Executive Summary

Introduction

Jamaica became a Party to the United Nations Framework Convention on Climate Change (UNFCCC) in January 1995. In keeping with its obligations under the Convention the Initial National Communications of Jamaica for 1994 was prepared. Funds from the Global Environmental Facility (GEF) were provided through the United Nations Development Programme (UNDP)

This National Communications has been prepared in accordance with decision 10/CP.2, 12/CP.4 and Articles 4 and 12 of the Convention of the UNFCCC.

The greenhouse gas inventory and removal by "sinks" has been prepared using the Intergovernmental Panel on Climate Change, (IPCC) 1996 Revised Guidelines for National Greenhouse Gas Inventories.

National Circumstances

Jamaica is an island in the Caribbean Sea with a total landmass of 10,991 square kilometres. The island is centered on latitude 18^{o}15' N and longitude 77^{o}20' W. Jamaica is approximately 145 kilometres south of the island of Cuba.

Jamaica is elongated along west-northwest to east-northeast alignment, roughly 230 kilometres long and 80 kilometres wide at its broadest point. The island's exclusive economic zone is approximately 25 times the size of its landmass. Jamaica has several rugged mountain ranges, with the highest point, the Blue Mountain Peak, soaring over 2,256 metres (7,402 feet). About sixty percent of the island's bedrock is white limestone; twenty five percent is volcanic and cretaceous, ten percent alluvial and five percent yellow limestone. More than 120 rivers flow from the mountains to the coast. There are fourteen parishes in Jamaica, with Kingston being the capital of the country. The coastline is approximately 1,022 kilometres.

The climate of Jamaica is mainly tropical with the most important climatic influences being the North East Trade winds and the island's orographic features, (mainly the central ridge of mountains and hills).

Other influences are the warm waters of the Caribbean Sea, as well as synoptic weather systems, primarily the Azores-Bermuda high-pressure system, surface, mid and upper level troughs, frontal systems, easterly waves, tropical depressions, tropical storms, hurricanes and infrequently, the inter-tropical convergence zone. Rainfall is the dominant meteorological variable that influences the meso-scale fluctuations of temperature, humidity, sunshine and evaporation.

Jamaica, like the other countries of the Caribbean, Central America and the Southern and Eastern sections of the United States is impacted from time to time by severe tropical weather systems including tropical waves, tropical depressions, tropical storms and hurricanes. The official hurricane season for the Atlantic is June to November, although systems have occurred outside this period. The mean average annual rainfall for the period 1881-1998 was1895 millimeters while the mean average temperature ranges from over 33° Celsius at the Norman Manley International Airport at sea level to a cool 12° Celsius at Cinchona Gardens located in the Blue Mountains.

The population in Jamaica in 1999 was estimated at 2,590,500 with a population growth rate of 0.7 percent. Crude Birth Rates declined steadily from 24.8 per cent in 1990 to 22.0 per cent in 1999, while crude death rate has been estimated at 6.7 percent in 1999. In 1994, 22.8 percent of the Jamaican population lived below the poverty line. During the past decade real GDP growth in the Jamaican economy has declined from 1.1 percent in 1994 to 0.4 percent in 1999. The major economic earners in Jamaica are tourism, agriculture, manufacturing and the bauxite-alumina industry.

Greenhouse Gas Inventory

In 1994 Jamaica's emission of Carbon Dioxide (CO2) was 8,585 gigagrams, Methane (CH4) 58.47 gigagrams and Nitrous Oxide (NO2) 344 gigagrams.

Land-use changes and forests removed 167 gigagrams of carbon dioxide.

The energy sector is responsible for the majority of the carbon emissions with 8182 gigagrams of carbon emitted as a result of fuel combustion. Further analysis shows that the manufacturing industries and construction are responsible for 4111 gigagrams of carbon being emitted into the atmosphere, while energy industries emit 2245 gigagrams of carbon. The transportation sector is responsible for 1257 gigagrams.

Agricultural soils emitted 339 gigagrams of nitrous oxide, 36 gigagrams of methane were emitted as a result of enteric fermentation.

More appropriate emissions factor data is required, as many emissions factors found within the IPCC literature are not relevant. There is a need for improved data systems and data gathering to ensure that appropriate and correct data is obtained for the production of inventories.

Vulnerability and Adaptation

The Vulnerability and Assessment Chapter is an initial assessment of Jamaica's vulnerability to climate change. The key sectors of agriculture, water resources and the coastal zone were examined utilizing interviews and consultations with relevant government agencies, non-governmental organizations (NGOs) and representatives of the private sector and a review of the available literature. Generally, available quantitative data was not in a form that allowed a specific quantitative analysis on the effect of climate change on the given issue of concern. However, quantitative data together with expert opinion and anecdotal evidence allowed for a qualitative assessment of climate change on the sector and, specifically, the areas most vulnerable to climate change. Adaptation measures have been proposed taking into account the need for an integrated approach noting existing activities. It is clear however that detailed technical vulnerability and adaptation studies are needed.

Coastal Zone

Jamaica is largely dependent upon its coastline. Key infrastructure such as the airport and many industries are located in coastal regions. Tourism is a key activity in the coastal zone contributing in 1998, 20 percent of GDP or an estimated foreign exchange earning of US$1.196 billion. The cost to protect Jamaica from a one metre sea level rise was estimated by the IPCC, in 1990 to be US$462 million which equates to a cost of US$197 per person or an annual cost that is 19% of GNP.

Sea level rise will compound beach erosion and permanent inundation in some areas could also occur, affecting industries and key infrastructure. The effects of climate change could be amplifying some natural hazards. Jamaica is already very vulnerable to tropical storms and hurricanes. It was estimated that the cost associated with damage from Hurricane Gilbert in 1988 was in the region of J$25milllion.

Climate change may have already affected the island's coral reefs. The death of large numbers of corals in 1988 and 1990 has been attributed to the increases in the temperature of coastal waters.

The economic value of all resources within the coastal zone will be adversely affected in a changing climate and a rising sea level. The resulting impact will be a loss of income, loss of commercial and industrial structures and infrastructure resulting in a detrimental impact on employment and the economy generally. Earning losses will occur in all sections of the community as a result of reduced economic activity and threats to human health.

Water Resources

Jamaica's freshwater resources come from surface sources (rivers and streams) and underground sources (wells and springs) and rainwater harvesting. Groundwater supplies most water demands (approximately 80% of production) and represents 84% of the island's exploitable water.

The island's water sources are associated with major rock formations and their interrelationships. The three dominant hydro-stratigraphic units are basement aquiclude, limestone aquifer, and alluvium aquifer/aquiclude. The island is divided into ten hydrological basins.

Raw water supplies are directly affected by changes in climatic conditions. Changes in the amount of rainfall as well as its frequency and intensity determine the amount of water that will be available for exploitation. The changes to the amount of total rainfall that Jamaica may receive under the climate change scenarios are uncertain; however, even minor changes in Jamaica's rainfall patterns could have significant impacts on its water resources.

Reductions in rainfall will have a number of effects on water sources and supply, most obviously reduced supply availability. Sea level rise most directly impacts water resources by causing increased saline intrusion in coastal aquifers. The effect of sea level rise will be exacerbated by lower rainfall thus reducing the groundwater head. Intrusion into alluvium aquifers may be moderate and higher in limestone aquifers. Saline intrusion into rivers or streams will affect the ecosystem balance of estuarine areas.

While a change in climatic conditions could have negative impacts on the water resources in Jamaica, the key issue still remains the effective distribution of the abundant available water resources.

Agriculture

Agriculture is one of the key economic sectors of Jamaica. This sector contributes approximately 7.3 percent of gross domestic product (GDP), represents approximately 12 percent of foreign earnings, and employs approximately 25 percent of the population. Sugar cane is the most important crop in Jamaica contributing approximately 45% of the export earnings for all export crops. Bananas are the second most important crop. Coffee citrus, pimento, coconut and cocoa are also exported.

Changes in temperature and atmospheric carbon dioxide will also affect agricultural output for Jamaica. Changing temperatures may result in changing wind patterns. If surface winds increase, soil erosion will increase. Increased soil erosion reduces the potential soil moisture reserves, which increases crop vulnerability to short-term dry spells. Any reduction in the amount of rainfall will result in lost production. In addition changes in patterns of rainfall will cause conditions to be more favorable for disease.

Adaptation

It is clear that there is a need for comprehensive adaptation strategies, which cross sectors. For the coastal zone there is a need for advanced planning to avoid worst impacts, assessments of need for modification of land use and implementation of identified land use guidelines, modification of building styles and codes, and a withdrawal of Government subsidies for development in high risk areas. In addition there needs to be more structured coral reef management and greater support for research and environmental monitoring.

In the area of water management their needs to be a greater use of water conservation techniques as well as improvements in the distribution and supply of water. For agriculture there needs to be continued research into different varieties of crops as well as utilising more efficient irrigation systems

National Policy and Actions

Decision and policy makers need to be sensitized on the importance of climate change and incorporating adaptation strategies into broader sustainable development. There is a need for further cross-sectoral consultation on the issue of climate change as well detailed comprehensive public awareness activities.

There is a clear need for continuous ongoing research in the area of climate change, particularly in the area of climate modeling. There is still a need for additional technical expertise in the area of climate change. There is a need for the development of capacity and the transfer of technology. The legal and policy framework with regards to climate change also needs to be analyzed effectively.

The Caribbean Planning for Adaptation to Climate Change has built significant capacity and there is a need for continuation of this work. There is a need for considerable financial assistance in the area of vulnerability and adaptation, and for renewable energy technologies.

The institutional framework for the management of climate change and its adverse effects exists within the region. However, the human, technical and financial capacities are lacking. If Jamaica is to take advantage of existing and future opportunities and face the challenge that climate change will bring, then it is a matter of urgency that these deficiencies be addressed.

Clifford Mahlung
Project Coordinator

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PART I

NATIONAL CIRCUMSTANCES

AND

CONVENTION ANALYSIS

1.1 INTRODUCTION

Global attention to Climate Change issues has mushroomed during the last two decades. The scientific community recognized prior to this period that the earth's average temperatures were increasing. Studies revealed that this was caused primarily by the higher than normal concentration of greenhouse gases mainly carbon dioxide in the atmosphere. The increased concentrations have been linked to human induced activities.

The United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature at the June 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. At the Rio " Earth Summit" over 150 states including Jamaica signed the Convention that entered into force on 24 March 1994. The objective of the Convention is to stabilize the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous human-made interference with the earth's climate system.

The Government of Jamaica recognized the clear dangers of the predicted impacts of climate change. Jamaica's Instrument of Ratification was deposited at the United Nations Headquarters in New York on January 6, 1995 and the country's accession entered into force on April 6, 1995.

The preparation of this initial National Communication is an important step towards the fulfillment of Jamaica's obligations as a Party to the Convention. The process is guided by Conference of the Parties Decision 10/CP.2 and 12/CP.4 (see Annex 1 & 2).

Table 1-1: Jamaica's National Circumstances 1994

Criteria	1994
Population	2,509,800
Relevant areas land (square kilometres)	10,830
GDP at Constant (1986) Prices	J$18.4 billion
Share of Manufacturing in GDP	18.7%
Share of Services in GDP	55.3%
Share of Agriculture, Forestry & Fishing in GDP	7.9 %
Share of Mining & Quarrying	9.2%
Share of Construction & Installation	8.8%
Land area used for agricultural purposes (hectares)	270,000
Forest area 1999 (hectares)	507,076
Life expectancy at birth (years)	75.6
Literacy rate	75.4%

Source Economic & Social Survey of Jamaica, 1994

1.2 COUNTRY DESCRIPTION

1.2.1 HISTORY[1]

The original inhabitants of Jamaica were the Tiano Indians (formerly called the Arawak Indians). They named the island "Xaymaca" - "land of wood and water". The Europeans discovered the island in 1494 when, in May of that year Christopher Columbus searching for new sea routes from Spain to India arrived in Jamaica.

Spain occupied the island for over one hundred and sixty years.

The British arrived in Jamaica in 1655. England and Spain fought for control of the island until the 1670's Treaty of Madrid gave governance to the British. When the Spanish left, their slaves escaped to desolate hilly areas in western Jamaica. There they formed independent groups known as Maroons. After a brief period of experimenting with indentured European labor, the British turned to large-scale importation of Africans to be used as slaves on the sugar plantations. Some slaves inevitably ran away from the estates to live with the Maroons.

After Emancipation in 1838, many of the ex-slaves settled down as small farmers in the mountains, cultivating steep hill slopes far away from the plantations. Still others settled on marginal lands in the plains near the plantations on land leased or bought in various land settlement schemes organized and sponsored by Christian groups such as the Baptists.

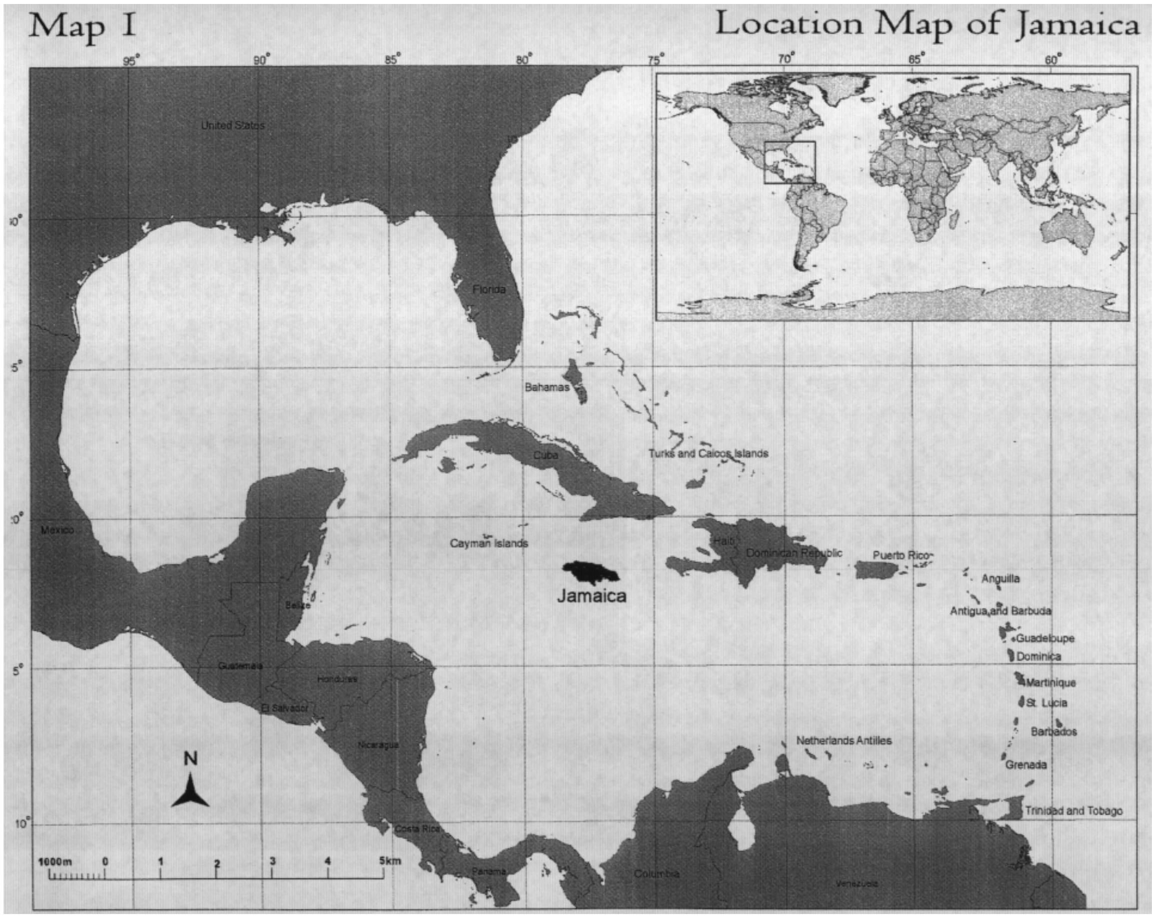
Jamaica gained political Independence in 1962, following rejection, by referendum, of membership in the Federation of the West Indies. Jamaica adopted a Westminster style constitution, with a Governor General as the representative of the British Crown, and a bicameral Parliament. Thus, there is a House of Representatives consisting of elected members and a Senate or Upper House whose members are appointed by the Prime Minister and the Leader of the Opposition. The government is guided by the Constitution of Jamaica.

1.2.2 GEOGRAPHY

Jamaica is the third largest of the group of islands known as the West Indies. Its total landmass is about 10,991 square kilometres. The island is located in the Caribbean Sea and is centered on latitude 18°15' N and longitude 77°20' W. It is approximately 145 kilometres south of the island of Cuba, or about 850 kilometres due south of the city of Miami.

[1] Excerpts from Compilation from various history books by Donna Essix

1.2.3. Location of Jamaica



Jamaica is elongated along west-northwest to east northeast alignment, roughly 230 kilometres long and 80 kilometres wide at its broadest point. The island's exclusive economic zone is approximately 25 times the size of its landmass. Jamaica has several rugged mountain ranges, with the highest point, the Blue Mountain Peak, soaring over 2,256 metres (7,402 feet). About sixty percent of the island's bedrock is white limestone; twenty five percent is volcanic and cretaceous, ten percent alluvial and five percent yellow limestone[2]. More than 120 rivers flow from the mountains to the coast. There are several plains, hectares of fertile agricultural lands, towering cliffs, magnificent waterfalls and dense tropical forests. The island is divided into fourteen parishes; Kingston is the capital city. Each parish has a capital that is the centre of economic, cultural and administrative activity.

[2] From Climate of Jamaica, Meteorological Services

1.2.4 CLIMATE

1.2.4.1 General

The climate of Jamaica is mainly sub tropical or tropical maritime. The most important broad-scale climatic influences are the North East Trade winds and the island's orographic features, (mainly the central ridge of mountains and hills). Other influences are the warm waters of the Caribbean Sea, as well as synoptic weather systems, primarily the Azores-Bermuda high-pressure system, surface, mid and upper level troughs, frontal systems, easterly waves, tropical depressions, tropical storms, hurricanes and infrequently, the inter-tropical convergence zone. Rainfall is the dominant meteorological variable that influences the meso-scale fluctuations of temperature, humidity, sunshine and evaporation.

Jamaica, like the other countries of the Caribbean, Central America and the Southern and Eastern sections of the United States is impacted from time to time by severe tropical weather systems including tropical waves, tropical depressions, tropical storms and hurricanes. The official hurricane season for the Atlantic is June to November, although systems have occurred outside this period.

It must be noted that general statements about the climate of small island states can be misleading in assessing potential climate change and its impacts as the elements of climate vary spatially from island to island.

1.2.4.2 El Nino Southern Oscillation Effect (ENSO)

The long-term large-scale human induced climate change will interact with natural variability on time scales of days to decades including ENSO (the warming of the eastern tropical Pacific). The worldwide 1997/98 El Niño was the most extreme on record. It is not yet certain whether global warming has led to more frequent or larger El Niño. The global effect of El Niño, however, demonstrates how vulnerable nation states are to changes in climate[3].

The 1997/98 El Niño phenomenon had its strongest impact on record on the Caribbean region. The 1998 hurricane season was especially devastating with long lasting effects resulting from hurricanes George and Mitch[4].

ENSO effect is believed to have had an impact on the climate of Jamaica through decreased rainfall, higher temperatures and the effects of the decreased number of hurricanes in the region during 1997/98. Rainfall for the period January – December 1997 was below the thirty-year normal for the entire year with April and May having rainfall reduced by twenty nine (29) and thirty one (31) percent of the thirty-year normal rainfall, respectively.

For the period January – December 1998 rainfall amounts were below the thirty-year normal for the months of February, April to June and August to September. The months of April and May received 40 percent and 39 percent respectively of normal rainfall.

These climatic changes resulted in millions of dollars of losses to the agricultural sector due to loss of crops, livestock and reduced crop yields. Domestic water supply was also severely affected and potable water had to be transported to the areas most affected.

1.2.4.3 Rainfall

Jamaica's rainfall is marked by its monthly, annual and spatial variability and to a lesser extent by seasonal rainfall patterns. Of the weather patterns affecting Jamaica rainfall is the most variable.

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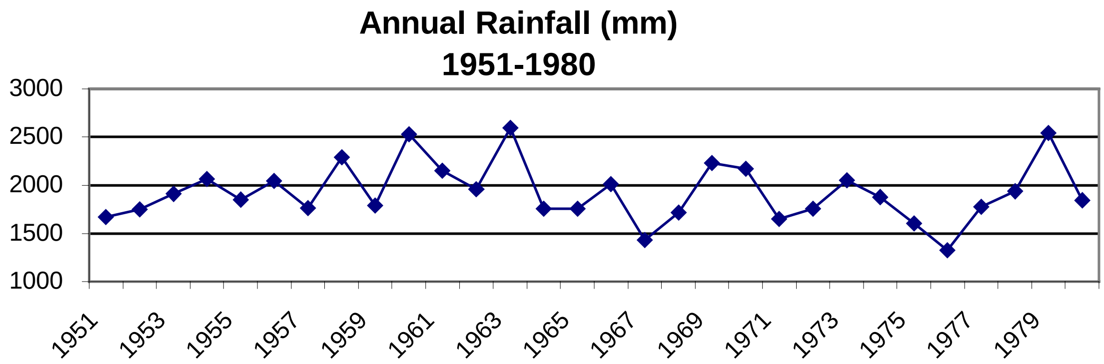
[3] Climate Change and its Impacts DETR November 1998
[4] Caribbean Environment Outlook UNEP 1999

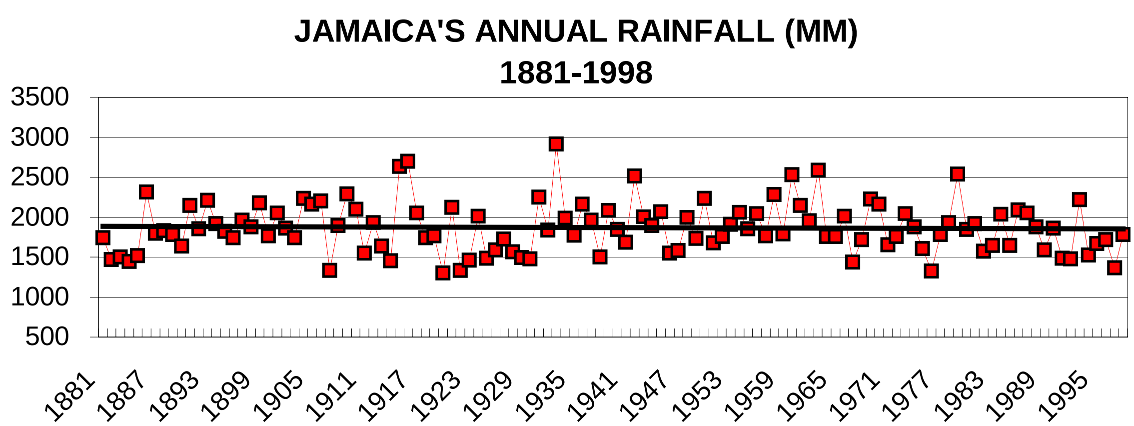
Figure 1-1



Source Meteorological Service

During the period 1951 to 1980 (Figure 1-1) annual rainfall ranged from a maximum of 2593 millimetres in 1963 to a minimum of 1324 millimetres in 1976 with an average of 1940 mm annually[5].

Figure 1-2



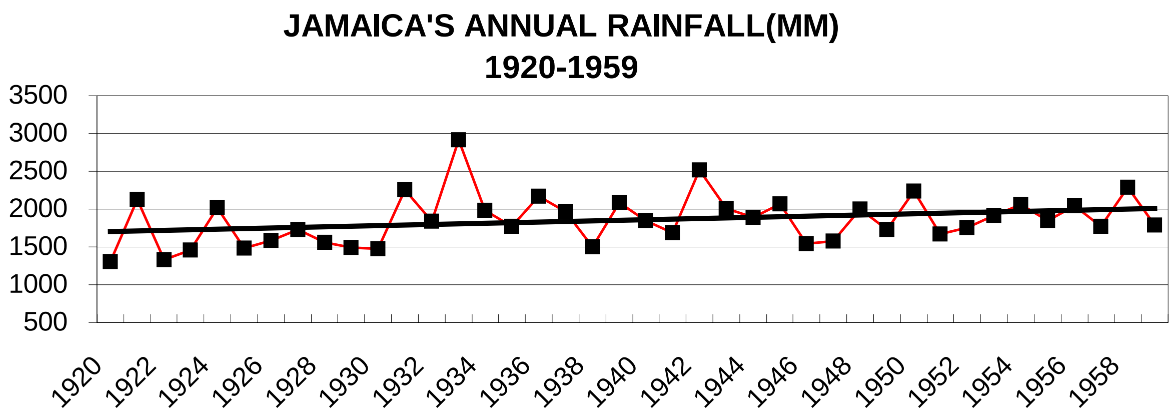
The mean average rainfall during the period was 1895 millimetres. The wettest year on record is 1933 (Figure 1-2), with an annual rainfall of 2960 millimetres, while the driest year is 1920 with 299 millimetres.

The rainfall trend over the 117 years is relatively constant, contrasting with the trends demonstrated in Figure 1-3 (1920 – 1959). This shows an increase in the

[5] Climate of Jamaica Meteorological Services

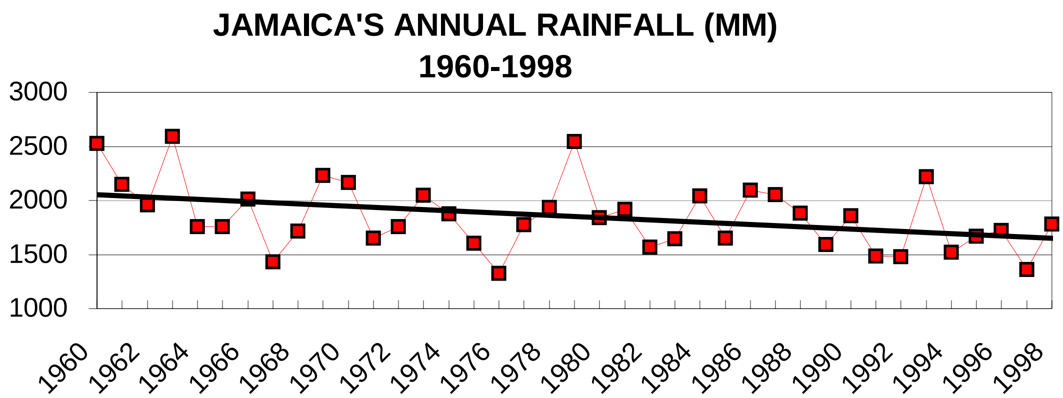
annual mean to 1959 compared with Figure 1-4, which shows a decline in the rainfall means from 1960 to 1998.

Figure 1-3



Source Meteorological Service

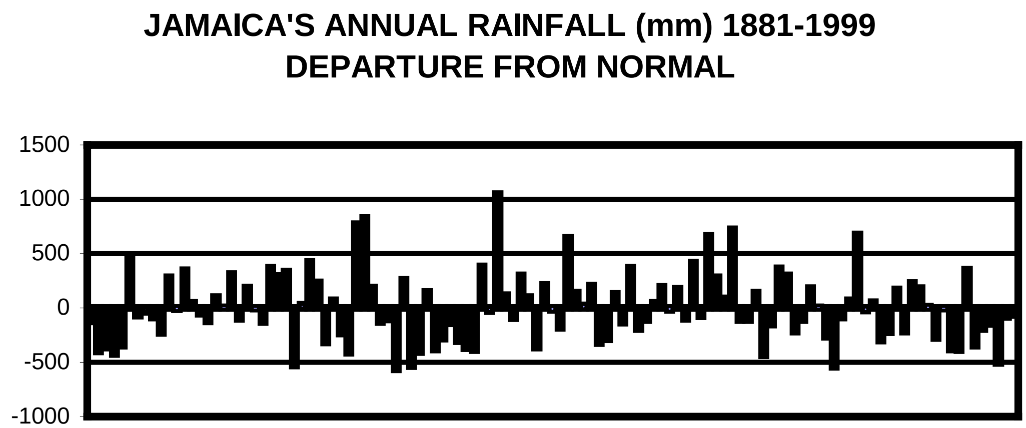
Figure 1-4



Source Meteorological Service

Figure 1-5 illustrates the departures from normal annual rainfall for the period 1881 – 1998.

Figure 1-5



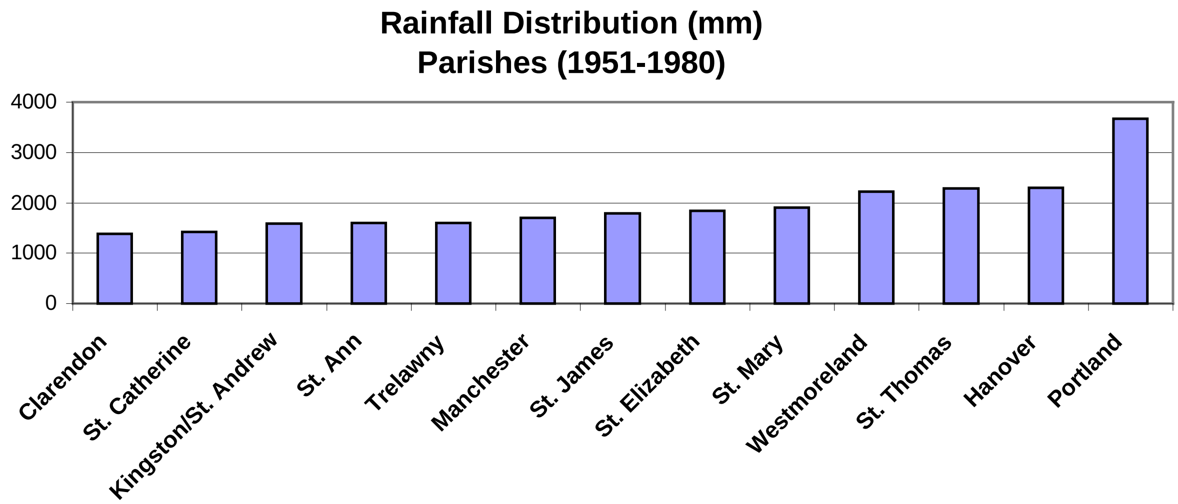
Source Meteorological Service

1.2.4.4 Rainfall Distribution

Northeastern Jamaica receives the highest annual rainfall, in excess of 5080 mm while parts of the southern coastal plains receive less than 1270 mm annually. Water shortages are common especially along the southern coastal plains.

Rainfall patterns for representative parishes are illustrated in Figure 1-6. This illustrates the spatial distribution of Jamaica's rainfall.

Figure 1-6



Source: Meteorological Services

The island's rainfall is bimodal with peaks in May and October and minimal in March and July. The two distinct wet seasons are April to June and September to November. These wet seasons occur as regular yearly cycles. Mean rain days vary from 60 to 200 days annually. Areas with less rain days receive low annual rainfall; however, regions with more rain days are not necessarily the wettest areas. In the eastern region of the Blue Mountain Peak 180 rain days produce more than 5200 mm annually, but only 1500 mm on the north coast.

1.2.4.5 Drought

Meteorological drought is the condition experienced when rainfall amounts are 60 percent or less of normal over a period of eight consecutive weeks. Extreme drought, if the amounts are 21 – 40 percent of normal, and severe droughts if rainfall is 20 percent or less of the normal. Normal is the thirty year mean. However an important point in assessing drought is that different areas have different water needs. Similar rainfall deficiencies may have dramatically different effects on different areas.

Jamaica's mean annual point rainfall varies from about 762 millimetres in coastal regions of both the north and south to over 7,620 millimetres in the Blue Mountains. Regions with average annual rainfall of 5,080 millimetres or more, will with a deficiency of fifty percent, still have sufficient water. Whereas, regions with an annual average of 1016 millimetres sometimes experience serious water stress with a rainfall deficiency of 20 percent of normal.

The years 1964 and 1965 were regarded as drought years in Jamaica, yet, island wide the recorded deficiencies were only eleven percent (11%) and twelve percent (12%) respectively. In 1967 it was twenty seven percent (27%) although there were individual stations with deficiencies of up to eighty percent (80%) and during the twelve-month period July 1972 to June 1973, the deficiency was twenty percent (20%) with individual stations down by as much as sixty percent (60%).

Jamaica experienced extreme drought conditions, during the period December 1996 to January 1997 and March to May 1997. Normal drought conditions (i.e. 60% or less of the 30 year normal for eight consecutive weeks) were experienced during the period May and June 1997 as well as April to June 1998.

1.2.4.6 Temperature

Temperature has implications for public health, agriculture, water resources and other economic activities of the island.

In Jamaica, the most important influences of annual variations of temperature include seasonal variations, exposure to cold air masses and to a lesser extent annual rainfall patterns.

Jamaica's minimum and maximum temperatures lag by two months behind the shortest (December 20) and longest (June 21) days of the year respectively. Although air masses from the United States do reach Jamaica during the Northern Hemisphere winter, they are modified considerably by heating over the still warm waters of the Gulf of Mexico and the Caribbean Seas. With the sun south of the equator less radiation reaches the island and these influences tend to suppress temperatures in December, January, February and March. The effect of rainfall on Jamaica's annual temperature variations is uncertain. The data shows that the maximum frequency and amount of rainfall occurs in May and October, however temperatures during these periods are not significantly lower.

Temperatures in coastal areas are comfortably warm, becoming cooler in the hilly and mountainous regions in the centre of the island, but more so in the Blue Mountain range at its highest point of 2,221 metres. Apart from rapid fluctuations associated with afternoon showers and or the passage of frontal systems, the island's temperatures remains fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

1.2.4.7 Winds

The northeast trades dominate the daily wind pattern of the island. During the day on the north coast the sea breeze combines with the trades to give an east-north-easterly wind at an average speed of 15 knots. Along the south coast a southeasterly wind with an average speed of 18 knots is prevalent. In the period December to March, however, the trades are lowest and the local wind regime is a combination of trade wind, sea breeze, and a wind with a northerly or northwesterly component associated with cold fronts and high-pressure areas moving from the North American continent.

By night the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, winds on the North Coast during the nights generally have a southerly component with the mean speed of 5 knots and on the south coast a northerly component with a mean speed of 7 knots.

By day, from June to July, mean onshore winds often reach a maximum of up to 23 knots along the north coast and 26 knots along the south coast during mid afternoon.

1.2.4.8 Humidity

Afternoon showers are the major cause of most daily variations in relative humidity. Highest values are recorded during the cooler morning hours near dawn, followed by a decrease until the early afternoon when temperatures are highest.

Annual range of humidity is very small. It is generally less than 10 percent for any given hour. The smallest annual range is in the predawn hours and the largest annual variations occurring in the afternoon.

1.2.4.9 Sunshine

Variations of sunshine hours for any area are usually quite small. Differences, however, are much greater between coastal and inland stations. Maximum day length occurs in June and the minimum occurs in December. The mean sunshine in mountainous areas is less than six hours per day, caused mainly by the persistence of clouds, while in coastal areas it is near eight hours per day.

1.3 DEMOGRAPHIC TRENDS

1.3.1 Social Indicators

Selected social indicators over the decade of the 1990s show that though there was an increase in population, there was a decline in the growth rate from 1.0 per cent in 1990 to 0.7 per cent at the end of the decade. Crude Birth Rates declined steadily from 24.8 per cent in 1990 to 22.0 per cent in 1999. Crude Death Rate remained relatively stable for the first four years of the decade but showed an upward trend thereafter. Unemployment remained relatively unchanged over the period as the rate of growth in the economy declined. With the improvement in Primary Health Care, Infant Mortality Rate recorded a steady decline (except for some years), from 27.3 per cent in 1990 to 24.5 per cent in 1999 (see Table1.2).

Table 1.2: Selected Social Indicators - Jamaica, 1994 – 1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Population (000 persons)	2378.8	2398.8	2423.7	2445.9	2472.9	2503.3	2527.5	2553.2	2571.8	2590.5
Population Growth Rate (%)	1.0	0.9	1.0	0.9	1.1	1.2	1	1	0.7	0.7
Crude Birth Rate (per '000 pop)	24.8	24.7	23.9	23.2	23.7	25.5	22.8	23.4	22.2	22.0
Crude Death Rate (per '000 pop)	5.1	5.5	5.4	5.6	5.4	6.1	5.9	5.9	7.1	6.7
Total Employment ('000)	.	..	..	..	..	963.3	959.8	946.8	953.6	943.9
Unemployment Rate (%)	15.3	15.4	15.7	16.3	15.4	16.2	16.0	16.5	15.5	15.7
Literacy Rate (%)	47.0	73.1	67.8	..	75.4	89.1	75.4	75.4	75.4	75.4
Infant Mortality Rate (per '000 live births)	27.3	25.5	34.0	32.5	28.7*	24.5	24.5	24.5	24.5	24.5
Access to Safe Water (% of households)	78.3	77.7	76.6	82.3	81.7	79.9	81.7	81.2	81.2	81.2
Sanitary Facility (% of households)	..	..	..	..	99.4	99.5	99.7	99.5	99.5	

*January-June1994

Source: Economic and Social Survey of Jamaica 1994 & 1999

1.3.2 Population Growth

The Jamaican population at the end of 1994 was estimated as 2,509,800. This showed an increase of 26,000 over the figure for the previous year that was 2,482,900. The estimated growth rate for that year was 1.1 per cent, showing a slightly higher rate than 0.9 per cent reported the previous year. Factors which contributed to this increase in the population growth rate could be attributed to the following:

- population decline due to net external movement and deaths were lower than the previous year with external movements falling by 11.7 per cent in 1994;
- an increase in the absolute number of births registered;
- there were no significant differences in the Crude Birth and Death Rates per 1000 population compared with the previous year which were 23.7 and 5.4 respectively.

The Crude Birth and Death Rates and net external migration are shown in (Table 1.3).

Table 1.3 Population Growth Statistics, 1985-1994

	Numbers							Rates (Per 1000 Population)			
	Population at the end of the year	Mean population	Live Births	Death	Net External Movements	Natural Increase Col. (4) – Col. (5)	Net Increase Col. (7)+Col (6)	Crude Birth Rate Col. (4)/ Col. (3)	Crude Death Rate Col. (5)/Col. (3)	Rate of natural Increase Col. (9) –Col. (10)	Annual rate of growth in Percent-ages Col. (8)/ Col. (3)
1	2	3	4	5	6	7	8	9	10	11	12
1985	2,325,700	2,311,300	56,200	13,900	-13,400	42,300	28,900	24.3	6.0	18.3	1.3
1986	2,346,400	2,336,100	54,100	13,300	-20,100	40,800	20,700	23.2	5.7	17.5	0.9
1987	2,355,400	2,350,900	52,300	12,400	-30,900	39,900	9,000	22.3	5.3	17.0	0.4
1988	2,357,900	2,356,600	53,600	12,200	-38,900	41,400	2,500	22.7	5.2	17.5	0.1
1989	2,392,300	2,375,100	59,100	14,300	-10,400	44,800	34,400	24.9	6.0	18.9	1.4
1990	2,415,100	2,403,000	59,600	12,200	-24,600	47,400	22,800	24.8	5.1	19.7	1.0
1991	2,435,800	2,425,500	59,900	13,300	-25,900	46,600	20,700	24.7	5.5	19.2	0.9
1992	2,460,700	2,448,200	58,600	13,200	-20,500	45,400	24,900	23.9	5.4	18.5	1.0
1993	2,482,900	2,471,600	57,400	13,900	-21,300	43,500	22,200	23.2	5.6	17.6	0.9
1994	2,509,800	2,496,100	59,200	13,500	-18,800	45,700	26,900	23.7	5.4	18.3	1.1

Source: Planning Institute of Jamaica

1.3.3 Population Structure

The age and gender structure of population for the year 1994 was reflective of that which was observed during the post 1982 census estimates of births, deaths and external migration. Table 1.4 shows that in 1994 the 0-14 age group declined slightly to 31.6 from 31.9 in 1993. Within this age group, the 0-4 years segment showed a slight decline from 11.5 per cent in 1993 to 11.4 in 1994. This decline may be reflective of the downward trend in fertility. The school age population (3-18 years) also continued the downward trend observed in 1993 from 33.3 per cent to 32.8 per cent in 1994. The proportion of the population in the economically active age group, (15-59 years) and the aged (60 and over), continued to show an increase from 57.9 per cent and 10.2 per cent respectively in 1993 to 58.2 per cent and 10.3 per cent respectively in 1994. Jamaica's population is considered youthful as 61.4 per cent was under 30 years in 1994 showing a decline from 62.2 per cent in 1993. The population has been ageing from the base as proportion of younger persons in the population declined and ageing at the apex as the proportion of older persons in the population increased. This is a phenomenon which is characteristic of developing countries.

Population trends showed that the sexes are approximately evenly distributed with males accounting for 49.96 per cent. Overall, the sex ratio remained stable at 99.8 per cent males to 100 females. In recent years the dependency ratio has been declining. In 1994, the dependency ratio stood at 719 per 1000 persons in the economically active age group.

Table 1.4 Population of Jamaica by Age, Sex and Percentage Distribution 1993 – 94

	Numbers				Percentages			
Age Group	Males	Females	Males	Females	Males	Females	Males	Females
		1993		1994		1993		1994
Total	1,240,770	1,241,860	1,253,780	1,255,790	49.8	50.02	49.6	50.04
0-4	144,280	141,520	143,940	142,090	5.81	5.70	5.74	5.66
5-9	126,220	126,180	126,370	126,770	5.08	5.08	5.04	5.05
10-14	125,860	128,290	124,800	128,450	5.07	5.17	4.97	5.12
15-19	131,860	126,800	127,410	125,560	5.31	5.11	5.08	5.00
20-24	129,070	129,210	127,830	128,210	5.20	5.20	5.09	5.11
25-29	115,650	119,210	117,720	120,830	4.66	4.80	4.69	4.81
30-34	97,200	99,790	100,310	102,440	3.92	4.02	4.00	4.08
35-39	73,020	72,970	78,650	77,220	2.94	2.94	3.13	3.08
40-44	53,230	53,300	554,650	55,680	2.14	2.15	2.21	2.22
45-49	45,580	42,580	46,640	44,130	1.84	1.72	1.86	1.76
50-54	41,300	37,430	42,610	37,530	1.66	1.51	1.70	1.50
55-59	36,460	33,430	37,440	34,150	1.47	1.35	1.49	1.36
60+	121,040	131,150	124,500	132,730	4.88	5.28	4.96	5.29

Source: Demographic Statistics, STATIN

1.3.4 Population Distribution

Jamaica's population is unevenly distributed as a direct result of the uneven distribution of the country's natural resources and economic activities. Jamaica can be described as being predominantly urban as the urban segment of the population accounted for 50.2 per cent in the 1991 Census of population. Since the 1960's rural-urban migration has been a significant feature of population growth. The two cities, Kingston and Montego Bay, account for 26.5 percent and

3.4 percent of the nation's population respectively, are the receiving areas for most of the migrating population.

1.3.5 Migration

Migration, both internal and external constitutes an important feature of the Jamaican demography. Migration impacts not only on the structure of the population in terms of size, age and sex ratio of the host and sending areas, but impacts on the parish and national populations. Net external migration for the year 1994 was 18 800. It was estimated that 14 700 Jamaicans emigrated in 1994. The main receiving countries for Jamaican emigrants were the United States (USA), Canada and the United Kingdom (UK).

1.3.6 Education

During 1994 the Jamaican education system catered for approximately 731 000 students in the 3 to 24 years age group. The enrollment rates for students in the primary age group (6-11 years) were universal. Student enrollments at the secondary (12-17 years) and tertiary (20-24 years) levels were 76 per cent and 9.2 per cent respectively.

1.3.7 Health

During 1994 primary health care continued to be the major focus of the Ministry of Health. The Ministry's aim was to promote healthy lifestyles, preventing diseases and facilitating accessibility to health care. The services offered were Maternal and Child Health, Dental Care, Health Education, Disease Control and Environmental and Veterinary Health Services. Through these programmes, vital statistics have remained stable and no major epidemics occurred during the year. Surveillance and monitoring of communicable diseases continued despite the high attrition rates among medical professionals.

1.3.8 Housing

During 1994, the average size of households was 3.69. This was made up of adult 1.16 males, 1.26 females and 1.27 children. The percentage of households owning the houses in which they lived was 59 per cent, continuing the trend observed in 1993. However, 37.0 per cent of households did not have access to private piped water while 50 percent of households had access to a water closet. There was an improvement in the availability of electricity to 71.0 per cent of households in 1994, the highest recorded since 1990 when the figure was 66.0 per cent. The number of households relying on kerosene as their source of lighting declined incrementally to 27.0 per cent down from 29.0 per cent the previous year. Telephone services available to households, showed a large increase of 19.0 per cent in 1994 up from 8.0 per cent recorded in 1990.

1.3.9 Tenure

Over 72.0 per cent of the households in Jamaica owned the dwellings which were either occupied by the owner's household ('Owned by Household Member') or by someone related to the owner. The number of households paying rent was 24.0 per cent. The number of squatter households was small at 1.7 per cent.[6]

1.3.10 Poverty

Since 1989, the percentage of Jamaicans living below the poverty line has fluctuated. About 22.8% of Jamaica's population lived below the poverty line in 1994. This represented a reduction of 1.6 percentage points over the previous year and was a continuation of the downward trend experienced since 1992.

[6] Jamaica Survey of Living Conditions 1994.

1.4 ECONOMIC TRENDS

1.4.1 Historical Background

Since the early 1980s, the Government of Jamaica (GOJ) has initiated fundamental reforms of economic policy aimed at fostering private sector activity, increasing the role of market forces in resource allocation and improving the efficiency of product and factor markets. The reforms entailed an overhaul of the trade policy and tax regimes as well as broader reforms of the financial and public sectors.

Over the period 1990 to 1994, the economy experienced positive growth. However, the rate of growth declined over the time period from 5.5 per cent to 0.8 per cent. In the Goods Producing sector, Agriculture had the highest rate of growth while performances in the sectors Manufacturing and Construction showed decline for some years. Performance in the Services sector was more robust over the period, led by the Financial Services sector and Distributive Trade. Sectors such as Electricity and Water performed well over the period (see Table1.5)

Table 1.5 Rate of Growth of Gross Domestic Product By Industrial Sectors At Constant Prices, 1990 -1994

Industrial Sector	1990	1991	1992	1993	1994
Agriculture, Forestry & Fishing	11.5	-0.2	13.0	10.1	7.5
Mining & Quarrying	22.8	5.7	-2.5	0.3	6.9
Manufacturing	3.7	-7.5	1.2	-1.8	-0.5
Construction & Installation	1.6	0.6	0.4	-0.5	-6.3
Electricity & Water	6.9	1.8	4.4	4.0	0.6
Transport, Storage & Communication	3.4	4.1	5.4	8.0	5.7
Distributive Trade	4.6	2.2	5.3	4.0	1.7
Financing & Insurance Services	10.5	19.4	8.0	-7.2	47.3
Real Estate & Business Services	6.9	4.1	5.4	2.5	5.0
Producers of Government Services	-2.7	-0.8	0.1	-0.4	-1.2
Miscellaneous Services	6.8	-2.8	1.1	5.3	-1.5
Household & Private Non-Profit Institutions	6.9	-5.9	-10.1	-14.0	1.2
LESS Imputed Bank Service Charge	**13.8**	**12.7**	**27.6**	**1.7**	**54.2**
TOTAL GDP AT CONSTANT PRICES	**5.5**	**0.7**	**1.4**	**1.4**	**0.8**

Source: Planning Institute of Jamaica

1.4.2 Growth in the Jamaican economy over the past decade.

Real GDP Growth declined from 1.1% in 1994 to 0.4 in 1999. Since 1996, there has been a consistent fall in real GDP (See Table 1.6). The fall of 0.4 per cent (measured in 1986 prices) in real GDP during 1999 was preceded by declines of

0.7 per cent in 1998, 2.1 percent in 1997, 1.4 per cent in 1996 and 0.7 per cent in 1995. The decline in real output since 1996 reflected:

(a) high real interest rates and real exchange rate appreciation during the dis-inflation process;

(b) financial sector distress;

(c) a severe drought; and

(d) external demand shocks, for example, the impact of NAFTA on the competitiveness of the local garment sector, and the impact of the Asian crisis on world demand for major export commodities.

In 1999, the explosion at the Gramercy Aluminum Refinery in Louisiana, U.S.A., contributed to a 7.6 per cent decline in total bauxite production.

Table 1.6: Selected Economic Indicators - Jamaica, 1990 – 1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
GDP at Current Prices (J$b)	30.7	45.2	74.7	102.4	135.2	172.0	204.8	225.3	238	256.8
GDP at Constant (1986) Prices (J$b)	17.4	17.6	17.9	18.2	18.4	18.5	18.3	17.9	17.8	17.8
Real GDP Growth (1986) (%)	5.6	0.9	1.6	1.7	1.1	0.7	-1.3	-2.0	-0.5	-0.4
Exchange Rate Change	..	..	..	..	-23.0	-6.5	-4.1	4.0	-3.0	-7.0
Trade Balance, (US$M)	-784.9	-677.9	-721.8	-1113.8	-957.7	-1395	-1530	1997	-1670	-1140.6
Stock of NIR (US$M)	-447.8	-443.0	-67.4	51.1	399	419	694	541	582	450.2
Total External Debts/GDP	..	..	..	..	92.0	79.9	55.3	53.2	51.6	51.7
Annual Inflation (Dec-Dec, %)	29.8	80.2	40.2	30.1	26.7	25.6	15.8	9.2	7.9	6.8

Source Planning Institute of Jamaica

The fiscal position has deteriorated to deficits of 9.0, 9.6 and 8.0 per cent of GDP during financial years (FY) 1996/97-1998/99 respectively. This reflected a combination of (a) high interest rates and the resultant sluggish output performance (b) increased domestic debt and (c) public sector wage increases. However, during FY 1999/2000, the fiscal position improved as programmed, reaching an estimated 4.4 per cent of GDP. The external current account position also deteriorated from the small surplus recorded in 1995 to deficits of between 4.0 and 6.0 per cent of GDP between 1996 and 1998, and 4.2 per cent in 1999.

1.4.3 Current Economic Performance

The medium term economic profile (Table1.7) reflects a gradualist approach to problems of deficit reduction, the maintenance of macro-economic stability and the restoration of economic growth. However, the GOJ has recognized that there exist a number of constraints to the achievement of growth. These include;

a. The availability of capital,
b. The absence of adequate provision of economic and social infrastructure for the emergence and development of new areas of economic activity.
c. The need for improvements in the legal, regulatory and bureaucratic framework
d. Financial sector difficulties and
e. Social conditions

Table 1.7 Medium Term Economic Programme - Main Targets

	Actual 98/99	Actual 99/00	Actual 00/01	Projected 01/02
Exchange Rate	36.87	40.12	42.50	42.50
Inflation Rate	6.0%	8.4%	4%- 6%	4%-5%
Real GDP	0.0%	0.6%	2.0%	4.0%
Change in Monetary Base	-4.0%	-1.8%	-1.0%	2.5%
Change in Money Supply (M3)	10.3%	19.3%	8.0%	9.4%
Change in NIR (US$M)	-13.5	122.0	103.0	41.1
Central Government Deficit	-7.5%	-4.4%	0%	0.1%

Source: Planning Institute of Jamaica

1.4.4 Debt Service

The total stock of debt has shown a gradual decline throughout the decade of the 1990's. National debt has decreased steadily from US$4.3 billion in 1994 to US$3.9 billion in 1998. It may be important to note, however, that in 1994, 27.4 per cent of total government budget was directed at servicing debt. This contributed to continuation of financial stagnation. This in turn has produced survival strategies, among the poor, that place social and ecological support systems at risk.

1.4.5 CONCLUSIONS
1.4.6

Against this background, the Government of Jamaica's Programme for achieving growth and stability objectives involve a mixture of policies aimed at containing excessive growth in demand, reducing interest rates and improving micro-economic efficiency through improvements in institutions, infrastructure and financial mediation. The medium term policy framework will therefore encompass a number of strategies including monetary, fiscal, and sectoral as well as institutional strengthening measures.

1.4.6 NATIONAL AND REGIONAL PRIORITIES

Over the years, a number of international and regional treaties and conventions addressing sustainable development issues have been negotiated and ratified by the Government of Jamaica. In 1994 these numbered about 180. Those that are related to global climate change are listed below.

- Convention on Biological Diversity
- United Nations Convention to Combat Desertification
- United Nations Convention on Law 0f the Sea
- Vienna Convention for Protection of the Ozone Layer
- Montreal Protocol on Substances that Deplete the Ozone Layer
- London Amendment to the Montreal Protocol
- The Copenhagen amendment to the Montreal Protocol

In 1994 a number of landmark events occurred that helped advance the work of environmental and sustainable development in the region. The most significant of these was the United Nations Conference on Sustainable Development of Small Island Developing States (SIDS) the entry into force of UN Convention on the Law of the Sea and the Summit of the Americas.

SIDS promoted the understanding that national priorities are often much larger than first perceived. By focusing on territorial waters it became obvious that the resource base and the space available for sustainable development are scarce. This has catalyzed a number of activities in many countries by governments, NGOs and private organizations.

The conference culminated with the adoption of a program of action for the sustainable development of SIDS, the Barbados Programme of Action. This program identified priority areas and specific actions necessary to address the special challenges faced by SIDS.

The actions related to climate change that are now being integrated into national and regional development policies of Jamaica are supplemented by the project: Caribbean Planning for Adaptation to global Climate Change, CPACC. The implementing agency the Global Environmental Facility funds this four-year project, through the World Bank. The Organization of American States is the executing agency. The main objective of CPACC is to support the members of the Caribbean Community, (CARICOM) that are Parties to the UNFCCC. This is achieved by increasing the national and hence regional resources and skills needed for strategic planning to minimize the adverse effects of global climate change.

The main areas of focus are the coastal zones and marine resources, the greatest source of income for the Small Island Developing States of the Caribbean.

As many of these adverse effects are projected to occur in the second quarter of this century, it is of paramount importance that a permanent institution specializing in climate change and its related issues be established. Such an institution should be regional based. CPACC fulfills these requirements and must be supported to assume this crucial role.

The institutional framework for the management of climate change and its adverse effects exists within the region. However, the human, technical and financial capacities are lacking. If Jamaica is to take advantage of the existing and future opportunities and face the challenge that climate change will bring, then it is a matter of urgency that these deficiencies be addressed.

PART II

NATIONAL INVENTORY

OF

GREENHOUSE GASES

2.1 Introduction

In accordance with Article 4.1(a) of the UNFCCC, all parties to the convention are requested to update and report periodically on their inventory of anthropogenic emissions and removals of greenhouse gases.

Jamaica has calculated greenhouse gas emissions and removals by sinks for the year 1994 utilizing the 1996 Revised IPCC Guidelines for the National Greenhouse Gas Inventories. This fulfills the objective of the Conference of the Parties for the use of comparable methodologies.

Jamaica is not a producer of fossil fuels and is therefore heavily dependent on the importation of fossil fuels for energy and transport requirements.

In 1994 Jamaica's emission of Carbon Dioxide (CO_2) was 8,585 gigagrams, Methane (CH_4) 58.47 gigagrams and Nitrous Oxide (NO_2) 344 gigagrams.

Land-use changes and its forests removed 167gigagrams of carbon dioxide.

Table 2.1: Greenhouse Gas Emissions of Jamaica for 1994

SOURCES AND SINK CATGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O
Total Emissions and Removals for Jamaica	**8,585**	**-167**	**58.5**	**344**
Total for Energy	**8,182**	**0**	**1**	**0**
Total Fuel Combustion (Sectoral Approach)	8,182	..	1	0
Energy Industries	2,245	..	0	0
Manufacturing Industries and Construction	4,111	..	0	0
Transport	1,257	..	0	0
Other Sectors	586	..	0	0
Other (please specify)	-18	..	0	0
Total Fugitive Emissions from Fuels	0	..	0	..
Total for Industrial Processes	**403**	**0**	**0**	**0**
Mineral Products	403	..	..	..
Total for Agriculture	..	..	**43**	**343**
Enteric Fermentation	..	..	36	..
Manure Management	..	..	7	4
Agricultural Soils	..	..	..	339
Total for Land-Use Change & Forestry	**0**	**-167**	**0**	**0**
Changes in Forest and Other Woody Biomass Stocks	88	-255	..	..
Total for Waste	..	**..**	**14.50**	**0**
Solid Waste Disposal on Land	..	..	14.50	..
Wastewater Handling	..	..	0.00	0

2.2 ENERGY AND INDUSTRIAL PROCESSES

The energy sector includes all fuel combustion-related emissions from energy industries, manufacturing and construction, transport and other source categories. Total CO_2 emissions from the energy sector based on a sectoral approach in 1994 were 8,182 Gg. Emissions of other GHGs were 0.567 Gg for CH_4, 0.118 Gg for N_2O, 31.5 Gg for NOx, 173.9 Gg for CO and 98.9 Gg for SO_2. Estimates of energy sector CO_2 emissions based on the reference approach were 8,076 Gg.

2.3 ENERGY

The energy industries comprise end-use of fossil fuels for power generation and energy used in refinery operations (see Table 2-2). Total CO_2 emissions from the energy industries in 1994 were 2,245 Gg. Emissions were 0.0892 Gg for CH_4, 0.0178 for N_2O, 5.94 Gg for NOx, 0.446 Gg for CO 0.149 Gg for NMOC and 30.1 Gg for SO_2.

Table 2 -2 Jamaica's Greenhouse Gas Emissions (Gg) For Energy and Industrial Processes Sectors, 1994

GREENHOUSE GAS SOURCE CATEGORIES	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
Total Energy	8182	0.67	0.113	30.90	173	29.10	98.90
Fuel Combustion Activities (Sectoral Approach)	8182	0.67	0.113	30.90	173	27.40	98.90
Energy Industries	2245	0.09	0.02	5.94	0.45	0.15	30.10
Public Electricity and Heat Production	2141	0.09	0.02	5.66	0.43	0.14	28.50
Petroleum Refining	105	0.00	0.00	0.28	0.02	0.00	1.62
Manufacturing Industries and Construction	4111	0.12	0.03	10.80	0.70	0.29	63.00
Bauxite	3749	0.10	0.03	9.81	0.49	0.25	60.10
Cement	235	0.00	0.00	0.69	0.19	0.032	1.42
Other Manufacturing	127	0.02	0.00	0.34	0.02	0.00	1.52
Transport	1257	0.39	0.01	12.20	106	20	2.10
Civil Aviation	7.89	0.12	0.00	0.00	0.011	0.00	0.01
Road Transportation	1208	0.00	0.01	11.30	105.90	19.90	1.65
Railways	0.10	0.28	0.00	0.00	0.00	0.000	0.000
Navigation	41.20	0.00	0.00	0.83	0.55	0.11	0.44
Other Sectors	586	0.07	0.05	1.91	65.70	6.97	3.58
Commercial/Institutional	119	0.00	0.00	0.16	0.03	0.00	0.81
Residential	316	0.02	0.02	0.96	26.90	2.30	0.68
Agriculture/Forestry/Fishing	151	0.05	0.03	0.79	38.80	4.66	2.10
Fugitive Emissions from Fuels	0.00	0.02	0.00	0.04	0.06	1.63	0.61
Oil and Natural Gas	0.00	0.02	0.00	0.04	0.06	1.63	0.61
Oil	0.00	0.02	0.00	0.04	0.06	1.63	0.61
Total Industrial Processes	379	0.00	0.00	0.00	0.00	5.84	0.24
Mineral Products	379	0.00	0.00	0.00	0.00	0.00	0.00
Cement Production	226	0.00	0.00	0.00	0.00	0.00	0.00
Lime Production	153	0.00	0.00	0.00	0.00	0.00	0.00
Glass Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Sulphuric Acid	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Total Other Production	0.00	0.00	0.00	0.00	0.00	5.83	0.00
Food and Drink	0.00	0.00	0.00	0.00	0.00	5.83	0.00

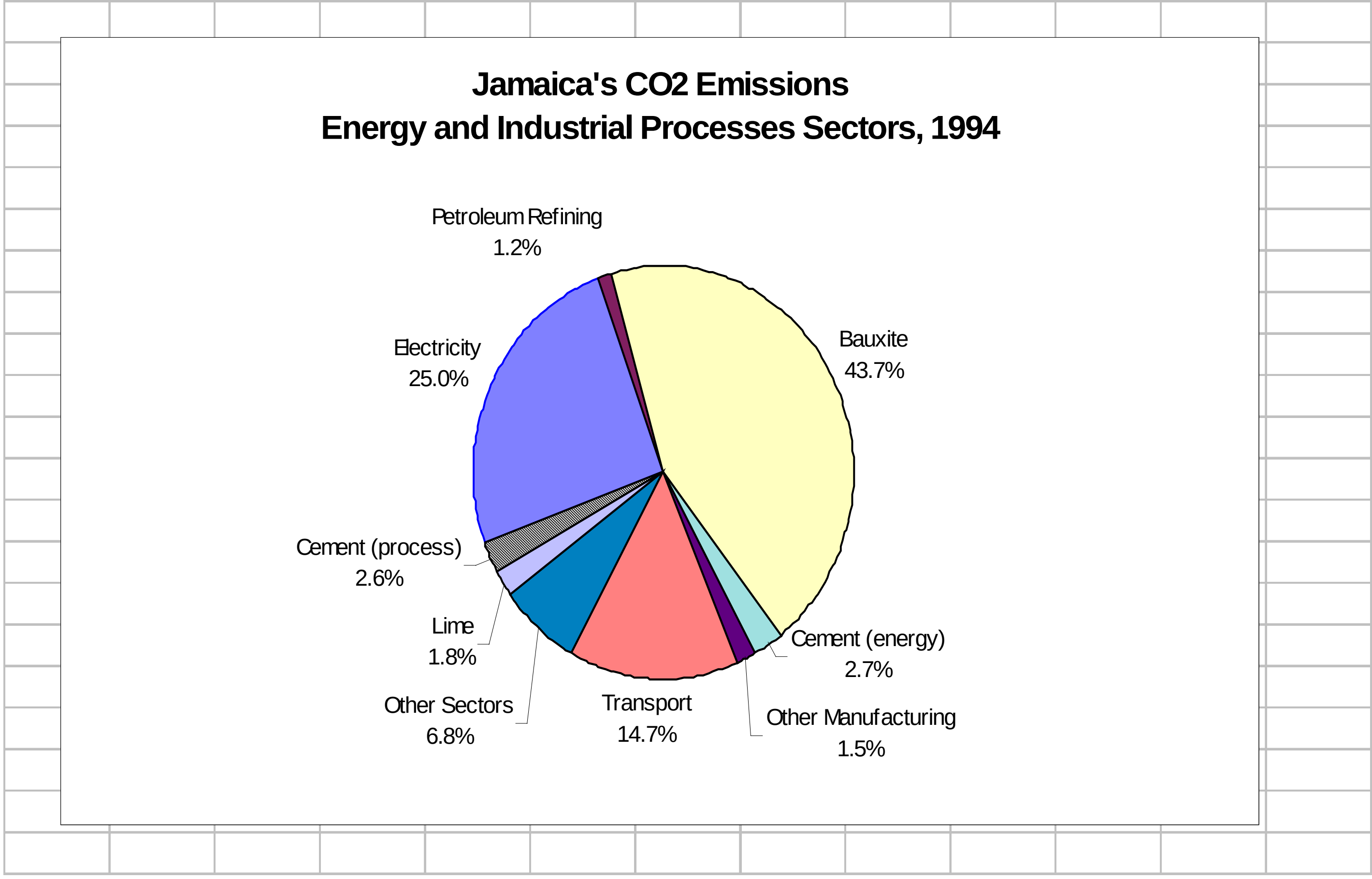


Figure 2.1 Jamaica's CO_2 Emissions (% Contribution by Each Sector) From Energy and Industrial Processes Sectors, 1994

Figure 2.2 Jamaica's NO_x Emissions (% Contribution by Each Sector) From Energy and Industrial Processes Sectors, 1994

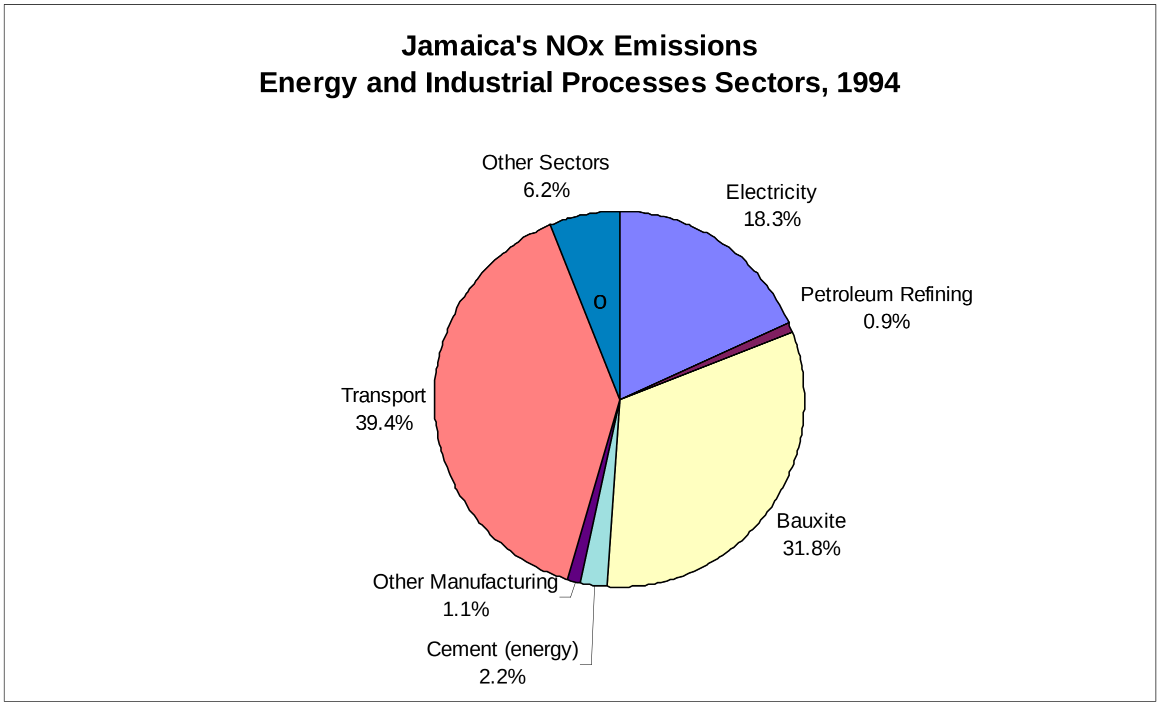


Figure 2.3 Jamaica's CO Emissions (% Contribution by Each Sector) From Energy and Industrial Processes Sectors, 1994

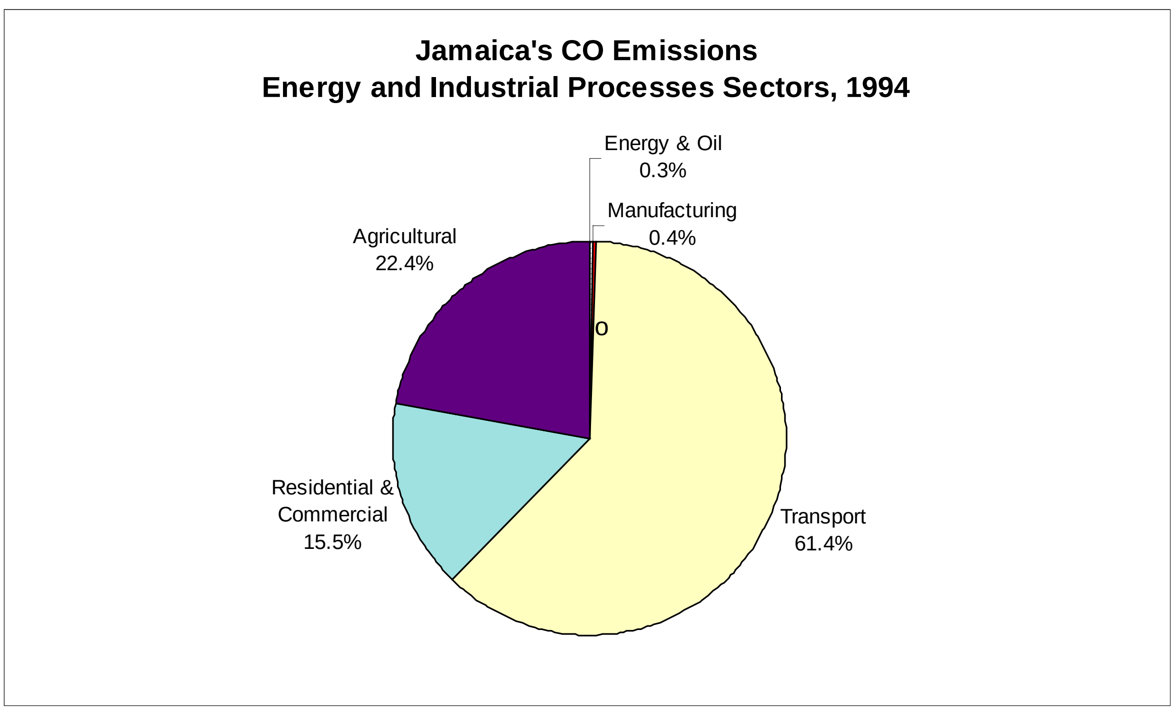


Figure 2.4 Jamaica's SO_2 Emissions (% Contribution by Each Sector) From Energy and Industrial Sectors, 1994

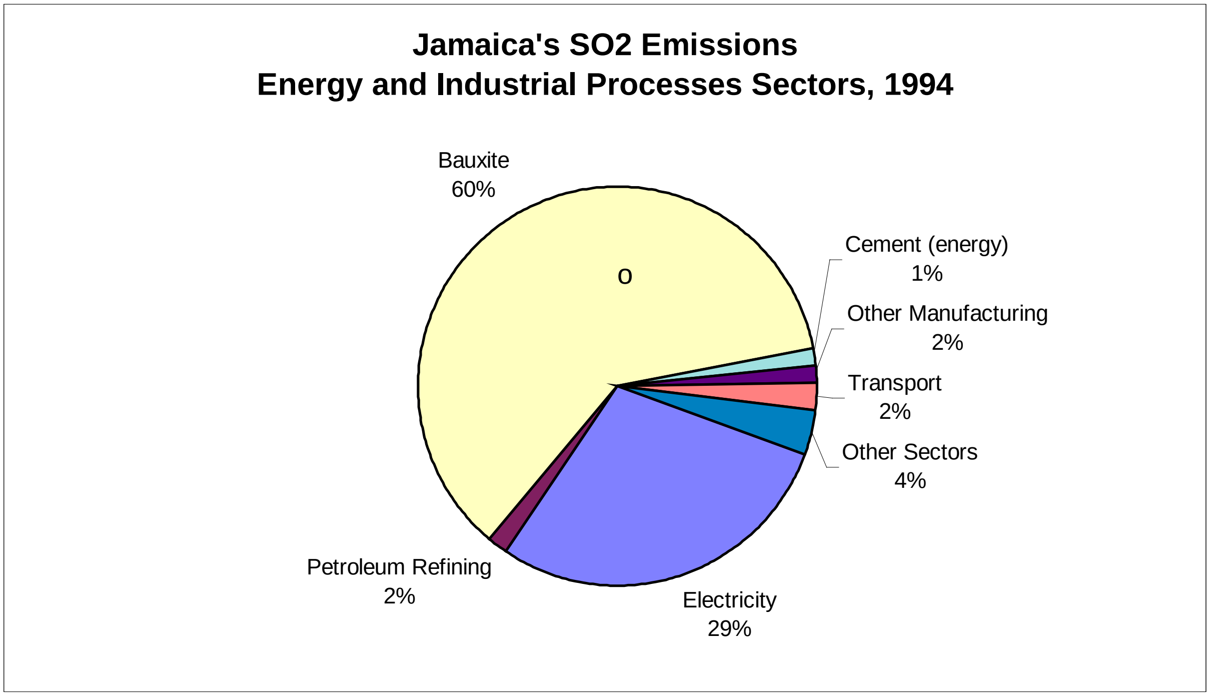


Table 2-3 Breakdown of GHG CO2 Emissions from the Energy Industries Category

Fuel	Consumption (bbl)		Emission Factor (TJ/bbl)	tC/TJ	CO_2 Emissions (Gg)		
	Refinery	JPSCo			Refinery	JPSCo	Sector Total
Heavy Fuel Oil	86,717	3,470,219	0.0060345	21.1	40.08	1,603.94	1,644.02
Diesel Oil	16,343	1,263,214	0.0058083	20.2	6.96	538.00	544.96
Kerosene	27,238	..	0.0057890	19.6	11.22	0.00	11.22
Refinery Gas (FOEB)	105,395	..	0.0060345	21.1	42.02	0.00	42.02
Propane (FOEB)	11,150	..	0.0060345	21.1	4.22	0.00	4.22
Lubricants (stored)	4,978	..	0.0056926	-20.0	..	-1.03	-1.03
Total	251,821	4,733,433	..	..	104.50	2,140.91	2,245.41

FOEB: Fuel Oil Equivalent Barrels

2.3.1 Electricity Generation

In 1994, the Jamaica Public Service Company (JPSCo) generated nearly all the electricity that was consumed by the ppublicly. Of the net generation the company purchased only 0.93%. It should be noted that the bauxite-alumina companies the Cement Company and others also generate electricity for their own use. The GHG emissions associated with the production of electricity by these industries are included in the industrial processes sector emissions. There is an increasing trend for public utilities to purchase electricity from independent power producers (IPPs) as well as from other industrial sources. Currently (2000) there are two main IPPs in Jamaica (Jamaica Private Power Company and Jamaica Energy Partners) but electricity is also purchased from cogeneration sources, which supply steam to industrial facilities. Ideally, the amount of CO_2 and other GHG emissions associated with the electricity sold to the public by such IPPs should be included in the energy sector, while the remainder of emissions used to provide steam should be attributed to the industrial sector. It will be difficult in the case of cogeneration and also from sales by the bauxite alumina industry to separate the emissions from these categories. For the IPPs, which only produce electricity that is ultimately sold to the public, their emissions can be included in the energy sector without any difficulty.

In 1994, the net generation and purchase of electricity for Jamaica was 2,324.3GW derived from steam, hydropower, diesel and gas turbines[i]. Steam units use heavy fuel oil and diesel is used in gas turbines. The fuel use for electricity generation in 1994 was 3.47 million barrels heavy fuel oil and 1.26 million barrels of diesel oil. Emissions from the electricity generation source category were 2,140.9 Gg (taking into account the amount stored in lubricants) which was 26.1% of the total CO_2 emissions from the energy and industrial processes sectors.

2.3.2 Petroleum Refining

Fuels used by the refinery in refining crude oil are included in the energy sector. The refinery used heavy fuel oil, refinery gas, kerosene, automotive diesel oil and propane in its operations. In 1994, the energy use by Petrojam amounted to 241,771 fuel oil equivalent barrels (FOEB)[ii] and resulted in emissions of 104.5 Gg of CO_2. The fuel used by the refinery were apparently not included in the annual energy reports and are additional amounts to what was reported in the Ministry of Public Utilities and Transport (MPUT) Annual Energy Reports[iii].

2.3.3 Manufacturing and Construction

Fuel combustion in this category of sources is dominated by the bauxite alumina industry that used 7.2 million of the 8.04 million barrels of heavy fuel oil consumed in the category in 1994. National heavy fuel oil use was 11.89 million barrels. Heavy fuel oil uses by the cement, and sugar industries accounted for most of the remaining heavy fuel oil use. Diesel oil (0.67 million barrels) was used by several industries including sugar, cement, and other manufacturing sources. It should be noted also that all of the gasoline used by industrial sources was assigned to on-road mobile sources.

In 1994, the total energy consumption by the manufacturing a category was 53,613 TJ and CO_2 emissions were 4,111 Gg or 50.2% of the total CO_2 emissions from the energy and industrial processes sectors.

2.3.4 Transport

The transportation sector includes emissions from aviation, marine and on-road and off-road mobile sources. Fuel use for the aviation and marine sources do not include fuel delivered to international bunkers. The CO_2 emissions in 1994 from the transportation sources were 1,257 Gg or 14.7% of the total CO_2 emissions from the energy and industrial processes sectors.

2.3.5 Aviation

Aviation emissions arise from the use of jet fuel and aviation gasoline and are generally broken down into emissions during landing and take-offs (LTOs) and cruising modes of operation. The LTO and cruising emission factors depend on the type of aircraft. Aviation emissions that are to be included in the IPCC inventory are those from international LTOs and domestic flights (LTO and cruising).

Since 1997, the LTO data at the two international airports, Norman Manley International Airport (NMIA) and Sangster International Airport (SIA) have been aggregated into international, domestic and general aviation movements. The LTOs from 1994 to 1999 at NMIA and SIA are shown in Table 2-3. Between 1994 and 1996 only the total LTOs were available so the estimates at these airports for these years were based on prorating the average data for 1997 to 1999. The numbers of movements by aircraft type are available only from hand written logs at each airport. Detailed calculations of LTO emissions were not feasible since a breakdown of aircraft movements by type of aircraft was not readily available.

Data for LTOs at airports other than at NMIA and SIA (see Table 2-4) are available for 1997 to 1999. These data show a rate of increase of between 15% and 17% and assuming a similar growth rate between 1994 and 1997, the LTOs for 1994 would be about 12,000.

Estimates of emissions during cruising modes for domestic flights require information on the routes flown between the local airports, the number of such flights, the types of aircraft used and the amount of fuel used. It should be noted that some international flights also make domestic trips between SIA and NMIA but not to any of the smaller airports.

The Jamaica Civil Aviation Authority provided data on the types of aircraft registered in Jamaica in 1996 (the closest year to 1994 for which data were readily available). The domestic fleet consisted mainly of aircrafts with jet engines. Air Jamaica the national carrier operated Airbus A300, Boeing 727s, two Lear Jets and three turboprops. The other local company, Trans Jamaica uses jet fuel, while a variety of smaller aircraft uses mainly aviation gasoline. Since no other data on the domestic fleet were available, the emissions from domestic flights were not broken down into those from LTO and cruising modes, but instead emissions were based on the total fuel sales for domestic aircraft. Hence, LTO emissions from domestic flights were not calculated.

Domestic sales of aviation fuels (jet fuel and aviation gasoline) are reported for locally registered airlines. In the case of jet fuel, the domestic sales in 1994 were 339,645 bbl most of which would have been to Air Jamaica which uses the bulk of such fuel on international flights. There are no readily available data on the amount of jet fuel used for domestic flights. An order of magnitude estimate of domestic jet fuel use is 15,000 bbl. This was based on in-flight jet fuel used for domestic flights between NMIA and SIA (e.g., five 25-minute flights/day for large jets and six 50-minute turboprop flights/day). It must be stressed that this is a very preliminary estimate and procedures need to be put in place to obtain fuel use and other data on domestic flights to obtain reliable estimates of domestic jet fuel use and hence emissions from domestic jet fuel use.

Estimates of aviation emissions were therefore based on domestic sales of aviation and jet fuel and average LTO emission factors for the international fleet and the international LTOs at NMIA and SIA. Estimates of GHG emissions for LTOs (international flights only) in 1994 are indicated in Table 2-6.

Table 2-4 Aircraft Movements at Norman Manley International and Sangster International Airports, 1994* to 1999

	International			Domestic	General Aviation		Total[1]
Year	Commercial Scheduled [b]	Commercial Unscheduled [b]	Total	Domestic Commercial	Military	Private	
1994	30,571	14,237	44,808	35,689	1,433	4,045	85,975
1995	31,080	7,077	38,157	35,220	1,414	3,992	78,784
1996	34,120	5,942	40,062	37,947	1,525	4,300	81,386
1997	35,468	7,056	42,524	34,238	1,880	4,713	88,456
1998	36,722	8,754	45,476	43,253	1,196	4,652	93,577
1999	36,820	7,209	44,029	50,420	2,154	5,676	102,279

1 Data from Airports Authority of Jamaica (March 2000) 1996 – 1999 and from Data from Statistical Abstract, 1996, Table 5.10, p 102 for 1994 and 1995.
b Data for 1994 – 1996 from Statistical Abstract, 1996, Table 5.10, p 102.
• Data for the Domestic Aviation and General Aviation movements for 1994 were estimated based on average data for 1997 through 1999.

Table 2-5 Aircraft movements Domestic Aerodromes, 1997 to 1999

Year	Tinson Pen	Negril	Boscobel	Ken Jones	Total
1997	2,473	7,963	3,006	3,346	18,785
1998	4,638	7,885	3,206	3,959	21,686
1999	4,620	10,664	4,068	4,060	25,411

Table 2-6 Emission Factors and Emissions from International Aircraft Landing and Take Off (LTO) Cycles in 1994

		Emissions						
	Fuel Consumption	CO_2	CH_4	N_2O	Nox	CO	NMVOC	SO_2 (a)
LTO average fleet (kg/LTO)	2,500	7,900	1.5	0.2	41	50	15	15
Fuel used (t)	112,020							
Emissions (b) (t)		353,983	67.21	8.96	1,837	2,240	672	336

From IPCC Workbook Vol. III, Table 1-52

(a) Sulphur content of jet fuel assumed to be 0.3%.
(b) 44,808 Landing and Take-Offs in 1994.

2.3.6 Mobile – On Road Sources

On-road sources in 1994 used gasoline (leaded and unleaded) and diesel fuels. Data for gasoline consumption were available for urban and rural retail and peddler users as well as for industrial, manufacturing and other users. All gasoline sales were assumed to be used for on-road transportation. This may represent an overestimate since a small amount of gasoline is expected to be used for marine transportation and off-road (e.g., agricultural and construction) use.

Consumption of automotive diesel based on sales to urban and rural retail and peddler users were assumed to be used for on road transportation sources while consumption by all other sources (JPSCo, bauxite-alumina, sugar, cement, other manufacturing, government and other)[iv] was assumed to be used for stationary fuel combustion. Some of the fuel supplied to these categories will be used for off-road mobile sources (mining, agriculture, and construction) but data for such use by these sectors are not available. The amounts are expected to be small relative to that used for fuel combustion. Based on the above allocations, estimates of fuel used by the domestic transportation category are indicated in Table 2-7.

Table 2-7: Fuel Use (bbl) by Domestic Transportation, 1994

	Gasoline	Jet Fuel	Diesel	Lubricants	Heavy Fuel Oil	Total
Road	2,409,387	..	807,309	17,962	..	3,234,658
Aviation	5,380	15,000	..	110	..	345,135
Marine	..	..	42,708	158	49,873	92,739
Rail	..	..	..	235	..	235
Total	2,414,767	15,000	850,017	18,465	49,873	3,672,767

Source MPUT Annual Energy Report

Estimates of on-road emissions were made based on total sales of each type of fuel and the corresponding gross emission factors. Estimates for NOx, VOC and CO in 1994 were also made for each of seven vehicle classes based on previous estimates[v] of on road emissions made for 1993 using a version of the U.S. EPA MOBILE 5 model that was adapted for Jamaican conditions.

Table 2-8 shows the fleet size, annual vehicle kilometres travelled (Vkmt), fuel economy and estimated emissions for CO, NOx and VOC for 1994. The fleet size for 1994 was assumed to be the estimates for 1993 scaled by the ratio of the vehicle population in 1994 over that in 1993.

The fuel economy data together with the Vkmt and the fleet size provide an “independent” method to estimate fuel use. Fuel economy for the U.S. fleet of cars and light trucks[vi] between 1978 and 1994 ranged from 20.1 to 26.2 miles per gallon or 11.7 to 8.98 L/100 km. These data refer to the U.S. fleet with emission control technology that would include sales of vehicles with technology that was current for each year.

Leaded gasoline was the only fuel used in Jamaica until 1990 when unleaded gasoline was first introduced. In 1994, sales of unleaded gasoline were approximately 30% of the market but the benefit from using such fuel would apply only to new vehicles or used imports that had never previously used leaded gasoline.

Between 1993 and 1994, imports of passenger vehicles were about 32,000 units and imports of commercial vehicles, some of which would have been diesel units, were 15,170 units[8]. All imports had to be less than 7 model years old and so would have been equipped with emission controls (three way catalysts) that included technologies that did not include the same proportion of current year technologies as say the U.S. fleet. The fuel economy for vehicles with these types of technologies is expected to be in the range 11.8 to 12.5 L/100 km. More appropriate estimates of fuel economy for the Jamaican fleet are those shown in Table 2-7 obtained from the IPCC Reference Manual. The fuel economy data were assumed to be for vehicles with three-way catalysts except for light duty gasoline vehicles where the assumed fuel economy for early oxidation catalyst equipped vehicles was used.

The estimates of fuel consumption based on fleet size, Vkmt and fuel economy compare favourably with the actual consumption estimates from MPUT Annual Energy Report. The estimates for gasoline vehicles agree to within 12%. The estimate for diesel use based on the fleet and the fuel consumption rate is about 2.5 times higher than that based on diesel fuel consumption. It is likely that the diesel fuel consumption is low since some of the diesel fuel used by industry may in fact be used for on-road vehicles. Recall that only urban and rural retail and peddler diesel fuel sales were assumed to be used for on-road vehicles while the sales of diesel fuel to industry was assumed to be used for fuel combustion. This is certainly the case only for JPSCo where diesel fuel is used in gas turbines for electricity generation and the MPUT sales data are the same as those reported by JPSCo. The automotive diesel oil (ADO) used by the remaining sources is 738,000 bbl and an upper limit for on-road diesel use would therefore be 1,545,000 bbl which would still be less than the 2,000,000 bbl estimated from fleet size, Vkmt and fuel economy. A more detailed breakdown of diesel fuel end-use for the transportation category as well as reliable fuel economy data is required to resolve this uncertainty.

The MOBILE5 model does not provide estimates of CO_2, methane (CH_4) and nitrous oxide (N_2O). Emission factors (in g/L) for these gases and the fuel use for each vehicle class were used to estimate the emissions. Data are shown in Tables 2-9 (emissions in Gg) and 2-10(emission factors). It should be noted that the detailed emissions from on-road mobile sources in Table 2-9 are in Gg while those in the Table 2-2 is in Tg.

Table 2-8: Estimates of CO, NOx and VOC Emissions and Fuel Consumption from On-Road Mobile Sources

	Mobile 5J Input						GHG Inventory Input		
Vehicle Category	Population	Vkmt	Fuel Economy (L/100 km)	CO (tonnes)	NOx (tonnes)	VOC (tonnes)	Gasoline (bbl)	Diesel (bbl)	Fuel Economy (L/100 km)
LDGV	119,779	20,080	12.5	45,427	2,912	6,393	1,891,117	..	11.76
LDDV	612	20,080	10.4	12	13	6		8,039	11.76
LDGT1	28,722	35,398	13.1	19,376	1,249	2,609	835,839	..	13.07
LDDT	14,273	35,398	13.9	547	590	306		441,737	10.69
LDGT2	398	35,398	16.7	352	21	51	14,810	..	13.07
HDGV	59	40,161	43.5	172	9	18	6,524	..	29.41
HDDV	10,211	57,924	41.7	3,979	7,297	1,059		1,551,407	39.21
MC	10,612	5,519	11.2	745	31	210	41,258	..	3.56
Total (1994)	184,666	..	..	70,610	12,122	10,652	2,789,548	2,001,183	..
						..	..	..	..
Total from MPUT	..	..	..	..	..	..	2,409,387	807,309	..

Source C. Davis & Associates

LDGV – Light duty gasoline vehicles
LDDV – Light duty diesel vehicles
LDGT1 – Light duty gasoline trucks <6,500 kg gross vehicle weight
LDDT – Light duty diesel trucks
LDGT2 – Light duty gasoline trucks 6,500 – 8,500 kg
HDGV – Heavy-duty gasoline vehicles
HDDV – Heavy-duty diesel vehicles
MC - Motorcycles

Table 2-9: Greenhouse Gas Emissions (Mg) From On-Road Mobile Sources in Jamaica, 1994

Vehicle Category	CO (Mg)	NOx (Mg)	VOC (Mg)	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)
LDGV	45,427	2,912	6,393	588.4	83.1	150.6
LDDV	12	13	6	1.4	0.0	0.1
LDGT1	19,376	1,249	2,609	260.1	47.1	114.8
LDDT	547	590	306	75.9	2.0	2.8
LDGT2	352	21	51	4.6	0.8	2.0
HDGV	172	9	18	2.0	0.2	0.9
HDDV	3,979	7,297	1,059	266.6	12.9	9.9
MC	745	31	210	12.8	7.9	0.3
Total	70,610	12,121	10,652	1211.8	154.0	281.4

Table 2-10: Emission Factors for On-Road Mobile Sources

	g/L	g/L	g/L
	CO_2	CH_4	N_2O
LDGV	2.266	0.32	0.58
LDDV	2.679	0.07	0.10
LDGT	2.266	0.41	1.00
LDDT	2.679	0.07	0.10
LDGT	2.266	0.41	1.00
HDGV	2.266	0.17	1.00
HDDV	2.679	0.13	0.10
MC	2.266	1.40	0.046

Source C. Davis & Associates

LDGV – Light duty gasoline vehicles
LDDV – Light duty diesel vehicles
LDGT1 – Light duty gasoline trucks <6,500 kg gross vehicle weight
LDDT – Light duty diesel trucks
LDGT2 – Light duty gasoline trucks 6,500 – 8,500 kg
HDGV – Heavy-duty gasoline vehicles
HDDV – Heavy-duty diesel vehicles
MC - Motorcycles

2.3.7 Marine Emissions

Fuel sales of marine diesel oil, heavy fuel oil and lubricants to marine transportation sources (domestic trips only) were identified in the 1994 MPUT annual Energy Report. These fuel consumption data together with appropriate IPCC emission factors were used as the basis for estimating emissions in 1994 from marine sources. These estimates are shown in Table 2-11.

Table 2-11: CO_2 Emissions From Marine Sources in Jamaica, 1994

	Consumption (bbl)	Conversion Factor (TJ/bbl)	Carbon Emission Factor	CO_2 (Gg)
Gas/Diesel Oil	42,708	0.0058083	20.2	18.19
Heavy fuel oil	49,873	0.0060345	21.1	23.05
Lubricants	158	0.0056926	-20.0	-0.03

Source C. Davis & Associates

2.3.8 Other Sectors

The sources included in this category are commercial, institutional, residential, government and other (not elsewhere specified) sources. Some of the diesel oil used is attributed to the government and "Other" categories as reported in the Annual Energy Reports. It is likely to include small amounts used for marine transportation and off road uses such as for agriculture and construction. However, the data collection procedures do not allow such uses to be separated.

Note that "Other" in the context of the Annual Energy Reports includes the commercial, institutional, residential, and other (not elsewhere specified) categories as defined in the IPCC workbooks.

The fuel used by the residential category includes kerosene and liquefied petroleum gas (LPG) as well as biomass (charcoal and wood). Only the GHG emissions from kerosene and LPG uses are included in the residential emissions (see Table 2-2).

2.3.9 Fugitive Emissions

Fugitive emissions of greenhouse gases from coal mining and handling, oil and natural gas activities are included in this category. The only activities in Jamaica that contribute to fugitive GHG emissions are refining and storage of crude oil since there are no coal mining or handling or oil and natural gas industries. The fugitive emissions of methane (CH_4) from petroleum refining were estimated based on the Tier 1 approach using the mid–range of the IPCC emission factors for crude oil refining and storage for the rest of the world countries.

2.4 INDUSTRIAL PROCESSES

Industrial processes that chemically transform materials have the potential for releasing greenhouse gases. In Jamaica, the transformation of limestone in the production of lime and cement are the major industrial processes that release GHGs. It should be noted that in Jamaica large amounts of limestone are used in a variety of industries such as marl use in road construction, marble industries and whiting production but these uses do not entail chemical transformation of limestone to release carbon dioxide. Other industries that produce GHGs (non-methane hydrocarbons (NMHC)) are the production of alcoholic beverages (beer, wine, and alcohol).

Lime used in the alumina industry is manufactured locally in kilns at alumina plants or imported. The Jamaica Bauxite Institute (JBI) tracks total use of lime by the bauxite-alumina industry. Lime use by the bauxite alumina industry in Jamaica averages 6.2% of alumina production or about 200,000 tonnes lime annually. In contrast, 3.32 million tonnes limestone and 3.81 million tonnes of marl and fill were produced in 1994.[vii]

CO_2 emissions from the cement industry, which uses limestone in the cement process, were the other significant source in the industrial sector.

Total CO_2 emissions from the industrial processes sector in 1994 were 163.34 Gg of which 153.37.Gg were from the lime industry and 9.97 Gg from the cement industry.

Emissions of SO_2 from the lime and cement industries were assumed to be zero since in both cases, flue gases come into contact with lime which absorbs SO_2 into the product. It is anticipated that measurements to determine the precise nature of the amounts in any SO_2 released from kilns (lime, cement and alumina) for Jamaican conditions will be required as part of the proposed air quality regulations for Jamaica.

Other industrial processes for which GHG emissions were estimated were for the glass manufacturing, sulphuric acid manufacture and the beverage and food industries. The emission factor for SO_2 emissions from sulphuric acid manufacture[viii] was assumed to be 13-kg/Mg product assuming 98% conversion efficiency for SO_2 to SO_3.

Production data for sulphuric acid were from the Economic and Social Survey Jamaica, 1994 Page 102.

Emission factors for release of NMVOC from the beverage and food categories under conditions that apply in Jamaican industries are not available and the emission factors used may not be appropriate for Jamaican conditions.

Estimates of emissions from road paving and roofing using asphalt were not estimated at the same level of detail as other industrial source categories. The emissions are however included in the reference approach since data on use of asphalt by road making and roofing are not readily available.

2.5 LAND USE CHANGE AND FORESTRY

The total change in the Forest Land use classes over the period 1989 to 1998 shows a decrease of 3,063.6 ha or -0.91%. The rate of decrease for the same period is approximately 0.1% per annum.

For non-forestland use changes, the largest increases have been in the areas that are mined for bauxite, which shows an overall increase of 4,989.6 ha.

Table 2-12: LAND USE / COVER CHANGE IN JAMAICA [1989 – 1998]

LANDUSE		1989	1998	Difference	Lost/gain (%)
Forestland use/cover (> 75%)					
BB	(Bamboo)	2791.20	2979.41	188.21	6.74
MG	(Mangrove)	9751.46	9731.37	-20.09	-0.21
PF	(Closed Broadleaf)	88716.63	88230.54	-486.09	-0.55
SF	(Disturbed Broadleaf)	177254.01	174724.64	-2529.37	-1.43
SL	(Short Open Dry)	12083.37	12104.02	20.65	0.17
SW	(Swamp)	2357.51	2247.03	-110.48	-4.69
WL	(Tall Open Dry)	42124.98	41998.54	-126.44	-0.30
	Sub-total	**335079.17**	**332015.55**	**-3063.62**	**-0.91**
Mixed land use/cover (first class > 50%, second class > 25%)					
BC	(Bamboo and Fields)	29818.44	29155.59	-662.84	-2.22
BF	(Bamboo and Disturbed broadleaf)	12311.14	12687.17	376.03	3.05
BS	(Bauxite and Disturbed broadleaf)	1590.46	2851.38	1260.92	79.28
CS	(Fields and Disturbed broadleaf)	118897.77	117966.13	-931.64	-0.78
PP	(Pine Plantations / Other)	8856.22	8186.94	-669.28	-7.56
SC	(Disturbed broadleaf and Fields)	166837.72	165953.86	-883.87	-0.53
	Sub-total	**338311.75**	**336801.08**	**-1510.68**	**-0.45**
Non-forest land use/cover					
BA	(Buildings / Other infrastructure)	51909.59	52259.78	350.20	0.67
BE	(Bauxite)	1193.29	4921.94	3728.66	312.47
BR	(Bare rock)	866.98	933.88	66.90	7.72
FC	(Fields)	273176.05	274478.64	1302.59	0.48
HW	(Herbaceous wetland)	10914.08	10914.08	0.00	0.00
PC	(Plantations)	83145.25	82341.34	-803.91	-0.97
WA	(Water)	1656.17	1586.03	-70.14	-4.23
	(Small Islands)	164.00	164.00	0.00	0.00
	Sub-total	**423025.41**	**427599.70**	**4574.29**	**1.08**
	TOTAL	**1096416.33**	**1096416.33**		

Source Forestry Department

2.6 AGRICULTURE

2.6.1 Introduction

Greenhouse gases as they relate to agricultural activities, is the emission of methane (CH_4), Nitrous Oxide (N_2O), Carbon Dioxide (CO_2), Carbon Monoxide (CO) and other oxides of nitrogen (NO_x). In the Jamaican context the measurement of these gases is not a common practice.

The main areas of concern are:

- Domestic Livestock
  Enteric fermentation
  Manure management
- Rice conversion: Flooded rice fields
- Prescribed burning of savannas
- Field burning of agriculture residues
- Agricultural soils

2.6.2 Domestic Livestock

The domestic livestock sub-module looks at the nitrous oxide content of both the enteric fermentation and manure management for the following animals: dairy, non-dairy, poultry, sheep, pigs, goats, horses, mules and donkeys.

2.6.3 Enteric Fermentation

For methane emission from domestic livestock enteric fermentation, the emission factor that is consistent with the Asian situation was selected, for dairy and non-dairy animals. Jamaica is characterized by small-commercialized dairy farms; many cattle are multi-purpose, providing meat and milk.

Table 2-13: Methane emissions from Enteric Fermentation

Livestock Type	Number of Animals ('000)	Emissions from Enteric Fermentation (t/yr.)
Dairy Cattle	387	21,672.00
Non-dairy Cattle	244	10,736.00
Buffalo	0	0.00
Sheep	5	25.00
Goats	284	1,420.00
Camels	0	0.00
Horses	2	36.00
Mules & Asses	10	100.00
Swine	132	132.00
Poultry	8366	1,673.20
Totals		35,794.20

Compiled from Data supplied by the Ministry of Agriculture

2.6.4 Manure Management

In Jamaica manure management is not a well-defined and organized practice by farmers. Even if this is carried out to some extent records are not usually kept. Most of the prescribed waste management systems are practiced to some extent. The liquid system was not represented among all the categories of animals stipulated. For the purposes of the assignment the following assumptions were made:

- In the case of dairy, farmers with 20 or more heads of milking animals would have practiced anaerobic waste management system.
- Besides poultry, a given group of animals may have spent some time in more than one waste management systems on a particular day hence the ad hoc representations of numbers of animals by waste management
- Emission factors were chosen on the basis of the Asian and Far East system.
- The solid storage and dry lot system are used in an ad hoc manner in Jamaica, depending on the particular type of farming system used by the farmer.
- However, the factors used are consistent with those of the IPCC.
- The Nitrous Oxide emission factor was chosen based on those used for Asia and Far East.

Table 2-14: Nitrous Oxide Emission from Animal Waste Management Systems

Animal Waste Management System (AWMS)	Nitrogen Excretion (Kg N/yr.)	Total Annual Emissions of N_2O (Gg)
Anaerobic lagoons	262.92	0.00
Liquid systems	96.34	0.00
Daily spread	312,439,576.00	
Solid storage & dry lot	1,368,695,640.00	4,301.61
Pasture range and paddock	48,411.60	
Other	0.00	0.00
Total	1,681,183,986.86	4,301.61

2.6.5 Rice Conservation: Flooded Rice Fields

In order to do some justice to the rice conversion sub-module, sugar cane production was considered in place of rice, since rice cultivation is virtually absent in Jamaica. In 1994, approximately 17,056 hectares of sugarcane produced in Jamaica were irrigated under the intermittent flooded system. During that same period 3,722 hectares of the area under rain-fed conditions were considered flood prone while 23,146 hectare were drought prone .

In Jamaica, the type of irrigation system used for sugarcane is the intermittently flooded, with multiple aeration. Sugarcane plantations also rely heavily on rainfall. Since much of the sugarcane lands are flood and drought prone the scaling factors were used.

2.6.6 Prescribed Burning of Savannas

Based on the IPCC definition, prescribed burning of savannas was not considered relevant to the Jamaican situation, as there is no such expanse of land on the Island.

2.6.7 Field Burning of Agricultural Residues

In Jamaica, field burning of agriculture residue is not a common practice. Where some amount of burning is done there is no recording of relevant data. Only sugarcane is readily identified with such a practice.

2.6.8 Agricultural Soils

Agricultural soils play an important role in green house gas emission especially because they emit or remove nitrous oxide (N_2O), carbon dioxide (CO_2) and/or methane (CH_4). In calculating Jamaica's national emissions of N_2O and other greenhouse gasses the IPCC emission factors were used.

2.6.9 Synthetic Fertilizer

Synthetic fertilizer is an important source of N_2O. In order to determine the amount of these fertilizers used in Jamaica, data from Antilles Chemicals, the company responsible for the importation of fertilizers in the island and the national agricultural census (1996) were used.

2.6.10 Animal Waste

For the purposes of the exercise, emission form manure applied to agricultural soils from stables (e.g., daily spreading) and from grazing animals (pasture range and paddock) is considered to be emissions from agricultural soils.

It must be noted however that available data are extremely limited due a lack of proper record keeping.

2.6.11 Crop Residue

Crop production data, inclusive of legumes and non-legumes were obtained from the Ministry of Agriculture data bank and the local 1996 agricultural census.

2.6.12 Areas of Cultivated Organic Soils

In Jamaica approximately 308 hectares of organic soils are recorded. Of this amount 60% (185 hectares) is assumed to be in cultivation. Emission levels are negligible.

2.7 WASTE MANAGEMENT

Methane is one the main contributors to global warming. In this sector of analysis emissions from waste was analyzed. For 1990 the net annual methane emissions from solid waste from landfills in Jamaica 10.75 $GgCH_4$.

For 1994 the net annual CH4 emissions were calculated to be 14.5 $GgCH_4$.

With regard to domestic and commercial wastewater, the methane emissions are as follows:

- 1990: - 7.82 x 10^{-8} $GgCH_{4,}$
- 1994: - 2.96 x 10^{-8} $GgCH_4$.

Methane emissions from industrial waters in 1994 were 1.7 x 10^{-3} $GgCH_{4.}$

With regard to nitrous oxide emissions from human sewage, the amount in 1990 was

0.14 Gg N_2O/yr and in 1001 0.15 Gg N_2O/yr.

Table 2-15: 1994 Estimation of Methane Emissions from Domestic/Commercial Wastewater and Sludge

	Total Organic Product (kgBOD/yr) A	Emission Factor (kgCH4/kgBOD) B	Methane emissions Without recovery C=(AXB)	Methane recovered or flared (kgCH4) D	Net Methane Emissions (GgCH4) E=(C-D) X 10^{-6}
Wastewater	1.48	0.02	0.0296	0	2.96E-08
Sludge	..	..	..	..	..

Table 2-16: Estimation of Methane Emissions from Industrial Wastewater and sludge

	Total Organic Product (kgBOD/yr.) A	Emission Factor (kgCH4/kgBOD) B	Methane emissions Without recovery C=(AXB)	Methane recovered or flared (kgCH4) D	Net Methane Emissions (GgCH4) E=(C-D) X 10^{-6}
Wastewater	37534.67	0.045	1689.06015	0	1.69E-03
Sludge	..	..	..	..	..

Table 2-17: 1994 Indirect Nitrous Oxide Emissions from Human Sewage

Per capita protein consumption kg/person/yr. A	Population B	Fraction of nitrogen in protein kg N/kg protein C	Emission Factor N/kg sewage-N produced D	Total Annual N2O emissions Gg N2O /yr. E
Aerobic	0.20	0.90	0.18	0.25

Table 2-18: 1994 Methane Emissions

Total annual MSW at SWDS (Gg MSW) A	202.51
MCF B	0.77
Fraction of DOC in MSW C	0.18
Fraction of DOC actually degraded D	0.77
Fraction of Carbon as CH4 E	0.5
Conversion Ratio F	1.33
Potential CH4 generation Rate (Gg CH4/Gg MSW) G = CXDXEXF	0.09
Country CH4 generation Rate (Gg CH4/Gg MSW) H = BXG	0.07
Gross Annual CH4 generation (Gg CH4) J = HXA	14.50
Recovered CH4 per year (Gg CH4) K	0
Net Annual CH4 generation (Gg CH4) L = J – K	14.50
1 minus CH4 oxidation correction factor M	1
Net annual CH4 emissions (Gg CH4) N = L X M	14.50

2.7.1 Data for solid waste disposal sites

Population statistics - Population data for urban areas were used as solid waste collection has traditionally occurred in the urban centres.

Population censuses for Jamaica were based on STATIN data (Demographics statistics 1998).

Estimated 1990 urban population - 1,132,560

Estimated 1994 urban population - 1,182,992

Waste Statistics - Information on Jamaica's per capita generation rate for Municipal Solid Waste (MSW) in 1994 was estimated from data obtained from the Norconsult Comprehensive Solid Waste Management Study National Waste Management Plan, Volume 1 Summary Report April 1997, the Parks and Markets companies responsible for solid waste management operations in Jamaica and supported by independent calculations based on 1994 population estimates and the estimated municipal solid waste generation rate.

2.8 DATA UNCERTAINTIES AND GAPS

2.8.1 Energy and Industrial Processes

Compilation of emission inventories requires activity and emission factor data. The majority of the activity data for the energy and industrial processes sectors are fuel use/consumption. These data are routinely collected and published on an annual basis by MPUT. Some of the fuel use data are also reported in annual "Statistical Abstracts" and "Social and Economic Survey of Jamaica" publications. The MPUT publications provide most of the required detail but additional segregation for some sectors (some of which is also available from MPUT) would allow for more accurate sectoral estimates.

With regards to data uncertainties and gaps in respect to the Transportation Sector, the relevant Ministry is in the process of establishing a transportation Statistical Unit which will collect, monitor and evaluate data from the affiliated agencies of the Ministry with a view of providing timely and relevant information for planning and decision making.

2.8.2 Emission Factors

The GHG emission factors for most petroleum products are well documented. However, literature emission factors for alcoholic beverages (rum, beer, stout) and biomass (charcoal, wood) are not based on local products and conditions and more appropriate factors are needed.

2.8.3 Land-Use Change and Forests

2.8.3.1 Estimating and Monitoring Deforestation rates

A retroactive analysis from old satellite imagery using the same classification scheme applied in the 1998 forest cover assessment has shed some light on current deforestation rates. What is required is more information to be gathered in a timely and systematic manner to allow for evaluation and monitoring on a regular basis. Additional equipment will be necessary to build on the support being received.

An expanded database that includes new information such as fuel wood and yam stick use will support governmental efforts to formulate appropriate policies based on criteria and indicators of Sustainable Forest Management (SFM).

2.8.3.2 Fuel wood and Charcoal

- It is undisputed that fuel wood and charcoal production is presently the largest user of forest biomass, but sufficient technical, social and economic information on which to base planning and investment decisions is lacking.

- There are also gaps with respect to information on the biomass as a whole. Whereas the focus of the Forestry Department is mainly on the stem and volumes, future GHG inventories will require more and more data on both the aerial and the underground parts of the tree. This will require additional equipment and training if the department is to be in a position to respond positively to the new challenge.

- If non-forest trees are to play an increasing environmental role, there is a need for estimation systems to be developed and staff trained to undertake this work on a regular, continuing basis.

2.8.3.4 Frequency of Fire Risks

Records showing the frequency and extent of fires in forest areas were not available.

2.8.4 Agriculture

The following were identified as possible causes for data gaps and uncertainties:

- Census data does not include information required in the IPCC guidelines
- Farmers and Agricultural administrators are not informed on Greenhouse Gas (GHG) emissions, and their effects on the environment.
- In case of direct interviews for data collection, most farmers have not been informed about GHG or that the period 1994 is too long past.
- IPCC tables for emission factors, default factors etc. are for regions that vary significantly from Jamaica and the Caribbean region in general.

2.8.5 Waste Management

2.8.5.1 Reliability of data

Historically data on solid waste generation, collection and disposal has been limited. Most studies focused on the metropolitan area of Kingston and St. Andrew. The most recent, comprehensive study to date is one conducted under the Jamaica Solid Waste Management Programme and this data was used, as it is the most reliable data representative of 1994.

Data with regard to the depth of the disposal sites would not be significantly different from the 1994 data and the level of management of the disposal sites has remained consistent for the past 10 years.

Data on the generation rate, fraction of waste and the composition of the waste taken to disposal sites for Kingston and St. Andrew (60% of island’s total) were obtained from the study.

As there was no census done in the base year of interest, the population growth projection of 1% per annum was used to estimate the 1990 and 1994 urban populations.

2.8.5.2 Improvements required

The collection of data needs to become a routine part of the day-to-day management of solid waste. The Ministry of Local Government Youth and Community Development, with some financial assistance from the Inter American Development Bank (IDB) is currently implementing the National Solid Waste Management Programme. This programme intends to establish new solid waste management systems. The waste disposal sites are to be upgraded and rationalised to a system of regional landfills. These landfills will be equipped with scales so that the amount of waste disposed of at landfill sites will be recorded.

The Riverton City waste disposal site that receives sixty percent (60%) of the island's waste is to be upgraded to a landfill during 1999 -2000 and methane gas collection pipes will be installed to flare methane generated from the site.

A National Solid Waste Management Authority will also be established and it will assume a management and regulatory role for operations in the solid waste sector. This Authority will be responsible for planning and zoning and will be the repository for all solid waste data in the country.

In the interim it is recommended that a waste disposal site manager be stationed at each disposal facility, the number of trucks, an estimate of the quantity of waste (full or half-full etc.) and the type of waste be recorded on a daily basis.

PART III

VULNERABILITY

AND

ADAPTATION

3.1 Introduction

The vulnerability and adaptation chapter is partially based on the IPCC technical guidelines as appropriate for Jamaica. The key sectors of agriculture, water resources and the coastal zone were examined. This was achieved through a review of available documents for the sector, interviews and consultations with relevant government agencies, non-governmental organizations (NGOs) and representatives of the private sector. Information obtained through this process included: expert opinion, anecdotal evidence, and quantitative and statistical data.

Generally, available quantitative data was not in a form that allowed a specific quantitative analysis on the effect of climate change on the given issue of concern. However, quantitative data together with expert opinion and anecdotal evidence allowed for a qualitative assessment of climate change on the sector and, specifically, the areas most vulnerable to climate change.

Proposed adaptation measures have been identified and take into account current practices with an emphasis on an integrated approach. Further, the proposed adaptation measures reinforce the principle, that policies and programs that support sustainable development and overall integrated environmental management will be beneficial to the social and economic well being of Jamaica, even if climate change and sea level rise does not occur.

3.1.2 Climate scenarios

Global change is defined as alterations in climate, land productivity, oceans and other water resources, atmospheric chemistry or ecological systems, including global warming which are significant enough to influence the future hospitality of the Earth. Whether such changes are caused by natural cycles or by human activity or a combination of both is not fully understood.

Forecasts of global climate change are typically projected with general circulation models (GCM's) using mathematical calculations and relationships. Their outputs should only be considered as possible scenarios for future climatic change rather than predications. The climate scenario is intended to be an internally consistent picture of possible future climatic conditions. In assessing the outputs of the GCM model analysts must recognize their limitations. One of the most significant for the Caribbean is the fact that the spatial resolution is too coarse for most impact studies. Most GCM studies consider only the equilibrium response to double or quadruple concentration of carbon dioxide. Orography is highly smoothed and small-scale weather systems are non-existent in the models.

The Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) was used for the vulnerability analysis for Jamaica with six climate scenarios reviewed. These are:

- IS92a,
- IS92c,
- IS92e,
- IS92f,
- Kyoto-Con 1,
- SRESA2 (still to be approved by IPCC).

Scengen a global and regional climate scenario generator, using global circulation models was also used for the determination regional climate change scenarios. It must be noted however that the baseline data are available on a 5-degree longitude/latitude grid and for some areas no baseline climate data seem to be available in particular the grid cell in which Jamaica is located.

3.1.3 Sea Level Rise and Temperature

Global sea level trends based on tidal gauges over the past century have been calculated to be 1.8 mm per year[7]. Some of the rise may be due to thermal expansion of the upper layers of the ocean resulting from global warming (0.4 – 0.5 mm per year) and from the retreat of alpine glaciers and small ice caps (0.2 – 0.7 mm per year). Over the past 60 years in the Caribbean a wide range of sea level changes have been experienced because of tectonic instability.

It has been estimated that sea level raised an average of 2.4 mm per year between 1940 and 1970.[8] In some areas a 3.6-mm per year relative rise is indicated while many regions show falls. Recent regional estimates from tide gauges indicate a relative sea level for parts of the Caribbean will be 15 – 20 cm greater than the world wide average because of natural subsidence and subsidence due to petroleum extraction, groundwater pumping, and sediment compaction.[9]

Because of the large spatial variability found in the contemporary tide gauge data, with Jamaica having had only two installed in the past year, a regional value for sea level rise in the Greater Caribbean must be viewed with caution. However, based on global projections and studies in other regions, sea level rise of 30 – 55 cm for the region over the next 50 years is a reasonable assumption. Such a sea level rise would pose serious problems for low coastal areas of Jamaica.

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[7] Journal of Coastal Research, Special Issue No 24 1997
[8] Aubrey DG Emery Ko and Uchupi E 1988 changing Coastal Levels of South America and the Caribbean Region from Tide Gauge Records
[9] Gable F 1987 Changing Climates and Caribbean Coastlines

Large populations are situated mainly on the coastal lowlands and estuarine areas and for whom lowland agriculture, fisheries and tourism are paramount economic sectors

Using MAGICC and Scengen the following scenarios were generated for temperature and sea level rise:

Table 3-1: Projected Scenarios for Sea Level Rise and Temperature

	2025	2050	2100
Temperature Change (º C)	0.70 - 0.79	1.13 - 1.57	1.80 - 3.64
Sea Level Rise (cm)	18	30 - 34	58 - 84

3.1.4 Rainfall Projections

Projected rainfall varies from model to model and thus it is quite difficult to establish a clear projection for rainfall. Utilizing the global scenario created by Scengen, and the HadCM2 GCM and the UIUC-EQ GCM for SO4 patterns for generating spatial patterns, the values below were generated for 2050 only for Jamaica.

It must be noted here that the coarse resolution of the models causes a major problem. Jamaica is located in the grid cell 15-degree north - 20-degree north and 75 degrees West- 80-degree's West. No baseline data were established for this grid. The closest grid with baseline data was 20 degree North - 25 degrees North and 75 degrees West - 80 degrees West to the north of Jamaica This highlights the need for a GCM or regional model on the scale of small island states.

Table 3-2: Regional Temperature Scenario for grid 20 – 25 N/80-75W using HadCm2/UIUC for SO_2 for 2050

	Baseline	IS92a	IS92c	IS92e	IS92f	Kyoto-Con1	SRESA2 (Preliminary)
	Temperature	Temperature Changes					
	Degree Celsius	Degree Celsius	Degree Celsius	Degree Celsius	Degree Celsius	Degree Celsius	Degree Celsius
January	22.8	0.6	0.7	0.5	0.6	0.5	0.8
February	22.7	0.8	0.7	0.8	0.8	0.7	1.0
March	23.5	0.9	0.8	0.9	0.9	0.8	1.1
April	24.5	1.0	0.9	1.0	1.1	1.0	1.2
May	25.7	1.2	1.0	1.2	1.2	1.1	1.4
June	27.0	1.5	1.2	1.6	1.6	1.4	1.7
July	27.7	1.5	1.3	1.6	1.7	1.4	1.8
August	27.7	1.4	1.2	1.5	1.5	1.3	1.7
September	27.6	1.4	1.2	1.5	1.5	1.3	1.7
October	26.7	1.2	1.1	1.3	1.3	1.2	1.6
November	25.0	1.1	1.1	1.1	1.2	1.1	1.5
December	23.2	0.8	0.8	0.8	0.9	0.8	1.1

Table 3-3: Regional Precipitation Scenario for grid 20 – 25 N/80-75W using HadCm2/UIUC for SO_2 for 2050

	Baseline	IS92a	IS92c	IS92e	IS92f	Kyoto-Con 1	SRESA2 (Preliminary)
	Precipitation	Precipitation change	Precipitation change	Precipitation change	Precipitation change	Precipitation change	Precipitation change
	Mm/day	mm/day	Mm/day	mm/day	Mm/day	Mm/day	Mm/day
Jan	1.3	+0.1	+0.1	+0.1	+0.1	+0.1	+0.1
Feb	1.5	-0.1	0	-0.1	-0.1	-0.1	-0.1
Mar	1.6	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2
Apr	2.5	-0.2	0	+0.3	+0.2	+0.2	+0.1
May	5.7	-0.7	-0.4	-0.9	-0.8	-0.7	-0.6
June	6.1	-1.1	-0.7	0	-0.2	-0.3	-0.7
July	4.1	-0.8	-0.5	-0.4	-0.5	-0.4	-0.7
Aug	4.9	-0.9	-0.5	-0.1	-0.2	-0.2	-0.7
Sep	5.8	-1.0	-0.6	-1.2	-1.1	-0.9	-1.2
Oct	4.8	-0.2	-0.1	-0.3	-0.3	-0.2	-0.2
Nov	2.4	+0.3	+0.3	+0.4	+0.4	+0.4	+0.3
Dec	1.2	+0.2	+0.2	+0.6	+0.5	+0.4	+0.4

3.1.5 Economic and Social Scenarios

Climate change is an ongoing process and Jamaica could currently be experiencing some of its effects. With the continued changes in Jamaica's social and economic environment it is necessary to understand the implications a changing climate may have, how to prepare and ultimately how to respond.

3.1.6 Projected Population Growth

The population of Jamaica was estimated at the end of 1998 at approximately 2,571,800 with a rate of natural increase of 15.1% and with an actual growth rate of 0.7%[10].

The Population Division of the United Nations Secretariat provides three projections of population growth for Jamaica: Low, medium and high variants. The estimates are derived from available national data that have been evaluated and where necessary adjusted for deficiencies and inconsistencies. Table3-4 shows the population scenarios for Jamaica. Estimates for 2100 were not available.

Table 3-4: Population Growth Scenarios for Jamaica

	2020[11]	2025	2050
	'000	'000	'000
High	3,413	3,530	4,682
Medium	2,933	3,245	3,801
Low	2,700	2,948	3,027

Based on the 1998 estimate the medium scenario may be considered to be the most appropriate for continuing into the future. This scenario is further substantiated by the current growth rate of approximately 1.0 percent, which has been evident over the decade of the nineties.

Special mention must be made of the growth rate of 0.9 percent in 1997, which exceeds the rate of 0.8 percent, which was established for containing the population within 3 million by the year 2020. Contributing to this was the fact that the Total Fertility rate at 2.8 children per woman on average has been above the projected figure[12] of 2.4.

The present spatial distribution of the population among urban areas and between rural and urban areas is considered unsatisfactory. Over 50 percent of

[10] Economic & Social Survey, Jamaica 1999
[11] The National Report on Population Jamaica1994
[12] Economic and Social Survey Jamaica 1998 Prepared by the Planning Institute of Jamaica

Jamaica's population currently resides in urban areas. Rural-urban migration dominates and has promoted not only the rapid growth on the Kingston Metropolitan Region but also the other main urban centers such as Montego Bay and Negril[13]. Current trends are that the population expansion is towards and into the coastal zone.

Emigration has contributed to moderating the rate of population growth in Jamaica and it is likely to continue to do so in the future. It is noted that many highly educated and skilled persons migrate to North America. The resources in training them are lost to Jamaica and it is doubtful if remittances from emigrants compensate for the loss suffered by the Jamaican economy. Emigration is expected to continue as long as the current differentials in economic opportunities between Jamaica and receiving countries remain.

3.1.7 Economic Projections

The last three years were directed at the implementation of the National Industrial Policy (NIP). The NIP is designed to confront directly and deal systematically with the challenges of the present. It will also prepare the country to meet the 21st century fully equipped to cope with future challenges.

In the medium term the focus has been on growth and stability whilst the long-term economic program has a central objective of achieving a high level of growth in order to generate employment and improve living standards.

Government is committed to taking a holistic and comprehensive approach to policy with full recognition that there are inter-dependencies among different components of the policy. Hence there is a need for establishing consistency, integration, and coordination among the different policy areas.

The emphasis has been on improved export performance, and targeting the export sector to transfer efficient technologies and develop industries that can compete internationally. Measures to maintain macro-economic stability and stimulate investment and growth were introduced after collaboration between public and private sector stakeholders.

[13] National Plan of Action on Population and Development Jamaica 1995 -2015

Table 3-5: Economic Growth Performance Targets

Performance Indices	1998*	2006#	2009#	2010#
Growth rate of GDP per Capita (average annual %)	-0.7	7.5	6.0	5.0
GDP Per Capita (US$ 1994 prices)	-	2,985.0	3,604.0	4,000.0
Population (millions)	2.5	2.73.0	2.82.0	2.87.0
Exports (US$ billions, 1994 prices)	1.2	7.49.0	9.20.0	10.35.0
Gross Investment (US$ million 1994 prices)	-	2,531.0	3,148.0	3,565.0
Unemployment Rate (%)	15.5	9.0	9.0	9.0
Poverty Rate (%)	-	8.0	5.0	2.0

* Economic & Social Survey, Jamaica 1998
# National Industrial Policy

3.2 VULNERABILITY

Jamaica as a small island developing state is vulnerable to the adverse effects of climate change. Sea level rise will pose problems for the coastal regions. Agriculture and water resources are the other major sectors that could also be affected.

3.2.1 The Coastal Zone

The coastal zone is a critical region for Jamaica. The Natural Resources Conservation Authority (NRCA) of Jamaica has stated, “90% of the island’s GDP is produced within the coastal zone.”

Jamaica coastline is approximately 886 kilometres in length and has diverse ecosystems, which include sandy beaches, rocky shores, estuaries, wetlands, sea-grass beds and coral reefs.

The coastal zone can be divided into 18 natural regions. These are listed in Table 3-6 below

Table 3-6: Natural Coastal Regions

Natural Region	Natural Features	Characteristic Developments
Negril	Coastal sand barrier and morass	High density tourism, plantation, mixed farming
Negril	Cliff and hill coast	
The South Western Coastal Plain and wetlands coast	Savannah La Mar – Surinam Quarters – Black River. Sandy bays coastal barriers, patch and fringing reefs	Livestock, mixed farming, fishing, low density tourism, port facilities
The Pedro Plains	Hill and cliff coast with minor beaches and limited fringing reefs	
Long Bay Hill and Vere Plains	Wetland coast with fringing reefs between Rocky Point and Jackson Bay	
Portland Scrubland Ridge and Portland Bight	Low cliffs, hill and low plains wetland coast with few sand beaches, scattered fringing reefs and patch reefs	Fishing, low density tourism, port facilities
Hellshire Scrubland Hills and Bay	Low cliff and sandy erosive barrier and lagoon with poor mangrove, patch reefs and limited fringing reefs	
Kingston	Domestic area	High density urbanization, tourism port facilities
St David Bush Hill	Bush hill and gravel beach system from the Palisadoes to Yallahs	
The Morant River gravel beach system	Low Hills with cane fields, a wide wetland without major drainage channels, very long sand beaches in the western part and a wide coral zone.	Plantations mixed farming, gravel excavation
The Morant Point Great Morass	Low hills with cane fields, a wide3 wetland without major drainage channels, very long sand beaches in the western part and a wide coral zone.	
The Eastern Coast	Hilly, cultivated, open rocky cliff coast with few small bays and sand beaches except Long Bay and with scattered near shore fringing reefs	
The North Eastern Portland Coast	Mixed wood/cultivated cliff coast with many narrow bays and pocket beaches	Plantations, low density tourism, port facilities
The Western Portland and St Mary Coast	Cultivated hills with large open bays with partly unstable gravel beaches and in some section a wide fringing reef zone	
St Mary Coast	Hilly, steep rocky cliff coast with few bays and partly well developed fringing reefs	Low/high density tourism, mixed farming
The straight Northern mixed coast	The mainly cultivated lowland coast from Oracabessa to Silversands with few bays scattered white sand beaches and wetlands and widely distributed coral reefs. The hilly woodland coast from Silversands to Falmouth with a narrow shore terrace with lagoons. The Falmouth lowland/wetland coast. The St James low, coastal foothill terrace, open coast with minor white sand beaches and near shore fringing reefs	Mixed farming low density tourism
The Montego Bay Coast	Dominated by coastal constructions	High density tourism urbanization, mixed farming, port facilities
The Hanover Coast	The northern rocky cliff coast with coves and limited fringing reefs: the northwestern coast with large coves, wetland and fringing and patch reefs.	

Coral reefs are one of the most important coastal resources and are of major socio-economic importance to the island. On the north coast, fringing coral reefs extend almost continuously along the edge of the shelf (1 km or less) from Negril to Morant Point.   These are well-developed, spectacular and diverse reefs. Discovery Bay, Ocho Rios, Montego Bay and Negril are the better-known reef localities on the north coast.

On the south coast, the greater part of the shelf is actually devoid of major coral reefs, except on the eastern portion between Kingston and Portland Bight (Old Harbour Bay), and at Alligator Reef (off Alligator Pond), where larger reefs and numerous coral cays exist. Reef development on the south coast is not continuous but is more diverse on the north coast. Many of these reefs are in a poor condition especially in the vicinity of the entrance to Kingston Harbour and close to river mouths such as Black River.   It is in these areas polluted wastewater; agricultural runoff and sedimentation are heavily stressing the corals.

On the western section of this coast, the reefs tend to be small, patchy and undeveloped, possibly due to the proximity of several larger rivers.

The majority of Jamaica's coastal communities depend on the coastal resources and the reefs for their livelihood. Fringing reefs are major source of biodiversity. They provide coastal protection as natural barriers by preventing erosion, provide a livelihood for artisanal fisheries and provide recreation for the local population and tourists.

The north coast has a long history as a recreational area and the south coast has become increasingly important in recent years.

Reef fisheries are of major importance in the Jamaican food chain. Healthy reefs have a significant role in ensuring the overall productivity of the near shore area.

In an ecological study [14]conducted between 1951 and 1961 of 11 coral reef sites around Jamaica, it was found that coral reefs have deteriorated at an accelerating pace due to a variety of causes including both human and natural activities. The activities responsible for degradation of coral reefs include:

- overgrowth by algae and sponges,
- eutrophication by sewage nutrients,
- over fishing,
- coral bleaching and
- tropical cyclones.

[14] Jamaica's Coastal Resources a Reconnaissance Report January 1995 – NRCA Pg. 33

The role coral reefs play in beach protection cannot be over emphasized. To further assess these concerns, a coral reef monitoring program has been implemented through the CPACC project. This project is being funded until the end of 2001.

Wetlands were, at one time, estimated to cover approximately 2% of Jamaica's total surface area, a figure that has declined over the years. Wetlands occupy nearly one third of the Jamaican coastline[15]. There are two main classifications for wetlands in Jamaica; swamps and marshes. Jamaica's wetlands are found mainly in the low coastal areas particularly along the south coast.

The role of coastal wetland ecosystems in maintaining shoreline stability and preserving biodiversity is well established. In its natural state, wetlands perform invaluable ecological functions. These include protection of the shoreline from erosion by wave action; protection against flood by acting as a sponge; sediment trap; wildlife habitat; nursery area and land building.

Special attention has been paid to mangrove communities and their function within the coastal environment. Mangroves form highly productive ecosystems capable of exporting energy and materials to adjacent, relatively deprived communities such as sea grass beds and mud flats.

Sea grass is found in the shallow coastal waters around Jamaica. They are marine flowering plants. Three species of sea grasses are known, the turtle grass (*Thalassia testudinum*), manatee grass (*Syrinogodium filiformae*) and midrib (*Halophilia).* The importance of these highly productive plants cannot be over emphasized as they provide a food source for many marine animals, ensure stability of the coastline and are good indicators of healthy, high quality marine waters.

Tourism is by far the largest and most important sector of the Jamaican economy. Tourism is the key activity in the coastal zone with the white sandy beaches providing the ideal location for several resorts. In 1998 it contributed 20 percent of GDP or an estimated foreign exchange earnings of US$1.196 billion. The economy has become increasingly dependent on tourism; projected capital investment for 1998 was approximately US$7.7 billion. The bulk of these funds were directed into new developments in all three major resort areas Negril, Montego Bay and Ocho Rios. This and other developments will provide on a continuing basis over 23 percent of the Jamaican population with employment.

3.2.1.1 Effects of climate change on the Coastal Zone

Preliminary analysis from the Southern Coast Sustainable Development Study has identified areas of the coastline, which are particularly susceptible to erosion

[15] Jamaica's Coastal Resources: A Reconnaissance Report January 1995

from storm surge effects. Beach erosion was determined to occur in areas, which have high populations and are dependent on the coastal activities.

Sea level rise will compound this situation in many areas, depending on the instability caused by beach erosion. Permanent inundation in some areas could also occur.

The effects of climate change could be amplifying some natural disasters. Jamaica is already very vulnerable to tropical storms and hurricanes. It was estimated that the cost associated with damage from Hurricane Gilbert in 1988 was in the region of J$25millIion.

The cost to protect Jamaica from a one metre sea level rise was estimated by the IPCC, in 1990 to be US$462 million which equates to a cost of US$197 per person or an annual cost that is 19% of GNP.[16]

Natural forces such as wind, waves, tides and currents, human activities such as beach sand removal and inappropriate construction of shoreline structures are continuously at work causing shoreline changes at numerous locations around the island. Examples of this have already been seen at Hellshire Beaches, Great Salt Pond and Half Moon Bay in St. Catherine. As a result of sea level rise erosion patterns will result in changing shorelines.

An increase in intensity and greater frequency of hurricanes that could result from climate change would worsen the effects of erosion.

Wetlands without inland barriers are less susceptible than many coastal ecosystems to the impacts of sea level rise. However, changes could occur to these areas if they become inundated with no buffer to absorb the saline water.

Large increases in freshwater flow into the wetlands may also upset the ecological balance of the ecosystem. Degraded wetlands as a result of other development pressures or inappropriate upstream land uses can result in reduction of the wetlands capacility to serve as a natural filter and buffering system for coral reefs from upstream flows.

In the event of increased frequency and intensity of severe events such as flooding, the degraded wetlands reduced capacity to buffer flood conditions may result in damages to coral reefs.

Sea grass is currently under threat from a number of direct and upstream land-based sources of pollutants, including sedimentation, direct dredge and fill activities (including expansion of beaches), nutrients from wastewater discharges and non-point sources.

[16] Strategies for Adaptation to Sea Level Rise, Intergovernmental Panel on Climate Change Response Strategies Group Nov. 1990

Climate change effects that increase the potential for flooding or high intensity rainfalls may increase the volume of polluted runoff from these upstream sources, unless appropriate management measures are undertaken.

Sea grasses are sensitive to thermal discharges and can only accept temperatures up to 2 - 3^0C above summer temperatures. This may be an indication that the sea grasses may have to adapt to temperature variations anticipated over established scenarios. Maintenance of sea grass will be more important with greater threats of hurricanes and severe storm events. Sea grass serves as natural filters and storm surge mediators that protect shorelines from storm surge. Sea grass has been valued at $86,000 per acre based in part on its protective processes as well as biodiversity values. Costs of restoration of sea grass beds have been estimated at $500 per acre in Jamaica.

Climate change may have already affected the island's coral reefs. The death of large numbers of corals in 1988 and 1990 has been attributed to the increases in the temperature of coastal waters.

Nine reefs on the north coast had a coral cover averaging 52% at a depth of 10m in the late 1970's but declined to 3% in the 1990's, along with an increase in fleshy macro-algae from 4% to 92%.[17] The loss of these corals has far reaching implications in terms of the loss of fish habitat and subsequent decrease in fish populations: the loss of source of beach sand replenishment will also further contribute to the critical status of the beach erosion facing the island.

These conditions will occur more frequently and with greater intensity with climate change and sea level rise. Coral reefs are also sensitive to heavy damage from hurricanes. The reefs are physically damaged and destroyed during high wave or storm surge events.

Jamaica has identified areas that are particularly sensitive and/or of great value as protected areas. In the event of climate change they may be likely to be damaged. However their protected status should allow implementation of appropriate adaptation measures to mitigate such effects. Protected areas in the coastal zone will remain at particular risk to sea level rise and storm events.

The coastal environment of Jamaica represents natural resources and numerous attractions of a quality that has earned worldwide reputation. These coastal areas are generally subjected to the most intense developmental pressures, including increases in population and economic activities, in particularly tourism. Climate change and sea level rise will expose the coastal zone to increasing pressures.

Inappropriate land and sea uses driven by demand for short-term cost-effectiveness and profits add to the problem. At the same time the coastal environment is very fragile with highly sensitive ecological systems providing the

[17] Status of Coral Reefs of the World, 1998, page 150

fundamental base for flora and fauna, of paramount importance to a sustainable environment as well as to the economic and social well being of the country.

The potential for damage to coastal infrastructure is thus high, as most of the tourism infrastructure and other industrial infrastructure are located in coastal regions. In addition the coastal areas have high populations, which will be displaced as a result of sea level rise.

The economic value of all resources within the coastal zone will be adversely affected in a changing climate and a rising sea level. The resulting impact will be a loss of income, loss of commercial and industrial structures and infrastructure resulting in a detrimental impact on employment and the economy generally. Earning losses will occur to all sections of the community as a result of reduced economic activity.

3.2.2 Water Resources

Jamaica's freshwater resources come from surface sources (rivers and streams) and underground sources (wells and springs) and rainwater harvesting. Groundwater supplies most water demands (approximately 80% of production) and represents 84% of the island's exploitable water.

The island's water sources are associated with major rock formations and their interrelationships. The three dominant hydro-stratigraphic units are basement aquiclude, limestone aquifer, and alluvium aquifer/aquiclude. The island is divided into ten hydrological basins.

Generally the boundaries of the basin are defined by surface water divides, but in some groundwater divides the outcrops of karstic limestone are used, since these represent more meaningful management units.

Groundwater is associated with limestone and coastal alluvium aquifers. Ninety-six percent of all available groundwater is associated with limestone aquifers, with alluvium sources providing the remaining 4%.

Surface water is associated with the basement, limestone and alluvial aquicludes. The basement aquicludes are characterized by dense network of surface streams with high flows during the rainy season and relatively low flows in the dry season. This formation occupies about 25% of the island's surface and occurs primarily in the Blue Mountain area and the central mountain spine, which runs ENE to WSW. As a result surface water is the main water source in the eastern one-third of the island. Flows over basal aquiclude constitute for most of the surface water. Some surface water can also be found on interior valley alluviums. The surface water is used almost exclusively for domestic water supply, primarily in the Kingston Metropolitan area and isolated communities in the Central Upland areas.

Reliable surface water and groundwater safe yields total 4,084 MCM/yr.

Island-wide water uses are estimated at 916 MCM/yr. Only 25% of the available groundwater and 11% of the available surface water are presently being utilised.

The unused groundwater potential is primarily associated with limestone aquifers, mainly in the Black River, Cabarita River, Great River, and Dry Harbour Mountains basins. Almost 80 percent of unused surface water occurs in the Blue Mountains North and South Basins.

Presently, there is a consensus that exploitable water and the developed infrastructure are not located in close enough proximity to water users to consistently meet all demands. The 1990 Water Resources Master Plan predicts shortfalls of 126 MCM between developed infrastructure and anticipated demands.[18] In addition, approximately 65% of the water produced is unaccounted for by the primary supplier of domestic water.[19] Some of this water is lost through illegal connection and some by not been metered. The formation of a Ministry exclusively for water and water related issues would substantially reduce the amount of water that is unaccounted for.

In some south central areas contamination of source waters has deleteriously affected the water supply available to the closest users. This has resulted in the need to transmit water from distant locations to service certain populations.

Two main water demand sectors are recognised: the agricultural sector and the non-agricultural sector. The agricultural sector represents approximately 75% of the water demand. The non-agricultural sector is further divided into sub-sectors of domestic-urban (15%), domestic-rural (2%), industry (7%) and tourism (1%).

Water demand distribution in Jamaica is based on the location of irrigated lands, population concentrations, tourism development and other water consuming industries. The demand in the south of the island is greater due to the extensive agriculture in areas of little rainfall. Demand in the north tends to be less because there is greater rainfall and less cultivable land. Bauxite –alumina and sugar cane processing industries, which are concentrated in the south, consume large quantities of water. The concentration of agriculture and industry in the south has also created an increased demand for labour, which in turn has created higher population densities and higher water demands for the domestic sector.

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[18] Jamaica Water Sector Policy Paper- Ministry of Water 28 January 1999 based on Water Resources Development Master Plan. Note review of based data indicates potential discrepancies in the calculation of this figure and the figure should be confirmed with WRA.

[19] *Economic and Social Survey of Jamaica, 1998.* Planning Institute of Jamaica. Government of Jamaica 1999. This is being addressed by a Special Division within NWC.

Table 3-7 shows the present and estimated future demands for water for the various sectors and sub-sectors.[20]

Table 3-7: Summary of National Water Demand

Demand Sector	**Present (2000)**		**2015**	
	(MCM/yr.)	Percent	(MCM/yr.)	Percent
Agriculture	1,149	80	1,338	79
Non-Agriculture	288	20	346	21
Of which Domestic-Rural	46	3	62	4
Domestic-Urban	161	11	181	11
Tourism	15	1	23	1
Industrial	66	5	80	5
TOTAL	1,437	100	1,684	100

Degradation of water quality has resulted in the loss of some 104.3 cubic meters per year, or 10% of exploitable groundwater as the result of pollution or saline intrusion[21]. An additional 241.2 million cubic metres have been affected but continue to be used for restricted purposes. Saline intrusion in the Clarendon and St. Catherine areas accounts for 75 % of the affected groundwater. Saline intrusion is associated with the overpumping of older wells, below sea level pumping of wells installed in aquifers of high natural salinity[22]

Therefore, it is important to caveat statements regarding the adequate availability of water resources. The spatial and temporal variations of rainfall and other climate parameters and the potential effects of climate change on the factors causing these variations must be considered in water resources planning to address the discrepancy between supply and demand sources.

[20] *Water Resources Development Master Plan*, page 4-24. As modified based on revised estimates for population and agriculture in 2000.
[21] Water Supply Master Plan and updated by 1993 Status of Water Supply –Fernandez
[22] In this discussion, wells installed in groundwater aquifer's with higher natural salinity are "associated" with saline intrusion because it has been found that in some cases the assumption has been made that saline intrusion exists when the water had always naturally been more saline.

3.2.2.1 Effect of climate change on water resources

Raw water supplies are directly affected by changes in climatic conditions. Changes in the amount of rainfall as well as its frequency and intensity determine the amount of water that will be available for exploitation. The changes to the amount of total rainfall that Jamaica may receive under the climate change scenarios are uncertain; however, even changes in Jamaica's rainfall patterns could have significant impacts on its water resources.

Changes in rainfall patterns while still receiving the same total rainfall may still result in decreased surface and groundwater supplies. When rainfall is received in short intense events, high runoff and low percolation generally occurs. This results in little recharge of groundwater aquifers and lower quality surface waters. The lower quality surface water may also have to be diverted to avoid siltation of reservoirs and reduced water storage capacity. With this type of rainfall pattern the ability to maintain adequate storage reservoirs is necessary to maintain a reliable supply. Also, treatment costs for domestic supplies will increase. Intense rainfalls followed by long dry periods also results in soil moisture deficiencies that result in decreased crop yields and/or increased irrigation demands.

Reductions in rainfall will have a number of effects on water sources and supply, most obviously reduced supply availability. The supply will be reduced directly through insufficient recharge and streamflows. It may also be reduced indirectly through potential degradation of water quality through saline intrusion from over pumping. Also, as groundwater storage is reduced so is the head over saline waters, which increases the potential for saline intrusion.

Decreasing rainfall will also mean an increase in irrigation requirements for rain-fed agriculture. If water management in these areas is imperfect, soil degradation could result from a build-up of mineral salts in the upper soils.
Reduced rainfall may also result in the necessity to use brackish water for agriculture. Continued use of high saline water will degrade soil conditions. If more saline water is used for irrigation on lands over aquifers of better quality, the aquifer will also become more brackish, thereby creating a cycle of increasing degradation of more and more water supplies.

Changing temperatures may result in changing wind patterns. If surface winds increase, soil erosion will increase. Increased soil erosion reduces the potential soil moisture reserves, which increases crop vulnerability to short-term dry spells. Increased winds also cause physical damage to crops and other vegetation, and increased evaporation, and increased transpiration.

Severe weather events in recent years, particularly the drought conditions of the 1997/1998 El Niño events, demonstrate the effects of climate change on water sources and water supply.

The El Niño event resulted in severe drought conditions for much of the country. The effects of the drought included:

- millions of dollars of agricultural losses as a result of decreased productivity,
- severe effects to domestic water supply resulting in water lock-offs
- the cost and need to truck water to the worst effected areas, and
- a reduction in streamflows – in some cases decline in available water-to-water systems as much as 50%.

It is quite likely that public health was negatively affected.

An insufficient quantity of water, particularly potable water, is related to increases in water-related diseases. This is particularly true when populations seek alternative sources, which may be of poor quality. Increases in the incidence of heat-related illnesses also occur during periods of drought and elevated temperatures.

An increased intensity of rainfall events could result in flooding. Flooding will result in social and economic losses. In addition, flooding may result in the downstream pollution of rivers through runoff.

Sea level rise most directly impacts water resources by causing increased saline intrusion in coastal aquifers. The effect of sea level rise will be exacerbated by lower rainfall thus reducing the groundwater head. Intrusion into alluvium aquifers may be moderate and higher in limestone aquifers. Saline intrusion into rivers or streams will affect the ecosystem balance of estuarine areas.

Water is an essential element to economic growth and productivity. Climate change and the resulting effects on water could have detrimental impacts on the economy, affecting the key areas of tourism, agriculture and industry.

By the year 2025 the population is expected to be 3,245,000 (median estimate). Given the current trends population distribution will continue along similar trends with migration to urban centres in search of employment an important feature. Demand for water services by the population will place further pressure on already stretched resources of the urban centres and further increase the number of those less able and below the poverty line. Population growth into areas with marginal water supply poses increased public health concerns such as water related diseases including those borne by parasites and malnutrition.

While a change in climatic conditions could have negative impacts on the water resources in Jamaica the key issue still remains the effective distribution of the abundant available water resources.

3.2.3 Agriculture

Agriculture is one of the key economic sectors of Jamaica. This sector contributes approximately 7.3 percent of gross domestic product (GDP), represents approximately 12 percent of foreign earnings, and employs approximately 25 percent of the population. The country is reasonably self-sufficient in food but still relies on imports of wheat, maize, meat, milk, dairy products, fish and lumber. In addition to its economic importance, this sector has direct influence over the landscape of the country and shapes the social and community structures in many areas.

This sector is closely interrelated to other sectors of the economy and to water and other natural resources. Agriculture productivity, yield, and product quality is dependent largely on available water and the influences of water on other key variables, such as soil quality. Agriculture also influences the quantity and quantity of water resources available to itself and other sectors by its direct demands and the influences of agricultural practices on soil and watershed conditions.

Sugar, coffee, bananas, citrus, pimento, coconut and cocoa are the main export crops of Jamaica. However there are a considerable variety of fruits and vegetables, which are produced for domestic consumption and export. Sugar cane is the most important crop in Jamaica contributing approximately 45% of the export earnings for all traditional export crops. Bananas are the second most important crop. Domestic food crops include legumes, vegetables, fruits, condiments, herbs and tubers.

Cultivated areas in Jamaica account for 270,000 hectares (ha) of the country's total land area of 1.1 million ha. The main crops under cultivation are estimated at 80,000 hectares of plantation sugar, banana, citrus, coffee, cocoa and coconut, 53,000 hectares of food crops; 120,000 hectares of improved pasture and 17,000 hectares of other crops.

There are obviously many constraints affecting agriculture, which a changing climate will compound. These include rainfall, pest and disease and soil conditions.

3.2.3.1 Effects of climate change on agriculture.

Rainfall's frequency, pattern and distribution will obviously affect production in agriculture. Thus the effect climate change will have on agriculture is linked to its effects on water resources. Changes in rainfall patterns will affect the distribution and production of crops. Table3-8 below shows the water requirements for selected crops for Jamaica.

Table 3-8: Normal Rainfall Requirements for Selected Crops

Crop	Recommended Rainfall Range (millimetres per year)
Sugar	1500 of well distributed water (no range provided)
Citrus	1,500- 1,800
Banana, Coffee, Yellow Yam, Ginger,	1,300 - 1,800
Cassava	750 - 1,000
Sweet Potato	1,000 - 1,300
Dasheen	1,500 - 2,000

Any reduction in the amount of rainfall will therefore result in lost production. In addition changes in patterns of rainfall will cause conditions to be more favorable for disease. For example bananas are highly water dependent. Bananas require some 1,300 - 1,800 mm of water annually. Adequate water is required to produce larger fruit size and the lack of water is associated with the onset of Black Sigatoka disease. Water logged conditions could also result in the development of disease for many crops. There could therefore be decreased yield for many crops with a changing climate.

Changes in temperature and atmospheric carbon dioxide will also affect agricultural output for Jamaica. Changing temperatures may result in changing wind patterns. If surface winds increase, soil erosion will increase. Increased soil erosion reduces the potential soil moisture reserves, which increases crop vulnerability to short-term dry spells. Increased winds also cause physical damage to crops and other vegetation, and increased evaporation, and increased transpiration. The regional report by the IPCC has noted that an increase in atmospheric carbon dioxide concentrations could cause a reduction in sugar cane yields. There is still a need for considerable research in Jamaica, on the effects a changing climate will have on agricultural production

3.2.4 CONCLUSIONS

While this initial national communications report has an initial investigation of potential vulnerabilities it is clear that there is a need for further work in the area of vulnerability with regards to climate change. There is a considerable amount of infrastructure located on the coast, with the international airports, seaports and a number of industries being located in areas that would be extremely sensitive to climate change.

It will be necessary to investigate a number of the socio-economic vulnerabilities, particularly in area such as tourism. Additional funding will be required for thorough in depth analysis in most areas, in particular coastal zones, water resources, agriculture and the health sector.

3.3 ADAPTATION

For Jamaica to respond to many of the vulnerability concerns which have been identified in the previous section it is clear that constructive adaptation policies will have to be implemented so that many of potential impacts of a changing climate could be avoided in Jamaica, or mitigated.

3.3.1 Coastal Zones

With regards to the coastal zones it is clear that there is the need for comprehensive management of the island's ecosystem, which would involve strategic planning to avoid the worst impacts, an assessment of the needs for modification of land-use and implementation of identified land-use strategies and guidelines.

Table 3-9: Coastal Zone Sub-sectors and Proposed Adaptation Measures

Sub-Sector	Adaptation Measure
Ecosystems and Near-shore areas	• Advanced planning to avoid worst impacts • Assessment of need for modification of land use and implementation of identified land use guidelines • Modification of building styles and codes • Protect threatened ecosystems such as the Black Morass • Strict regulation of hazard zones • Hazard insurance to reinforce regulation • Conditional phased out development in high risk areas • Withdrawal of Government subsidies for development in high risk areas • Resettlement packages
Coral Reefs ***Jamaica National Environmental Action Plan JANEAP 1998 Action 23***	• More structured coral reef management • Promote research and monitoring • Monitoring of construction that may contribute to coral reef destruction • Support for coral reef mapping and monitoring programme.
Reef Resources (fisheries)	• Development of fishery management plan • Exercise greater control over fishing activity • Continued support for NGO's with monitoring programs • Pelagic and Reef Species assessment • Biological and Data collection research programs enhanced • Policies and guidelines related to the collection and export of materials • Fishing gear and net limitations • A fishers education publicity campaign
Protected Areas	• Continued support for ecosystem protection • Support for research and environmental monitoring
Improved integrated watershed management	• Public education and awareness • Implement integrated watershed management • Promote appropriate agricultural practises • Promote improved soil management practices • Improve crop selection and planting/harvesting practices
Coastal Water Quality	• Regular monitoring of water quality • Develop and implement non-point source (pollution) • Improve wastewater discharge regulation and enforcement

3.3.2 Water Resources

Adaptation options for the Water Resources sector will revolve around an improved distribution network incorporating water conservation techniques.

Table 3-10: Water Sector and Adaptation Measures

Sub-Sector	Adaptation Measure
Demand-Side Management	
Reduction of Unaccounted for Water	• Establish Leak detection/repair program
Promote Domestic Water Conservation	• Low-flow toilets and showers • Household leak repair • Re-use of gray water • Enhanced Education and Awareness Programs
Promote Industrial Water Conservation	• Promote re-use of acceptable quality water • Industrial Recycling • Develop Environmental Management System requirements include market/economic instruments
Promote Agricultural Use Conservation **National Irrigation Development plan provides specific planning recommendations for this area*	• Night time irrigation • Lining of open channel canals • Use of drip irrigation systems where soil conditions allow • Use of closed pipe systems where feasible • Use of treated wastewater effluent • Better control and management of supply network • Develop Environmental Management System requirements include market/economic instruments
Supply-Side Management	
Reduction of unaccounted for water	• Establish leak detection/repair program • Improve monitoring and metering
Improved integrated watershed management *See Watershed Policy for Jamaica and proposed institutional mandates*	• Public education and awareness • Implement integrated watershed management • Promote appropriate agricultural practices • Promote improved soil management practices • Improve crop selection and planting/harvesting practices
Increase Storage Capacity	• Encourage household water catchments • Encourage farm/estate-based water storage facilities
Development of infrastructure	• Upgrade existing infrastructure • Develop new extraction facilities as geographically appropriate • Investigate dual supply systems • Storage facilities to harness wet season flows particularly in the rural areas • Investigate water intake locations • Artificial recharge • Consider expansion of inter basin transfer • Improve flood control structures to handle more frequent and extreme events
Information Gaps: Research and Planning Measure	
Meteorological data gaps and inconsistencies	• Improve the availability and interpretation of climate data and services • Further research on climate change and variability • Country-specific modeling of potential climatic change impacts
Data Coordination Mechanism	• Development of Clearinghouse for water resources information – Common GIS

Sub-Sector	Adaptation Measure
Need for more detailed information on country's regional climate patterns and integration of water resources planning	• Integrate climate information into water resources planning • Hydrological research
Need for more detailed contour data and vertical land movement	• Additional topographic surveys • Complete digital elevation modeling of existing data
Information Gaps: Research and Planning Measure (continued)	
National Meteorological Service	• Research and forecasting
Natural Resources Conservation	• Appropriate legislation and environmental plans
Water Resources Authority	• Monitor water resources and detect trends
Office of Disaster Preparedness and Emergency Management	• Communication linkages between Kingston and rural areas
Parish Councils	• Parish planning for vulnerable areas
Ministry of Agriculture	• Collation and analyses of relevant data
Integrated Management and Coordination	• Establish technical and management coordination systems

3.3.3 Agriculture

Changes in the climate will obviously affect agricultural production and output. The recent chapter the IPCC regional impacts report notes that with an extension in a dry season in Pacific islands yields from sugar cane will decrease. Thus the need to examine alternatives is quite clear.

Table 3-11: Agricultural Sub-sector and Adaptation Options

Sub-Sector	Adaptation Measure
Water Supply	• Improve efficiency of irrigation • Improve land grading in the other surface irrigation areas • Further installation storage water facilities • Rehabilitate drainage infrastructure • Rehabilitation of areas affected by salinity and alkalinity • Night time irrigation • Lining of open channel canals • Use of drip irrigation systems where soil conditions allow • Use of closed pipe systems where feasible • Use of treated wastewater effluent • Better control and management of supply network • Develop Environmental Management System requirements, include market/economic instruments
Soils	• Improve drainage • Improve watershed management • Public education and awareness • Implement integrated watershed management • Promote appropriate agricultural practices • Promote improved soil management practices • Improve crop selection and planting/harvesting practices • Use reduced tillage

Sub-Sector	Adaptation Measure
	• Change mulching practices • Alter timing of operations • Alter crop husbandry
Physical Damage	• Wind Rows • Disaster Planning
Pests and Disease	• Integrated Pest Management • Alter agricultural chemical use
Economic Considerations	• Considered subsidy Policy review • Review water pricing policy • Cost benefit analysis • Research into value added processing Integrated marketing, transportation and production systems
Traditional Crops	
Sugar	• Continue research into crop varieties and weather patterns for influences on crop timing
Coffee	• Irrigation options/water storage need to be explore
Bananas	• Flood control and water storage options explored
Non Traditional Crops	• Investigate drought tolerant crops • Plant quicker or slower maturing varieties • Use altered mix of crops • Investigate drought tolerant crops • Plant quicker or slower maturing varieties • Use altered mix of crops
Domestic Food Crops	• Investigate drought tolerant crops • Plant quicker or slower maturing varieties • Use altered mix of crops • Use altered mix of crops • Bringing education and awareness to bring improved agricultural practices to farmers
Information Gaps: Research and Planning Measures	
Meteorological data gaps and inconsistencies	• Improve the availability and interpretation of climate data and services • Further research on climate change and variability • Country-specific modelling of potential climatic change impacts
Need for more detailed information on within country regional climate patterns and integration of water resources planning	• Integrate climate information into agriculture planning • Hydrological research
Need for more detailed contour data and vertical land movement	• Additional topographic surveys • Complete digital elevation modelling of existing data
Agricultural Research	• Agricultural research to test new farming strategies and develop new crop varieties
Capacity Building Measures	
Integrated Management Systems	• Research and forecasting • Appropriate legislation and environmental plans • Monitor water resources and detect trends • Communication linkages between Kingston and rural areas • Parish planning for vulnerable areas • Collation and analyses of relevant data

3.3.4 CONCLUSIONS

While the above tables have suggested possible and potential adaptation options it is clear that there is a need for further comprehensive integrated studies in the area of adaptation, which will examine the socio-economic issues which are relevant for the implementation of suggested adaptation options. What is clear is that the cost for implementing many adaptation options will be prohibitive and will call on financial resources that may not be available to the Government of Jamaica.

PART IV

NATIONAL POLICY

AND

ACTIONS

4.1.1 Introduction

Jamaica and other signatories to the UNFCCC must make periodic reports in their National Communications recording annual inventories of ghg emissions, and detailing the policies and programmes implemented at the national level to redress climate change.

Jamaica's experience in the preparation of this National Communication was constrained by lack of capacity, and underscores the urgent need for meaningful support for capacity building initiatives. Some of the difficulties experienced were:

- Inappropriate methodological framework (IPCC Revised 1996 Guidelines) for assessing the GHG emission of small states;
- Lack of expertise/knowledge in implementing test methodologies and establishing baseline conditions;
- Lack of country-specific data and inadequate/inappropriate statistics for simulation models;
- Difficulties in identifying experts for multi-disciplinary teams to undertake cross-sectoral assessments;
- Very low public awareness of climate change issues and inadequate sensitisation to anthropogenic factors that exacerbate vulnerability;
- Inadequate private sector support, demonstrated lack of commitment to climate change issues;
- The absence of strong academic, research or regional environmental institutions to provide substantive support in the process;

Noteworthy is the support provided to the countries of the South Pacific by the South Pacific Regional Environment Program (SPREP). The Caribbean has no regional institution designated to address the issue of climate change, nor to provide a regional framework of support for national action.

There is a clear need to strengthen policy coordination and institutional support if regular reporting requirements implicit in the National Communication process are to be fulfilled and if the successive national reports are to record progress in the implementation of the mandates of the UNFCCC and the KP.

4.1.2 Recommendations for National Action

The direction in which national policy and actions should be pursued in the future should include the following considerations:

a. Sensitize Policy-makers

There should first be promoted a greater awareness and understanding among the relevant agencies and institutions of the importance of the issue, and of the need to mainstream vulnerability, mitigation and adaptation strategies in the broader national sustainable development plan.

b. Establish an Inter- disciplinary Committee

The need for regular cross-sectoral consultation and cooperation to address all factors that directly or indirectly affect climate change must be underscored. Consideration should be given to the establishment of an interdisciplinary committee that would include the national focal point for climate change, biodiversity and desertification, representatives of the energy sector, both public and private, the relevant government Ministries and agencies engaged in sustainable development policy planning, as well as institutions like the Scientific Research Council and University of the West Indies Centre for Environment and Development.

c. Public Awareness

The need for an enhanced public awareness and education programme to fully engage all stakeholders, including the private sector and community organisations, is of utmost importance. For vulnerability, mitigation and adaptation measures to be most effective will require the full cooperation of the population. Public awareness is undertaken mainly as sensitization for climate change workshops and seminars. CPACC has assisted with public awareness, through the publication of brochures, videos, other printed materials and the organization of workshops for special interest groups including the private sector and the media.

d. Consortium of Scientific and Research Institutions

The direction and degree of policy interventions in implementing the UNFCCC and the KP will be predicated on the findings of complex scientific analysis and projections; the successful transfer of appropriate technology, and the development of indigenous capacity in the pertinent fields of science.

A very strong case can therefore be made for the establishment of a Consortium of scientific and research institutions, which could comprise both national and regional bodies, to consolidate and enhance the knowledge base in the related branches of science. This consultative group could have a direct interface with policy-making institutions, with a view to ensuring that decision-making is informed by the best available scientific and technological information.

This reaffirms earlier views regarding the increasingly important role of science and technology in the development dialogue and in the conduct of foreign policy.

4.1.3. Sustainable Development Programs

The Jamaican Government has recognised that the environment and its sustainable management is key for further social and economic development. Table 4-1 are examples of some of sustainable development projects that the country participates in.

Table 4-1: Sustainable Development Projects

PROJECT TITLE	OBJECTIVE	IMPLEMENTING AGENCY
CARICOM Fisheries Resources Assessment & Management Program	To assess the fisheries resources of Jamaica and develop management plan for the sustainable utilization of these resources	Fisheries Division
Coastal Water Quality Improvement Project	To support community based initiatives to identify, prioritize and address environmental concerns related to water quality	NRCA, NWC, MOEH, NEST
Development of Marine Park and Protected area in Negril	Creation of Marine park and protected area, educational program and development infrastructure.	Negril Environmental Protection Trust
Environmental Action Program	To promote sustainable development by supporting capacity development of key organizations involved in decision-making, management and use of Jamaica's natural resources.	NRCA
Environmental Audits for Sustainable Tourism	To develop awareness of the benefits and provide training in Environmental Audits.	JHTA
National Biodiversity Strategy and Action Plan	To formulate a strategy and action plan for the protection and sustainable use of Jamaica's biodiversity.	NRCA
Trees For Tomorrow PhaseII	To ensure the sustainable use of land and forest resources for the benefit of the Jamaican people.	Forestry and Soil Conservation Department
Development of Environmental Management Organization	To strengthen the capacity of public and private environmental organizations to manage Jamaica's most economical natural resources	NRCA, FSCD, UWI

A sustainable development study was completed for the south coast (from the Great Salt Pond in the Hellshire Hills in St. Catherine to the eastern boundary of the Negril – Green Island Development area in Westmoreland). The goal of the study was to develop an integrated plan (inclusive of guidelines to conserve and protect the natural and the built environment). The plan will seek to ensure that the South Coast (now experiencing rapid growth as a tourist resort area) does not develop in a haphazard manner, as happened in Ocho Rios, Negril and Montego Bay. Coastal zone management thus forms an integral and important part of the sustainable development policies of the government of Jamaica. With critical infrastructure and key resources located with the coastal zone it is clear that effective policies need to be formulated in order to sustainable manage these resources.

Another major project is the Highway 2000 Project. This ambitious initiative aims to reduce the travel time between the major cities of Kingston and Montego Bay.

4.1.4 Climate Change Related Programs, Research and Systematic Observation

4.1.4.1 Numerical Climate Prediction

There is the clear need for continuous ongoing climate change research in Jamaica. The Physics Department of the Faculty of Natural Sciences, University of West Indies has established a climate-modeling group. This group is examining medium and long term models with regards to climatic change, as well as looking at the effects of changes in sea surface temperature and El Nino events.

4.1.4.2 National Meteorological Services

Systematic meteorological observations are the responsibility of the National Meteorological Service, NMS. This scientific division of the Ministry of Water and Housing has the national responsibility for providing the local and international community with:

- Synoptic reports
- Aviation routine weather reports
- Climatological report
- Radar reports
- Upper Air reports
- Terminal aerodrome Forecasts
- Local weather forecasts
- Warnings of severe weather (Hurricanes, floods, thunderstorms, etc)

The service was established in the late eighteen hundreds when the island was still under British Colonial Rule. Jamaica became a permanent member of the World Meteorological Organization in 1962 and is a member of the Caribbean Meteorological Organization. The operations of the NMS are coordinated through a national meteorological centre and upper air station at the Norman Manley International Airport in Kingston, a synoptic sub station at the Donald Sangster

International Airport in Montego Bay, several climatological stations and over four hundred rainfall stations.

The service's weather observing capability was boosted with the acquisition of a state of the art Doppler radar. This is the first in the English speaking Caribbean.

4.1.4.3 Caribbean Planning For Adaptation to Climate Change

The project, Caribbean Planning for Adaptation to Climate Change (CPACC) commenced in 1998. It originally had nine components, four regional and five pilots. A tenth, the preparation of the first National Communication of St. Vincent and the Grenadines was added. Jamaica received two state of the art sea level/climate-monitoring stations under the project. These were installed on the south coast at Port Royal, the site of a former tide gauge that was destroyed by Hurricane Gilbert, and on the south coast at Discovery Bay.

The Caribbean Institute for Meteorology and Hydrology in Barbados analyses climate data. Tidal information is analysed at the St. Augustine Campus of University of the West Indies, Trinidad and Tobago and the Institute of Marine Affairs.

Jamaica benefits greatly from its participation in CPACC and is one of the pilot sites for coral reef monitoring. This component aims to finalize methodologies for coral reef monitoring in the Caribbean Sea and to highlight areas that will require specific attention.

CPACC is also designing a Coastal Resources Information System, which can be used by policy makers to assist with decision-making and policy development, particularly in the field of adaptation planning.

CPACC has provided comprehensive training in all nine components of its project. Several Jamaicans have benefited including in the use and application of information systems including metadata, data collection and data analysis.

4.1.4.4 Demand-side Management Demonstration

The Jamaica Public Service Company, (JPSCo), the country's premier light and power provider is making considerable advances in improving energy efficiency and promoting the use of renewable sources of energy. The company has been practising demand side management since the early nineties through a GEF funded demonstration project. The results have been so encouraging that the company now has a permanent DSM unit.

The use of renewable energy accounts for about 10% of commercial energy requirements. There is currently some experimentation with wind, while charcoal has traditionally been used in rural areas. The solar water-heating program provides a solar water heater at minimal cost to the consumer who then repays over an extended period of time. The photovoltaic pilot program has been effective in complementing grid-based power in remote areas of the island.

4.1.4.5 National Communication Support Programme

The United Nations Development Program through the National Communications Support Programme has provided training, mainly for completing greenhouse gas inventory, vulnerability studies and adaptation assessments.

4.1.4.6 University of the West Indies Centre for Environment and Development

The University of the West Indies Centre for Environment and Development in collaboration with CPACC is currently designing a module on climate change for its postgraduate environmental program.

4.2 INFORMATION GAPS AND TECHNOLOGY NEEDS

While Jamaica has made good progress in the analysis of issues pertaining to vulnerability and adaptation it is clear that further work has to be initiated in this area. There is a clear need for further training in the area of vulnerability and adaptation technologies. There is also a need for the development of regional climate models at a scale of small islands to allow for better analysis and understanding of the climatic processes.

Impacts assessment models are required to examine issues pertaining to water resources and the possible effects of saline intrusion on the water supply of Jamaica. There is also a requirement for effective storm surge modelling and the creation of hazard maps. The design criteria of buildings and the building codes should be reviewed to include climate change concerns. The requirement for coastal protection structures must also be re-examined.

Many of the scientific institutions in Jamaica will require additional technical expertise in climate change and its related fields. This will enable them to perform the additional functions, as well as allow for additional research as Jamaica prepares for a changing climate. Some organisations will require additional equipment including high-speed computers and other specialized technical equipment. An initial needs assessment will be required of all relevant institutions.

There is a need for the collection of more baseline data so that specific analysis can be done to completely assess vulnerabilities and the best adaptation options. There is the need for continuous research, particularly in the area of agriculture, so those crops that will survive in the changing climate can be identified. This will require considerable transfer and diffusion of technology.

The legal and policy framework with regards to climate change also needs some careful examination so those public and private organisations can more effectively co-operate and develop. The socio-economic effects of climate change also need to be addressed. There will be the need for detailed examinations of how the Jamaican population will be affected from a socio-economic perspective given the changing climate.

There will also be a need to identify and examine the possibilities for indigenous insurance schemes, as Jamaica's susceptibility to natural disasters such as hurricanes are well known. The cost of hurricane insurance in particular is constantly increasing and the persons with the least resources are often the most vulnerable.

A comprehensive climate change public awareness campaign and education programme is needed. This will ensure that the public better understand the issues, the challenges and the opportunities that could arise from a changing climate.

As the other islands of the Caribbean Community will have similar information gaps a regional approach may in some instances be the most feasible and cost effective option. This must be firmly rooted to national priorities and actions.

Jamaica involvement with CPACC is testimony of its commitments to addressing this problem, nationally and regionally. The proposal for a second phase of CPACC and the establishment of a regional climate change centre has received the support of the Government of Jamaica. This is recognition of the importance of having an institution solely dedicated to addressing the concerns that climate change poses for the region in general and Jamaica in particular.

4.3 Financial/Resource Constraints/Needs And Possible Projects

It is clear that Jamaica cannot provide all the finances that will be required to combat the adverse effect of climate change. It will need considerable financial assistance to complete and continuously update the required vulnerability analysis, to develop, design and implement effective adaptation measures.

Financial resources will be required for institutions to train personnel who can formulate and implement the effective policies and measures that will be required in an environment of a changing climate.

A good example of the funding that will be required is the IPCC study that has estimated that it will take about US$462 million to adequately protect Jamaica's coast from a one-metre sea level rise. This cost is only for infrastructure and does not include relocation and other socio-economic costs.

Financial and technical assistance will be required for research to identify agricultural crops varieties that will be tolerant to climate change, yet suitable for Jamaica.

The Jamaican Public Service Company will require an extra 360 MW of new base load capacity over the next 10 years. There is a possibility for renewed activity in exploiting the use of renewable energy to aid in the production of the required capacity. Solar, hydro and wind have been identified as possible areas for investments under the Clean Development Mechanism of the Kyoto Protocol. Energy efficiency, greater utilization of bagasse for the production of electricity is other areas that will be included. Transportation (proposed reopening of railway service) is also another area that could attract investments under this mechanism.

Waste management is a key concern in Jamaica and there are some possibilities for projects, which can minimise, capture and utilise methane, which is produced from landfills.

4.4 CONCLUSIONS

The effects and the understanding of climate change, particularly vulnerability and adaptation, need further analysis to fully address many of the gaps in information and knowledge.

There will the need for the formulation of a comprehensive adaptation plan for the entire island once all the potential vulnerabilities have been identified.

Public awareness and education will be key in any adaptation plan.

Renewable energy use and energy efficiency is no regret options and will yield positive benefits regardless of a change in climate.

Jamaica accession to the Kyoto Protocol is a clear indication that the protocol represents a significant step in the reduction and stabilization of greenhouse gases in the atmosphere and wishes for its early entry into force.

PART IV

ANNEXES

Annex 1
Decision 10/CP.2

Communications from Parties not included in Annex I to the Convention: guidelines, facilitation and process for consideration

The Conference of the Parties,

Recalling Article 12.1, 12.5 and 12.7 of the United Nations Framework Convention on Climate Change,

Recalling also its decision 8/CP.1 on first communications from Parties not included in Annex I to the Convention and decision 4 /CP.1 on methodological issues,

Noting that, in accordance with Article 12.5 of the Convention, each Party not included in Annex I to the Convention shall make its initial communication within three years of the entry into force of the Convention for that Party, or of the availability of financial resources in accordance with Article 4.3, and that Parties that are least developed may make their initial communication at their discretion,

Recognising that, in accordance with Article 4.7, the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology, and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties,

Having considered that from its first session, in accordance with Article 12.7, the Conference of the Parties shall arrange for the provision to developing country Parties of technical and financial support, on request, in compiling and communicating information under this Article, as well as in identifying the technical and financial needs associated with proposed projects and response measures under Article 4. Such support may be provided by other Parties, by competent international organisations and by the secretariat, as appropriate,

1. *Requests* the Convention secretariat:

(a) In accordance with Article 8.2(c), to facilitate assistance to Parties, particularly developing country Parties, in the preparation of their initial communications, through the organisation of workshops at the regional level; to provide a forum for the exchange of experiences in the development of emission factors and activity data for the estimation of the inventory, as well as, on request, for other elements of information in the initial communication; and to provide a report to the Subsidiary Body for Implementation and the Subsidiary Body for Scientific and Technological Advice at each of their sessions; and

(b) To make available to the Subsidiary Body for Implementation, at each of its sessions, details of the financial support made available to Parties not included in Annex I to the Convention (non -Annex I Parties) from the interim operating entity of the financial mechanism for the preparation of their initial communications, including projects in this regard proposed by each Party, the funding decision and the date and amount of funds made available to the Party;

2. Decides:

(a) That non-Annex I Parties should use the guidelines contained in the annex to the present decision when preparing their initial communications under the Convention;
(b) That the national and regional development priorities, objectives and circumstances of non-Annex I Parties should, in accordance with Article4.1, and the provisions of Article 3 and Article 4.3, 4.4, 4.5, 4.7, 4.8, 4.9 and 4.10, be taken into account by the Conference of the Parties in considering matters related to their initial communications; and
(c) That non-Annex I Parties which wish to submit voluntarily additional information may use elements from the guidelines approved for Parties included in Annex I to the Convention when preparing their initial communications.

8th plenary meeting
19 July 1996

Annex2
Decision 12/CP.4

Initial national communications from Parties not included in Annex I to the Convention

The Conference of the Parties,

Recalling the relevant provisions of the United Nations Framework Convention on Climate Change, in particular Articles 4.1 and 10.2 (a) and Article 12.1, 12.4, 12.5,12.6 and 12.7 thereof,

Recalling also its decisions on first communications from Parties not included in Annex I to the Convention (non-Annex I Parties), in particular decisions 10/CP.2 and 11/CP.2,

Noting that, in accordance with Article 12.5 of the Convention, each non-Annex I Party shall make its initial communication within three years of entry into force of the Convention for that Party, or of the availability of financial resources in accordance with Article 4.3 of the Convention, and that Parties that are least developed may make their initial communications at their discretion,

Noting further the differentiated timetable for the submission of initial national communications from non-Annex I Parties,

Having considered that from its first session, in accordance with Article 12.7 of the Convention, the Conference of the Parties shall arrange for the provision to developing country Parties of technical and financial support, on request, in compiling and communicating information under that Article, as well as in identifying the technical and financial needs associated with proposed projects and response measures under Article 4 of the Convention, and *having also considered* Article 12.4 of the Convention,

1. *Decides:*

(a) To consider the information communicated by non-Annex I Parties in assessing the overall aggregated effect of the steps taken by the Parties, pursuant to Article 10.2(a) of the Convention;

(b) That communications from non-Annex I Parties shall be considered in a facilitative, non-confrontational, open and transparent manner;

(c) That, pursuant to decision 10/CP.2, the national and regional development priorities, objectives and circumstances of non-Annex I Parties should, in accordance with Article 4.1 of the Convention and the provisions of Article 3 and Article 4.3, 4.4, 4.5, 4.7, 4.8, 4.9 and 4.10 of the Convention, be taken into account by the Conference of the Parties in considering matters related to their initial communications;

(d) To ensure that issues and concerns identified by non-Annex I Parties in their initial communications are brought to the attention of the Global Environment Facility (GEF) and, through it, as appropriate, its implementing agencies when undertaking the comprehensive review of enabling activities projects;

2. *Requests* the subsidiary bodies to consider issues raised in the first compilation and synthesis report of communications from non-Annex I Parties at their eleventh sessions under relevant items of their agendas;

3. *Requests* the Subsidiary Body for Implementation, at its eleventh session, to consider the information communicated by non-Annex I Parties in assessing the overall aggregated effect of the steps taken by Parties;

4. *Requests* the Subsidiary Body for Scientific and Technological Advice to prepare scientific assessments of the overall aggregated effects of measures taken, in accordance with Article 9.2 (b) of the Convention;

5. *Decides* to continue to address the consideration of communications from non-Annex I Parties at its fifth session, with a view to taking a further decision on this matter;

6. *Requests* Parties to submit their views to the secretariat by 31 March 1999 on the consideration of communications from non-Annex I Parties, as well as the timing of second national communications**,** taking into account Article 12.5 of the Convention, for consideration by the Subsidiary Body for Implementation at its tenth session.

7. *Requests* the secretariat:

(a) To further facilitate assistance to developing country Parties, on request, in the compilation and communication of information required, in accordance with Article 8.2 (c) of the Convention;

b) To compile and synthesise the information provided in initial national communications from non-Annex I Parties, as indicated in decision 10/CP.2, and in so doing to report on the problems encountered in the use of guidelines for the preparation of initial communications by non-Annex I Parties, and on other issues communicated by non-Annex I Parties, with a view, among other things, to further enhancing the comparability and focus of the communications;

(c) To prepare the first compilation and synthesis report of communications from non-Annex I Parties based on submissions received from Parties by 1 June 1999 and make that report available to the subsidiary bodies at their eleventh sessions and to the Conference of the Parties at its fifth session;

(d) To compile and make available to Parties a list of projects submitted by non-Annex I Parties in accordance with Article 12.4 of the Convention;

(e) To compile and make available to the Subsidiary Body for Implementation a report containing views and concerns identified by non-Annex I Parties, and to ensure that such views are taken into account in the GEF review of enabling activities on climate change;

8th plenary meeting
14 November 1998

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[vii] U.S. EPA AP-42, Chapter 8. Compilation of Air Pollutant Emission Factors (AP-42):

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