the 1990s, and continue at a relatively high level. Between 1980 and 2000, donor commitments to projects related to natural resources (including water resource infrastructure) exceeded US$435 million. The two largest donors were the World Bank and the Inter-American Development Bank, each with programs of well over US$100 million during the period. A second tier of donors includes bilateral programs from the governments of Germany, Japan, Switzerland, and the United States, joined by smaller bilateral programs such as that of Spain. The UN Development Program and the European Community are also major multilateral donors (Arias).

Table 9.3 International Environmental Agreements

Agreement	Fundamentals	Status	Country Situation
Convention on International Commerce governing endangered flora and fauna (CITES)	Protects endangered species threatened by excessive exploitation via import/export permits	Signed March 17, 1987, and confirmed by the National Congress	Convention requirements have been executed through the wildlife department of the SURENA-SEA and the botanical garden
Vienna Convention (Montreal Protocol) relative to the substances threatening the ozone layer	Reduces substances causing destruction of the ozone layer, regulating the amount of atmospheric contamination by gases that react with ozone in the upper atmosphere	Confirmed by the National Congress, August 16, 1993	A governmental committee on ozone (COGO) coordinates activities
Convention governing Biological Diversity	Conservation of biological diversity, and sustainable use of natural resources used.	Signed June 5, 1992, and confirmed by the National Congress December 6, 1996	The country has participated in the Conference of the Parties (COP) and has initiated implementation activities for the national strategy and action plan
Framework Convention to Combat Desertification and Drought	Combats desertification and mitigates the effects of drought.	Confirmed by the National Congress and proclaimed by the president, 1997	Assisted with Conferences of the Parties (I, II); actively participated in regional meetings, creating a National Action Plan
International Conference for the prevention of discharging wastes from ships in transit	The elimination of the right to discharge wastes that threaten the environment from ships in transit	Confirmed by the National Congress, May 1998	In February, established an international forum on the prevention of marine contamination.
Conference on Climate Change	Establishes allowable emissions levels for carbon dioxide and other gases that cause greenhouse and global warming	Confirmed by the National Congress and proclaimed by the president, 1998	Approved proposed implementation activities to establish the national strategy; initiated the next inventory of gas emissions and their mitigation.

Note: The Dominican Republic is also party to five regional agreements, including the Inter-American Institute for Global Change Research (since 1997), the Cartagena Agreement for Protection of the Marine Environment (1998), the Protocol on Marine Contamination from Coastal Rivers and Estuaries (1999), and the two Cartagena Protocols for the Greater Caribbean Region on Hydrocarbons (1998) and Native Flora and Fauna (2000).
Source: Arias.

The advantages that these programs bring to the country—in addition to the purely financial and physical—include major increments in the body of knowledge regarding local environmental and natural resource conditions and relationships, enhanced environmental education coverage and impact, increased public awareness, improved ability to comply with terms of environmental agreements, and greater facility to handle environmental analysis and policy. The prospects for a continued high level of donor assistance in this area beyond 2000 are good. The fact that this country's economic indicators have been improving may argue for reductions in some areas or by some donors, or for a shift to more loans and fewer grants. But the country remains a viable partner for environmental initiatives with high chances for both visible impact and implementation success. Indeed, a number of major environmental programs with relatively long life spans are even now in early stages of implementation. For example, Germany (Yaque del Norte watershed), Switzerland (watersheds, environmental consortium), the World Bank and Inter-American Development Bank (watersheds, environmental policies, wastewaters), Japan (irrigated agriculture), and the European Community (environmental services) are all in very early phases of major environmental or natural resources projects here. Ongoing initiatives with United States government participation include continuing hurricane reconstruction activities, an analysis of impacts of mining, watershed management activities, potential technical support in the environmental sector, and this update of the CEP.

9.2.3 Environmental Institutions

Public Sector. The most important development among public environmental institutions is the establishment of the Secretariat of the Environment and Natural Resources. This institution is described in greater detail in a subsequent section on structure and functions of the secretariat.

In addition to the secretariat and its allied institutions, there are other institutions involved in environmental management. These include municipal governments; the Secretariats for Public Health and Social Assistance, Industry and Commerce (includes mining), Agriculture, External Relations, Armed Forces, and Tourism; the National Potable Water Institute; the Technical Secretary to the President; and the public works corporations.

Private and NGO Sectors. According to PRONATURA, one of the pioneering—and still very important—NGOs in this sector, there are now more than 130 NGOs in the Dominican Republic reporting some kind of environmental activity. In addition, there are seven universities and ten quasi-governmental agencies, such as museums, botanical and zoological parks, and research centers, that are involved in the sector. This is a dramatic increase over the eight private institutions active in 1981.

Private for-profit firms do not universally embrace environmental programs anywhere, (although there certainly are numerous anecdotal cases of environmentally friendly voluntary actions in this regard in the Dominican Republic, as elsewhere). This should not suggest that most firms involved in development investments in this country routinely ignore possible environmental impacts. For example, most international banks and donor organizations now have environmental guidelines that must be followed by any contractors—including local ones—involved in carrying out activities financed with their resources. In the future, developing effective working relationships with developers, the tourism industry, and other industrial sectors will be a key challenge for environmental policy formulators and officials.

9.2.4 Environmental Policy Framework

The environmental policy framework underwent sweeping change in 2000. The approval by the National Congress of Law 64, of August 18, 2000, created a new legal and institutional framework. It created the Secretariat of Environment and Natural Resources, and integrated the secretariat and the other public institutions with environmental functions, incorporating for the first time within the environmental regime of the Dominican Republic the vision of integrated environmental management. It also established a series of environmental policy principles for the country, to which the private sector and current and successive governments presumably must adapt. The General Environmental Law (64-2000) not only reorganized the policy and public institutional frame. It also established the underlying instruments through which policy may be executed, and formed the basis for empowering Dominican individuals, communities, NGOs, firms, and others to participate more fully in environmental dialogue and in the planning and execution of environmental initiatives.

Legal and Regulatory Framework. Law 64-00 stipulates that the policies, plans, and programs of the public sector be subjected to environmental evaluations and that such analysis be applied in a manner that is consistent with the national environmental policies in effect. The law states, "Planning of national, regional, and provincial development of the country must incorporate the environmental dimension through a dynamic, permanent, participative, and concerted process among the different entities involved in environmental management." With respect to enforcement, the law created a judicial system for the defense and protection of the environment, which is housed administratively in the Office of the Attorney General.

A number of environmental policy principles have been articulated for the application of Law 64-00. Several of these principles reflect efforts to link environmental policy with economic or development policy. These include:

1. Environmental programs are to be integrated with general economic development plans and programs.
2. Environmental costs are to be incorporated in the national accounts and national production.
3. Economic analysis will be applied in the prevention and restoration of environmental damages.
4. Judicial norms and policy principles for environmental management are public law.

This approach seeks to identify and hold responsible parties that damage the environment, to charge for use of natural resources, and to include from the outset of development planning appropriate consideration of environmental effects. These are important principles, but their effective application will require substantial public relations work and a mix of penalties for non-compliance and positive incentives to encourage and reward compliance.

Other key principles deal with national policy complying with international environmental agreements, the need to decentralize environmental management (consistent with integrated watershed management, which is not yet universally applied in the Dominican Republic), and the proclamation that human consumption is the highest priority for water use.

Several instruments available to the secretariat for putting environmental policy into practice have been identified, including:

- Environmental planning
- Environmental law and related technical norms
- National land use planning
- National protected areas system
- Environmental licenses and permits
- Environmental impact analyses
- Environmental vigilance and inspections
- National environmental information system
- Scientific and technological developments
- National fund for the environment and natural resources
- Environmental education and dissemination

Other Relevant Environmental Laws. A number of other laws relating to environmental and natural resources management remain on the books and in effect. These treat such areas as water rights and use, hunting and fishing, pesticide use, mining, parks, and waste disposal. Among these laws are the following:

- Law 85 of 1931, on hunting
- Law 3003 of 1951, on marine ports and coasts
- Law 4471 of 1956, on health codes
- Law 4990 of 1958, on vegetative sanitation
- Law 5852 of 1962, on ground water and public water distribution
- Law 5914 of 1962, on fishing
- Law 6 of 1965, creating INDRHI
- Law 55 of 1965, instituting social and economic planning
- Law 305 of 1968, establishing maritime zones
- Law 311 of 1968, regulating pesticides
- Law 487 of 1969, on ground water regulation
- Law 123 of 1971, on extraction of stone, gravel, and sand
- Law 146 of 1971, on mining
- Law 67 of 1974, on national parks
- Law 218 of 1984, on toxic and other wastes
- Law 112 of 1987, on obligatory forest service.

9.2.5 Structure and Functions of the Environmental Secretariat

Organization. The secretariat, under overall direction of a cabinet level secretary, is organized into five sub-secretariats: Environmental Management, Soils and Water, Forest Resources, Protected Areas and Biodiversity, and Coastal and Marine Resources. These sub-secretariats are further divided internally into appropriate directorates and departments. Unfortunately, the secretariat does not yet have a single physical plant, and its sub-secretariats and many staff members are still scattered around Santo Domingo in different government office buildings. Many of them are still housed in former quarters that may keep them physically attached to other secretariats or other institutions from which they were recently detached administratively.

In addition, the following institutions are now dependencies of the new secretariat: Sectoral Planning and Programming Office, National Environmental and Natural Resource Council, the National Botanical Garden, the National Zoo, the National Aquarium, and the Museum of Natural History.

General Objectives. The general objectives of environmental policy under the secretariat include the following:

- Prevent, regulate, and control causes of environmental deterioration.
- Establish measures and opportunities for conservation and sustainable use of resources.
- Recognize the real value of natural resources, including the environmental services they provide.
- Achieve national planning that is founded in sustainable development, and social justice.
- Promote correct use of public space via land use planning.
- Strengthen the Protected Areas System.
- Guarantee rational management of watersheds.
- Stimulate environmental education.
- Establish and strengthen a decentralized national system of environmental management.
- Comply with international environmental commitments.
- Provide a safe environment that contributes to sustained health and disease prevention.

Strategic Plan. The purpose of the near-term strategy is "to apply an integrated public policy, for the conservation and protection of natural resources and the environment." The mission of the secretariat has been articulated in terms of regulating the management and use of the environment, the ecosystems, and natural resources, to reach sustainable development. The vision of the secretariat has been defined as follows: "to comply with its mission, the (Secretariat) will develop an open, democratic, and participatory policy, based on cooperation, strategic alliances, the communities and business sector; in order to imbue every public and private entity that intervenes in the environment with a sustainable development model that guarantees an adequate quality of life for present and future generations."

Mid-term strategic objectives include: (a) collaborating with the Technical Secretary of the Presidency and other organizations in the definition of a policy and general plan for national land use planning; (b) implanting a national environmental action plan via the following sub-systems—environmental norms, environmental evaluation, environmental quality monitoring, and environmental protection; (c) developing a national system of environmental quality indicators; (d) collaborating with appropriate institutions to incorporate environmental education in every curriculum, and developing a massive education campaign; (e) formulating and implementing a national approach for managing solid wastes, sewage, and toxic wastes; (f) promoting sustainable use forest management; (g) conserving native genetic resources in flora and fauna; (h) recuperating natural water sources; and (I) designing, developing, and administering a national system of natural, cultural, and historic areas.

Near-Term Objectives. In the short term, the secretariat is proposing to:

- Save, study, conserve, and use the biodiversity and ecosystems consistent with the natural patrimony of the country.

- Develop tree planting to conserve and improve the environment, combat erosion, and protect water resources and infrastructure.
- Adopt and put in place emission limits and quality control norms.
- Establish agreements and strategic alliances with local governments and other public and private entities to put into practice watershed management plans.
- Foment and regulate research on environmental conditions and biodiversity.
- Establish a national environmental information system.

Sub-Sectoral Strategic Objectives. Several objectives have been identified for the near term (one year) for specific sub-sectors. These include:

- The *Environmental Management* sub-secretariat, essentially the "new" part of the public institutional structure, is beginning to elaborate, adopt, and put into practice quality control and emissions norms and standards. (Public agencies with responsibilities for forestry, soils and water, marine resources, and protected areas all existed before Law 64-2000, while the new sub-secretariat took over and greatly expanded the functions of the Environmental Protection Institute.) A recent report on their activities through the end of the year 2000 indicates that in only four months, the sub-secretariat has completely re-oriented the processes it inherited, restructured internal operations, and diversified the framework of public environmental interventions. Substantial achievements were also noted in the design of an operational framework for the environmental evaluation department; installation of an office for coordinating action at the municipal level; preliminary design work towards monitoring systems for hotels, industries, and water quality; and follow-up on international environmental agreements.
- In *Soils and Water*, staff members are in the process of developing clear standards for extracting aggregates, and initiating plans for designing land use planning and watershed management policies. Of course, in this and the other sub-secretariats that follow, a major concern for staff has been the continuation of public administration responsibilities held prior to the Law 64 reorganization, while adapting to a new organizational regime with added responsibilities.
- In *Forestry,* development is underway on tree planting initiatives, and high priority is also placed on development of technical norms for management plans, forest industry and permitting, and forest transport. Also, work is underway on reconciling provisions of the 1999 Forestry Law with Law 64-2000.
- The *Protected Areas and Biodiversity* group is making plans to save, study, and effectively use Dominican biodiversity and ecosystems. It is recognized that few of the country's parks and protected areas are currently under management plans, and that preservation of these natural areas will be very much in jeopardy until real management occurs.
- In *Coastal and Marine Resources,* employees are developing norms for planning fishery resource management and fomenting a management and conservation ethic among those who participate in the fishing industry.

9.3 Key Policy and Institutional Issues

In the course of developing the above overview of the institutional and policy framework, a number of potential problems or issues or opportunities present themselves. The sector is much better prepared to deal with such issues than it was at the time of the 1981 CEP. That said, there

are more problems and more immediate issues to deal with now than there were 20 years ago. The structure of the public institutions and policy regime was much improved by the new Environmental Law. However, the law and its institutional base are both far from being set firmly and permanently in place, and the leaders involved in this process are aware of that and are working diligently to take advantage of their challenge and their opportunity. It is critical that this window to achieve fundamental change for the sector be open long enough to allow full institutionalization of the integrated sector approach enabled by Law 64-2000. Hence, the primary and most critical environmental issue facing the Dominican government in 2001 is achievement of permanence and credibility for the secretariat.

Chapter 10. Toward a National Environmental Vision

10.1 Opportunities for Action

On the basis of the research carried out to develop this environmental profile, the investigators have identified a series of environmental sector "Opportunities for Action." They are presented for consideration to the Dominican environmental community (public, NGO, and commercial sectors) and international funding organizations in the formulation of a proactive plan to manage the country's natural resource base in an efficient, sustainable way.

10.1.1 Institutional Strengthening

- *Secretariat*—The Secretariat for the Environment and Natural Resources came into existence with the passage of the Environmental Law in August 2000. The secretariat was created by joining together five previously existing entities under a new senior management overlay. While the secretariat has made significant strides in its first months, a concerted effort at institutional building could weld the secretariat into a thoroughly professional, effective environmental management organization.
- *Municipal Government Environmental Management*—The new environmental law provides an enhanced role for municipalities in management of environmental matters at the local level. Both municipal authorities and senior Secretariat officials are enthusiastic about this legislative endorsement. However, the local governments require considerable institutional development assistance to effectively carry out their new mandate.

10.1.2 Policy

- *Laws and Implementing Regulations*—The new Environment Law (Law 64-2000) established a framework for a proactive plan of action to protect and to manage in a sustainable way the country's natural resources. That said, there is important substantive work required to complete the environmental framework by developing sub-sectoral laws and/or implementing regulations for, among others, the forestry sector, land use zoning), fisheries, and water use. Based on the experience of other countries, these regulatory tools are most successful when they are developed in a participatory way with stakeholder consultation and input. Best practices also suggest that are most effective when they are designed with incentives to counterbalance sanctions.
- *Norms and Standards*—Essentially the country is devoid of environmental norms and standards. Secretariat senior management has placed high priority on establishing such a regulatory regime and is anxious to launch a program that includes guidelines for, among others, atmospheric pollution, groundwater contamination, solid and liquid waste disposal, noise pollution, and coastal zone defilement. Again, implementation of such regulatory regimes has achieved best results when carried out with active stakeholder participation and incentives to counterbalance any sanctions that might be put into place.
- *Involving Communities*—Environmental and natural resource management issues are frequently matters of community-wide interest. That said, there is a growing body of evidence that indicates that the solutions to these issues are being generated through participatory problem solving. Review of Law 64-2000, as well discussions with Secretariat

officials, clearly indicate that both the legislation and political will exist to engage stakeholders, in an active, substantive way, in addressing environmental issues. Effective implementation of this policy should be part of environmental sector institution building efforts.

10.1.3 Land Use and Soil Management

- *Data Collection and Analysis*—Improved data collection on land use and cropping patterns, employing state-of-the-art technology (remote sensing and GIS) would furnish meaningful, needed assistance in soil conservation and management planning.
- *Land Use Planning*—Land use in the Dominican Republic has not evolved in an orderly or planned fashion. The absence of such planning has contributed to the deterioration of the country's natural resource base. A proactive land use planning initiative would make a significant contribution to environmental protection. The current scheme under consideration, a comprehensive, top down, nationwide zoning effort may not be the most appropriate approach. Other country experience has demonstrated "micro-zonification" (micro-watershed by micro-watershed planning with active stakeholder participation) to be a far more effective watershed planning and management tool. Moreover, the micro-zonification approach would be most effective if it were to give priority attention to key watersheds, high value agricultural lands threatened by urbanization and areas with tourism potential.
- *Watershed Management Models*—Appropriate models for watershed management and soil erosion control with an emphasis on perennial cropping systems and economic development opportunities, have been developed for the country. However, they are known only to a small group of technicians and administrators engaged in the environmental sector. Making the models user-friendly (understandable to laypersons) and distributing them broadly among agricultural producers would contribute directly to sustainable use of natural resources.
- *Irrigated Soil Management*—Improving management of irrigated soils will require improved water management. Broadening and deepening the national government's irrigation district privatization initiation would be an effective means to this end.
- *Sustainable Hillside Agriculture*—Hillside agriculture, as traditionally practiced in the Dominican Republic has been a destructive force. As a result, many areas have become deforested and unproductive. Shade coffee holds promise as an option for addressing this problem. There is evidence that high quality coffee can be produced in the Dominican Republic, provided there is adequate financing and acceptable production system management. Investments in shade coffee could improve upland watershed management, create employment, and generate export earnings.

10.1.4 Water Resource Management

- *Data Collection and Management*—Water resource data collection, from precipitation to stream flow to groundwater, has been by and large neglected in the Dominican Republic for the past 15 years, although a very good system was in place in the early 1980s. Reactivation of this the system, as a part of the institution building process within the secretariat, would help promote sustainable use of this vital resource.
- *Water Quality Monitoring*—Initiating a water quality-monitoring network would be a valuable compliment to reactivation of a data collection and analysis system.

- *Municipal Watershed and Aquifer Protection*—The land use planning exercise recommended above should also give priority to protection of municipal source watersheds and aquifers. Attention to these important "resource niches" could be part of a municipality-based (at least active participation of local government) sustainable resource management initiative.
- *Bathometric Research*—It is generally recognized that siltation is diminishing the water storage capacity of the country's reservoir network. However, little quantifiable data exists on the degree of the problem. Accordingly, bathometric studies to determine the extent of storage capacity loss would be useful for planning decisions regarding water for a variety of purposes—irrigation, energy, human consumption.

10.1.5 Forestry

- Silviculture and Forest Management Models—The little research being carried out on forest management focuses on imported, exotic species and indigenous pine. Numerous native hardwoods exist and significant reforestation could be accomplished if research, and proper incentives, were applied. Native hardwood specie research could also be applied to reforestation efforts on public lands and lands being taken out of sugar cane production.

10.1.6 Coastal and Marine Resources

- *Eco-tourism*—Protection of endangered coastal ecosystems and species can be integrated into eco-tourism options for the rapidly growing hotel industry. The opportunities are numerous (whale watching of Samana, off-shore bird watching, nocturnal sea turtle observations). A policy regime emphasizing incentives, and eco-tourism education for hotel managers and tourists would be essential parts of programming in this area.
- *Wastewater Management*—The rapid growth of the hotel industry has placed enormous pressure on the coastal ecological niches. Untreated hotel wastewater is presenting a critical threat to coastal area biodiversity. An aggressive program of wastewater treatment systems is needed to correct this critical problem.

10.1.7 Biodiversity Conservation

- *Collaboration on Conservation*—Excellent opportunities exist for collaboration with international conservation organizations and universities interested in biodiversity conservation. Past Dominican administrations have been developing these institutional contacts. Given the threat of extinction to a variety of species found in the country, the moment is opportune for expanding on these institutional arrangements.
- *Eco-tourism*—Growing worldwide interest in eco-tourism provides the Dominican Republic with opportunities to capitalize on its unique island biodiversity. To illustrate, the above-mentioned whale and sea turtle watching possibilities could be used as springboards from which to expand on eco-tourism themes, especially in the biologically rich and little visited (by tourists) southwest section of the country.

10.1.8 Protected Areas

- *Financing*—Adequate financing to administer protected areas is and has been an important issue. At present, money for protected area maintenance is derived from two sources—government transfers and park entrance fees. In the aggregate these revenues are not

sufficient to improve and maintain the protected areas to standards that will protect biodiversity and that are internationally accepted. A financial self-sufficiency program should be launched immediately. Such a program should be based on the "diversification of revenue streams" (e.g., trust funds, debt for nature swaps, merchandizing, park entrance fees, international donor grants, partnerships with commercial operators) to assure achievement of adequate income levels.

- *Protection, Physical Demarcation, and Patrol*—A large number of the protected areas have no physical demarcation of boundaries, signs designating borders, nor staff to educate and patrol and educate local communities and visitors about the biodiversity in the parks. An initiative to correct these shortcomings would contribute directly to conservation of natural resources. This type of program achieves best results when they are carried out on a collaborative basis with active participation of local stakeholders.
- *Tourism Facilities*—Investing in interpretation centers, rest rooms, reception facilities, and the like would greatly improve park visitations, thereby generating revenues for park maintenance.

10.1.9 Urban Environment

- *Managing Urban and Tourism Growth*—Having experienced extraordinary growth in urban population and in tourism and associated industries, the Dominican Government recognizes the need to bring order to the development process. This growth has exacerbated environmental problems allied with urbanization, including air, water and noise pollution. The need to treat these issues is reflected in the environmental policy principles identified earlier. The challenge is moving from the principles to concrete actions to address the problems.
- *Solid Waste Management*—In an economy in which tourism plays a large and ever increasing role visible solid waste management deficiencies can have serious adverse effects. In the heavily visited eastern part of the country, unregulated trash lines miles of highway leading to international destination resorts, and punctuates beaches, markets and urban centers. In addition to the serious health hazard to Dominicans and tourists alike, posed by the unregulated trash, it is also part of a message the Dominican Republic sends back to tourism "origin" countries (the United States, Germany, Japan). To avoid creation of a negative image that might drive tourists to seek alternatives venues, a concentrated effort to manage this problem is clearly needed.

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Environmental Regulations in the Dominican Republic

Year	*Law*	*Subject*
1931	85	Regulations on hunting
1951	3003	Creating polices for harbor and coasts
1956	4471	Code of health
1958	490	Vegetal health
1962	5582	Control of fresh and grown waters and distribution of public waters
1962	5914	Regulations for fishery
1965	55	Creating the national system for social, economic and administrative planning
1965	6	Creating the National Institute for Hydraulics Resources (INDRHI)
1965	8	Determining the responsibilities of Secretariat of State of Agriculture (SEA)
1966	257	Creating the National Office for Civil Defense
1968	305	Modifying Law 1474 about maritime and fresh water areas
1968	311	Regulations for the presentation, management, and use of pesticides
1969	487	Control and exploitation of grown waters
1971	123	Prohibiting the extraction of non-metallic minerals
1971	146	Updating the mining regulations
1974	67	Creating the Directorate of National Parks (DNP)
1977	602	Norms and quality systems.
1984	218	Prohibiting imports of any kind of wastes
1987	112	Creating the obligation of Forest Services for individuals

1991	14	Creating the civil service and the administrative career
1998	300	Creating "Environment and Natural Resources" as obligatory subject in the national education system
2000	64	Creating the a new and general framework for the management of environment and natural resources and the Secretariat of Environment and Natural Resources (SEMARN).

People and Institutions Consulted

Dr. Ana Mercedes Henríquez, INTEC-Ecologic
Julio Cícero, Loyola Polytechnical Institute
Luis Carvajal, UASD/Academy of Science
Dominican Zoological Gardens
Simón Guerrero, Sub-Director ZOODOM