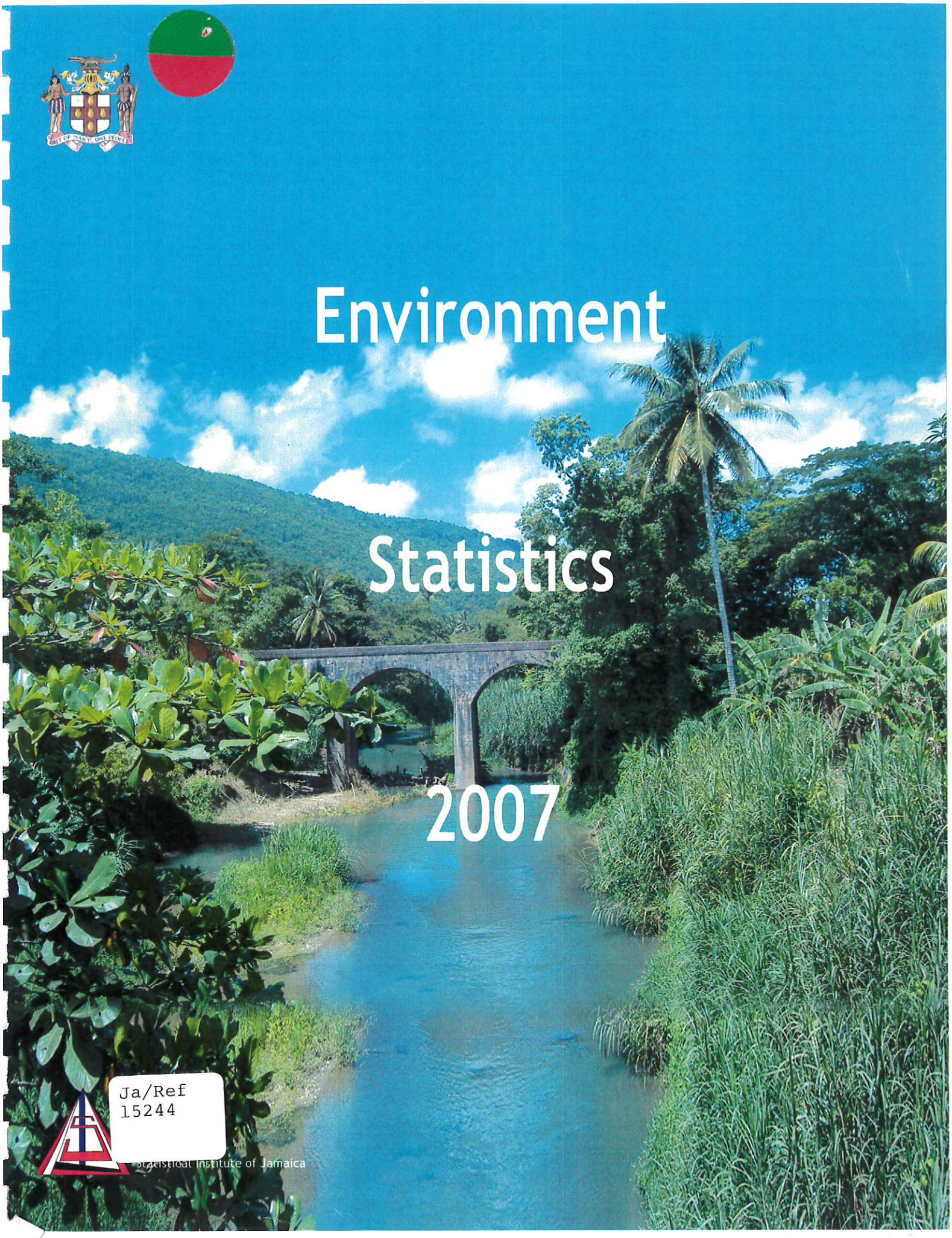

Environment Statistics 2007

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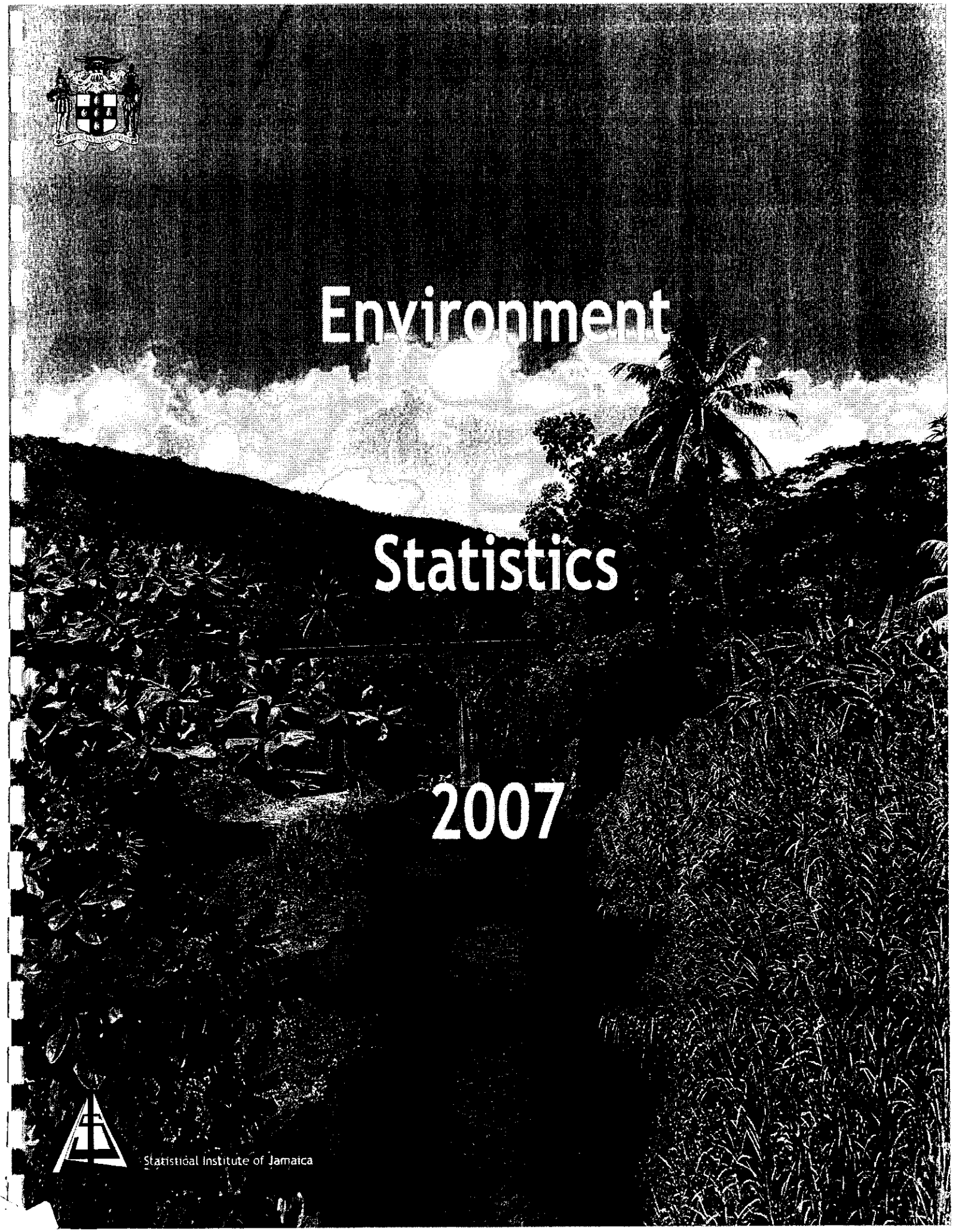
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Contents

Preface

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This book was made available to you through the Environment Statistics Unit in the Censuses and Demographic and Social Statistics Division. Ms Janet Geoghagen-Martin, with the assistance of Ms Philone Mantock, was responsible for the production of this book.

We believe that much can be done to improve the content, scope, design and timeliness of the environment statistic reports. The team continually strives to improve each aspect to make the publication as relevant and responsive to users' needs and expectations and any feedback is welcome.

This book is available in limited prints, on compact disc and in electronic format. It is also available as reference in STATIN's library.

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International Energy Agency (IEA)

International Union for Conservation of Nature

Jamaica Bauxite Institute

Jamaica National Heritage Trust

Jamaica Public Service Company Limited

Jamaica Tourist Board

Mines and Geology Division, Ministry of Energy and Mining

Ministry of Finance and Planning

Ministry of Industry, Technology Energy and Commerce

Ministry of Energy and Mining

Ministry of Land and Environment

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National Irrigation Commission

National Meteorological Service

National Solid Waste Management Authority

National Water Commission

Office of Disaster Preparedness and Emergency Management (ODPEM)

Ozone Secretariat – United Nations Environment Programme

Planning Institute of Jamaica

Port Authority of Jamaica

Water Resources Authority

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Notation

- – nil or negligible
- ... data not available or category not applicable
- p preliminary
- r revised

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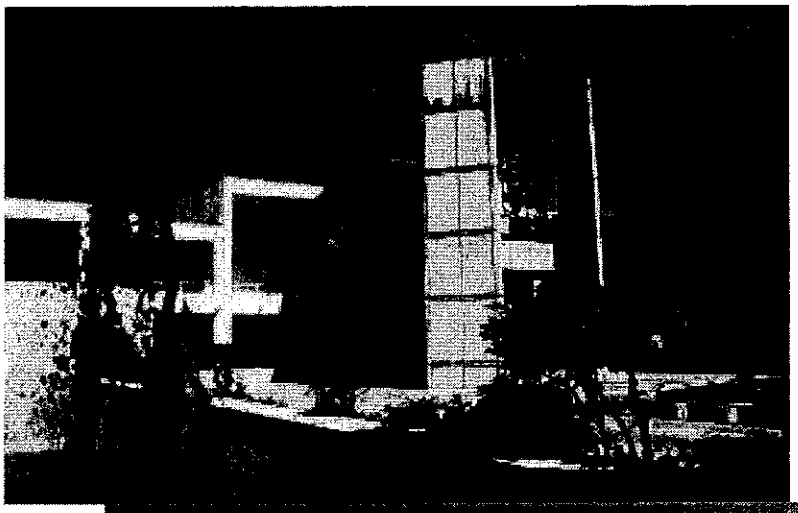
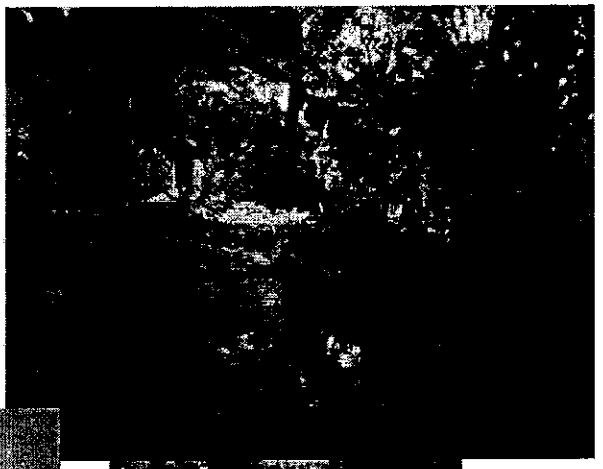
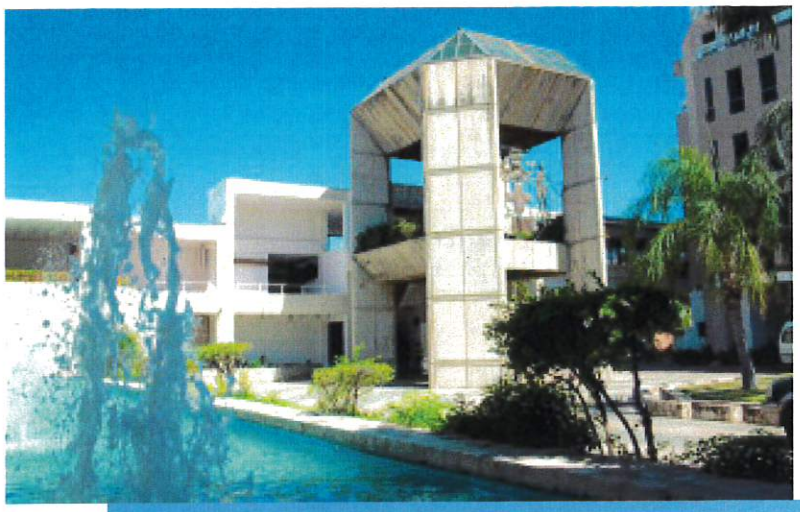
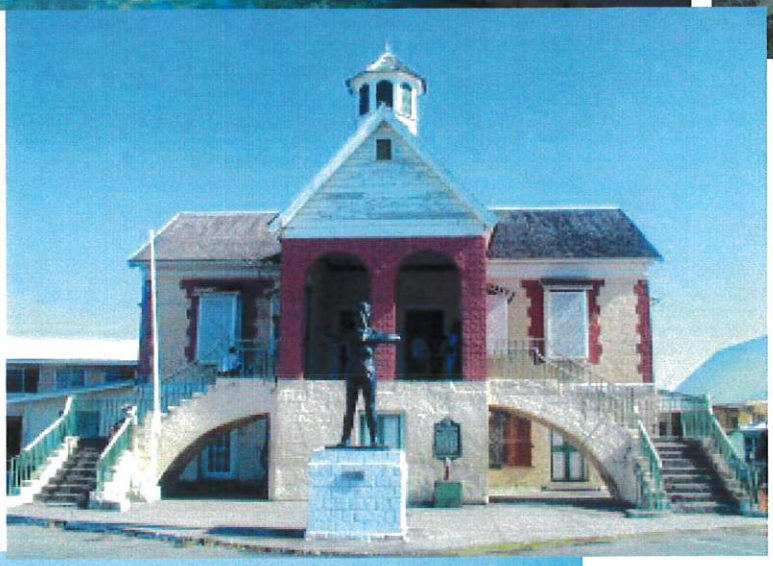








Introduction

All species on Earth are interconnected and dependent on each other – from the smallest to the largest. To this end there exists the need to ensure sustainability of the environment, still a topic of great importance to the government, non-government agencies and individuals. ***Environment Statistics 2007*** tries to address the environment issues identified in *Jamaica's Environment 2001 - Environment Statistics and State of the Environment Report* as they are still relevant.

While the connections between the environment and species are complex, in a simplified way plant growth relies on the breakdown of organic material by bacteria and insects; some insects and animals help to pollinate the plants so that they can reproduce; the plants in turn provide oxygen and food for animals and insects. As the world's population grows so too does the level of consumption and poverty. The increased numbers of humans put pressure on the environment, altering the use of supplies of freshwater, polluting the land and sea and overexploiting marine resources. At the same time increasing greenhouse gas emissions have modified Earth's systems leading to global climate change.

The United Nations Millennium Development Goal (MDG) No. 7 is to 'Ensure Environmental Sustainability'. The ten targets under Goal 7 are highlighted in relevant chapters in this book.

These pressures can affect the way in which the environment functions and the services provided by different ecosystems. **Forests and grasslands** purify air and water; produce and maintain soil; absorb carbon dioxide; are a wildlife habitat and provide wood, food and recreation for humans. **Freshwater systems** moderate water flows; dilute and remove pollutants; provide a habitat for wildlife habitat; provide drinking and irrigation water, food, electricity and recreation for humans. **Coastal areas** provide buffers against storms; dilute and remove pollutants; provide habitat for wildlife and food for humans; provide harbours and transportation routes and are recreational areas. **Sustainable agricultural ecosystems** produce and maintain soil; absorb carbon dioxide; provide wildlife habitat for birds, insect pollinators and soil organisms; provide humans with food and fibre crops (as these are man made they are different from other ecosystems).

The fifteen chapters are loosely structured according to the Pressure-State-Response (PSR) principle which is widely used internationally. The *Responses* are the measures undertaken by government, business enterprises, NGOs and others.

The PSR used in this book covers: **Pressure** – human activities and natural events that can degrade the natural environment, affect health, threaten survival of species; place pressure on resources and cause deterioration in the quality of human settlements. This leads to the **State** or quality of the environment and to the **Response** – the observations made of the effects of stress on the environment and the measures undertaken by government, business enterprises, NGOs and others to environmental changes, e.g., environmental protection and conservation.

1 Human Settlements

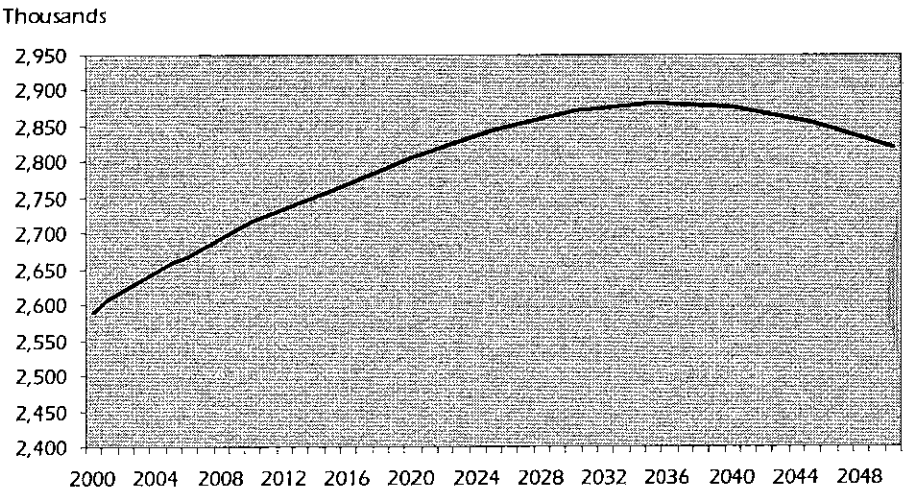
Population growth is an important factor in the state of the environment. As the population increases, so too do the effects and strains on the environment. Dense populations usually mean higher concentrations of waste products, emissions, sewage, etc. and higher risk for environmentally conditioned diseases such as gastroenteritis and typhoid. With higher concentrations of waste products, emissions and sewage there are threats of land, atmospheric and water pollution which will all result in degradation of the environment.

Human settlements encompass all places where people live, including remote communities, rural centres and cities. The physical elements of a human settlement include shelter, infrastructure and services. The impact that human society has on the environment relates to its size, production and consumption, resource use, technology used to supply goods and services and the effectiveness in preventing or repairing environmental degradation.

Population Changes

The 2001 census of Jamaica counted 2,607,632 persons as usual residents. Based on the population of 2,607,632 at census 2001 and 2,380,666 at 1991, the numerical increase in the population of Jamaica in the ten years since the 1991 census was 226,966, with the average annual growth rate estimated at 0.9 per cent.

Figure 1.1
Population Size 2000–2050

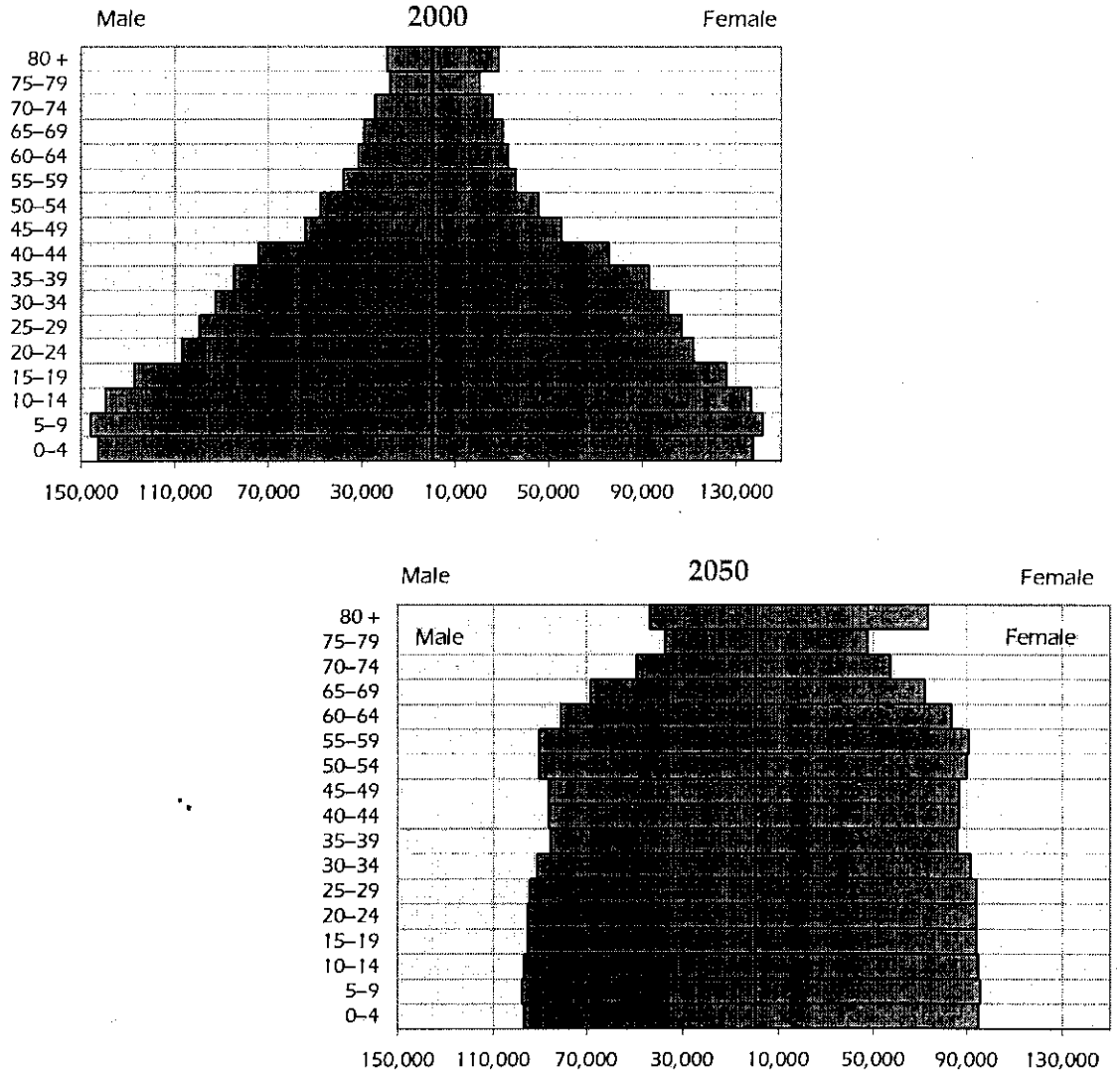


Source: Statistical Institute of Jamaica

Just over two-fifths (43.5 per cent) of the population, a total of approximately 1,134,200, lived in the contiguous south-eastern parishes of Kingston, St Andrew and St Catherine. One of the most significant aspects of population change in the past thirty years has been the growth of the parish of St Catherine. Between 1991 and 2001, St Catherine grew by 26.3 per cent, nearly three times the growth observed for the country as a whole. In terms of actual numbers, the parish of St Catherine grew by 100,336 between 1991 and 2001, thereby contributing 44.2 per cent of the overall growth of 226,966. (STATIN, 2001: 15).

At the end of 2007, the population was estimated at 2,682,100. This represents an increase in absolute terms of about 71,000 persons since 2001. The average annual rate of growth for the period was 0.47 per cent. Low growth rates are largely the result of declining fertility. Natural increase (the difference between births and deaths) for the period since 2001 is estimated at 212,100 but the change in population size was kept to 71,000 due to a net outflow of an estimated 136,800 persons, which is equivalent to approximately 64 per cent of the natural increase.

Figure 1.2
Population Size by Five-year Age Groups 2000 and 2050



Source: Statistical Institute of Jamaica

Population projections based on revised estimates at mid-year 2000 derived from the 2001 Population Census of Jamaica suggest that Jamaica's population will increase to 2.82 million people by the year 2050. This means an absolute increase of approximately

230,000 people in the fifty years. In relation to age structure, the only segment of the population which is expected to grow will be the elderly population. The percentage of the population aged 65 years and over will double from approximately 8 per cent to 16 per cent. The medium projections assumes a linear decrease in the total fertility rate to replacement level (approximately 2.1 children) during the period 2014 to 2015, a moderate decline in migration levels from an annual average of 20,000 at the base period to 15,000 at the end of the projection period. Average life expectancy for men and women is expected to be 72 years and 77 years respectively by 2050; an increase of approximately two years for both sexes.

The overall changes are expected to result in a slowing of population growth and an eventual decline in growth rates. This would likely result in decreased pressure on the environment.

Urbanisation

The 2001 census data showed that just over a half (52 per cent) of the population lived in areas classified as urban. For the census, a place was classified as urban if it had a population of 2,000 or more and provided a number of amenities that in Jamaica indicated modern living. In addition there are criteria related to land use which must be satisfied. Such criteria include the existence of commercial, industrial and residential areas. The urban share of 52 per cent represented an increase of two per cent over 1991 as the urban population rose from 1,192,000 to 1,355,300, an annual rate of growth of 1.24 per cent (see Table 1.3). Most parishes have remained predominantly rural and it is only in four parishes that the urban population is in excess of 50 per cent of the total population of the parish; Kingston (classified as all urban), St Andrew (87 per cent), St Catherine (74 per cent) and St James (55 per cent).

Table 1.3
Urban/Rural Distribution of the Population 1991 and 2001

Item	2001	1991	Percentage Change 1991–2001	Annual (%) Rate of Growth 1991–2001
Jamaica	**2,380,666**	**2,607,632**	9.53	0.88
Urban	1,192,047	1,355,346	13.70	1.24
Rural	1,188,619	1,252,286	5.36	0.50

Source: Statistical Institute of Jamaica

One of the most significant aspects of urbanization in Jamaica evident since 1970 has been the development and growth of centres outside the parish capitals. Some of these centres have actually surpassed the capitals in population size. Perhaps the most outstanding growth witnessed over the past three decades has been the development of the Portmore community in the southern part of St Catherine. In 1970 the section of the parish was a largely uninhabited area with a population of about 5,000. By 1982, as a result of major new housing developments, the population had grown to 77,600, indicating a rate of growth of 25 per cent annually in the twelve years. Portmore then, accounted for 23 per cent of the population of St Catherine. A slower rate of growth of two per cent between 1982 and 1991 took the population of Portmore to in excess of 90,000. In 2001

Portmore grew faster than Spanish Town the capital at an annual rate of 4.7 per cent, adding just fewer than 60,000 to see a population of 156,500. The area has increased its share of the parish population from a quarter in 1991 to almost one third in 2001. (STATIN 2001: 24)

Table 1.4
Population of Parish Capitals and Main Urban Centres, 1991 and 2001

Parish & Urban Centre	1991 Total Population	Per cent of Total	2001 Total Population	Per cent of Total	Percentage Change 1991–2001	Annual Rate of Growth 1991–2001
Jamaica	**2,380,666**		**2,607,632**		9.53	0.88
Total Parish Capitals	929,243	39.0	993,581	38.1	6.92	0.67
Total Other Urban Centres	206,482	7.9	290,466	11.1	40.67	3.41
Kingston & St. Andrew	**639,644**		**651,880**		1.91	0.18
Kingston Metropolitan Area	565,876	88.5	579,137	88.8	2.34	0.22
St. Thomas	**84,701**		**91,604**		**8.15**	**0.75**
Morant Bay	9,711	11.5	10,782	11.8	11.03	1.01
Portland	**76,317**		**80,205**		**5.09**	**0.47**
Port Antonio	13,261	17.4	14,568	18.2	9.86	0.91
St. Mary	**108,779**		**111,466**		**2.47**	**0.23**
Port Maria	7,281	6.7	7,439	6.7	2.17	0.21
Highgate	5,482	5.0	6,051	0.2	10.38	0.95
Annotto Bay	5,533	5.1	5,423	0.2	-1.99	-0.19
St. Ann	**149,425**		**166,762**		**11.60**	**1.06**
St. Ann's Bay	11,143	7.5	10,441	6.3	-6.30	-0.62
Ocho Rios	6,874	4.6	15,769	9.5	129.40	1.53
Browns Town	8,325	5.6	8,054	4.8	-3.26	6.32
Runaway Bay	5,749	3.8	5,840	3.5	1.58	0.15
Trelawny	**71,204**		**73,066**		**2.62**	**0.25**
Falmouth	8,039	11.3	8,188	11.2	1.85	0.18
St. James	**154,197**		**175,127**		**13.57**	**1.23**
Montego Bay	85,097	55.2	96,477	55.1	13.37	1.21
Hanover	**66,106**		**67,037**		**1.41**	**0.13**
Lucea	5,479	8.3	6,245	9.3	13.98	1.26
Westmoreland	**128,361**		**138,948**		**8.25**	**0.76**
Savanna-la-mar	16,629	13.0	19,893	14.3	19.63	1.73
St. Elizabeth	**145,651**		**146,404**		**0.52**	**0.05**
Black River	3,610	2.5	4,095	2.8	13.43	1.22
Santa Cruz	8,189	5.6	10,785	7.4	31.70	2.68
Manchester	**159,606**		**185,801**		**16.41**	**1.47**
Mandeville	40,680	25.5	47,467	25.5	16.68	1.49
Christiana	7,368	4.6	8,276	4.5	12.32	1.12
Porus	5,189	3.3	5,924	3.2	14.16	1.28
Clarendon	**214,704**		**237,024**		**10.40**	**0.95**
May Pen	48,262	22.5	57,334	24.2	18.80	1.67
St. Catherine	**381,872**		**482,308**		**26.30**	**2.26**
Spanish Town	114,175	29.9	131,515	27.3	15.19	1.36
Portmore	97,024	25.4	156,469	32.4	61.27	4.69
Old Harbour	18,389	4.8	23,823	4.9	29.55	2.59
Old Harbour Bay	5,591	1.5	6,344	1.3	13.47	1.20
Linstead	14,630	3.8	15,660	3.2	7.04	0.65
Bog Walk	9,096	2.4	11,241	2.3	23.58	2.05
Ewarton	9,043	2.4	10,807	2.2	19.51	1.78

Source: Statistical Institute of Jamaica

The growth in the parish of St Catherine, was also the result of fairly significant increases in other towns. The town of Old Harbour was second to Portmore, experiencing growth of 29.6 per cent between 1991 and 2001. The population of Old Harbour moved from 18,400 in 1991 at an annual rate of growth of 2.5 per cent to reach 23,800 in 2001. The population of Bog Walk increased by just over 2,100 in the ten years to exceed 11,000. Developments in the parishes of St Ann, and St Elizabeth are worthy of note. In St Ann, while the population of the capital town, St Ann's Bay, decreased, the resort town of Ocho Rios gained approximately 5,400 increasing in size by over 80 per cent between 1991 and 2001 to reach 15,800, thereby showing the highest rate of growth of any centre. In St Elizabeth, while the capital Black River declined, Santa Cruz grew by 31.7 per cent from about 8,200 to 10,800.(STATIN 2001: 24)

Table 1.5
Population in Urban Centres 5,000+ Population by Parish, 2001

Parish	Population in Urban Centres of 5,000+	Per cent of Parish Population
Kingston & St. Andrew	579,137	88.84
St. Thomas	10,782	11.77
Portland	14,568	18.16
St. Mary	18,913	16.97
St. Ann	40,104	24.05
Trelawny	8,188	11.21
St. James	96,477	55.09
Hanover	6,245	9.32
Westmoreland	19,893	14.32
St. Elizabeth*	14,880	10.16
Manchester	61,667	33.19
Clarendon	57,334	24.19
St. Catherine	355,859	73.78
All Jamaica	**1,284,047**	49.24

Source: Statistical Institute of Jamaica
** Includes the parish capital with a population of 4,095.*

Table 1.5 which summarises the data shown in Table 1.4 shows that an estimated 1.3 million persons, about 49 per cent of the population of Jamaica, lived in the parish capitals and main towns with populations of 5,000 or more in 2001. The main urban centre of the Kingston Metropolitan Area, with over a half a million people is located in the parishes of Kingston and St Andrew and accounts for more than 80 per cent of both parishes combined. The parish of St Catherine had seven urban centres with populations exceeding 5,000. The total population of these centres, approximately 356,000, accounted for almost three quarters of the population of that parish. In St James, Montego Bay, the parish capital with a population of 96,477 was the only centre in the category but accounted for 55 per cent of the population of the parish. Of the remaining parishes, Manchester had three urban centres including the capital with populations in excess of 5,000, which with a total of 61,667 accounted for three

per cent of the population of the parish. Clarendon had one and St Ann had four centres. For Clarendon, the capital May Pen with a population of 57,334, was representative of about 24 per cent of the population while St Ann had four centres with a combined population of 40,104, a 24 per cent of the parish population. Of interest also, is the fact that there were four communities, classified as rural (not shown in the table), with populations over 5,000 each. These had a total population of just fewer than 28,000 and were to be found in the parishes of St Andrew, (Lawrence Tavern and Golden Spring), Clarendon (Hayes) and St Catherine (Hellshire).

Population Density

The movements in parish populations described, are reflected in changes in density which are shown in Table 1.6. The population density for Jamaica in 2001 was 237 persons per square kilometre, 20 more persons than in 1991. Kingston and St Andrew has the second smallest area of all the parishes and the largest population, so its population density has been the highest. In 2001 there were 1,441 persons per square kilometre in Kingston and St Andrew. The parish of St Catherine followed with a population density of 404 persons per square kilometre. Trelawny had the lowest population density of 84 persons per square kilometre. The largest increase in density in the ten years is however seen for St Catherine, from 320 persons per square kilometre to the 404 persons per square kilometre in 2001 followed by St James which saw an increase from 259 persons per square kilometre in 1991 to 294 persons per square kilometre in 2001. The regional variations in densities undoubtedly result in varying impacts on the environment. In some areas population pressure may lead to devastating and unsustainable use of natural resources while other areas remain underutilised and underdeveloped.

Table 1.6
Mean Population and Population Density by Parish, 1991 and 2001

Parish	Census Population		Area (km^2)	Population Density	
	1991	2001		1991	2001
Kingston & St. Andrew	639,644	651,880	452.5	1,414	1,441
St. Thomas	84,701	91,604	742.8	114	123
Portland	76,317	80,205	814.0	94	99
St. Mary	108,779	111,466	610.5	178	183
St. Ann	149,425	166,762	1,212.6	123	138
Trelawny	71,204	73,066	874.6	81	84
St. James	154,197	175,127	594.9	259	294
Hanover	66,106	67,037	450.4	147	149
Westmoreland	128,361	138,948	807.0	159	172
St. Elizabeth	145,651	146,404	1,212.4	120	121
Manchester	159,606	185,801	830.1	192	224
Clarendon	214,704	237,024	1,196.3	179	198
St. Catherine	381,972	482,308	1,192.4	320	404
Jamaica	**2,380,667**	**2,607,632**	**10,990.5**	**217**	**237**

Source: Statistical Institute of Jamaica

Due to the vulnerability of coastal areas, it is especially important within coastal areas to maintain a balance between various demands for land presented by housing, industry and recreation. An estimated 9.3 per cent of the population lived in coastal areas at the time of the 2001 census. The population of coastal areas represents the population in enumeration districts with at least one boundary along the coastline. Table 1.7 presents data showing the population of inland and coastal areas for the parishes, from the censuses of 1991 and 2001.There were large variations between the parishes. In terms of absolute numbers, the largest number of persons living in coastal areas, approximately 41,000 was found in the parish of St Catherine. This represented approximately nine per cent of the population of the parish. In percentage terms it was the parishes of Hanover and Portland which had the highest percentage of population living in coastal areas. More than a third (33.6 per cent), of the parish of Hanover and just over one fifth (22 per cent) of the population of Portland lived in such areas.

For an estimate of the population in coastal areas the population in all enumeration districts (EDs) that border the coast were totalled.

What the data also show is that although the inland population far exceeds the coastal population, the latter grew at a much faster rate in the ten years. The coastal population grew at an average annual rate of 3.2 per cent between 1991 and 2001, more than double the national average of 0.9 per cent (see Table 1.7) and more than four times the 0.7 per cent average for the inland population.

Table 1.7
Estimated Population Living in Coastal Areas by Parish, 1991 and 2001

Parish	Population 1991				Population 2001			
	Inland Number	%	Coastal Number	%	Inland Number	%	Coastal Number	%
Kingston	–	–	99,762	100.0	–	–	96,052	100.0
St. Andrew	518,026	96.0	21,854	4.0	527,484	94.9	28,344	5.1
St. Thomas	65,739	77.6	18,962	22.4	71,615	78.2	19,989	21.8
Portland	60,273	79.0	16,044	21.0	62,392	77.8	17,813	22.2
St. Mary	92,684	85.2	16,095	14.8	93,830	84.2	17,636	15.8
St. Ann	132,434	88.6	16,991	11.4	147,517	88.5	19,245	11.5
Trelawny	65,125	91.5	6,079	8.5	66,011	90.3	7,055	9.7
St. James	137,926	89.4	16,271	10.6	150,436	85.9	24,691	14.1
Hanover	45,472	68.8	20,634	31.2	44,507	66.4	22,530	33.6
Westmoreland	112,320	87.5	16,041	12.5	119,326	85.9	19,622	14.1
St. Elizabeth	137,682	94.5	7,969	5.5	138,143	94.4	8,261	5.6
Manchester	156,379	98.0	3,227	2.0	181,751	97.8	4,050	2.2
Clarendon	207,442	96.6	7,262	3.4	230,232	97.1	6,792	2.9
St. Catherine	373,555	97.8	8,417	2.2	441,062	91.4	41,246	8.6
All Jamaica	**2,105,057**	**88.4**	**275,608**	**11.6**	**2,274,306**	**87.2**	**333,326**	**12.8**

Source: Statistical Institute of Jamaica

Household Consumption and Poverty

National average household size at the time of the 2001 census was 3.5, which represented a decline of 0.5 people in the 10 years since 1991. Data from the annual surveys of living conditions (JSLC) conducted since 2001 show that the decrease in household size has continued. In 2007 average household size was estimated at 3.3. Average household size in 2007 was highest in the rural areas (3.4) and lowest in the Kingston Metropolitan Area (3.1). Simultaneous with this decline has been the increase in the proportion of one person households. The proportion of households in Jamaica with only one person increased from 22.5 per cent of all households in 2002 to 23.8 per cent in 2007. At the same time, the proportion of households in Jamaica with six or more persons declined from 17.2 per cent of all households in 2002 to 14.9 per cent in 2005.

For the SLC, the KMA is defined to include not only Kingston and St Andrew but also Spanish Town and Portmore in St Catherine.

Table 1.8
Distribution of Households by Size and Region, 2002–2007

Household Size	KMA						Other Towns					
	2002	2003	2004	2005	2006*	2007	2002	2003	2004	2005	2006*	2007
1	20	24	24	24	24	21	22	25	27	25	25	25
2–4	57	56	55	56	56	58	50	44	48	52	51	48
5	9	10	10	8	21	11	10	15	11	10	24	12
6+	14	11	12	12	...	11	18	17	14	14	...	14

	Rural Areas						Jamaica					
	2002	2003	2004	2005	2006*	2007	2002	2003	2004	2005	2006*	2007
1	24	22	23	24	24	26	**23**	**23**	**24**	**24**	**24**	**24**
2–4	45	47	47	47	49	45	**50**	**49**	**50**	**51**	**52**	**50**
5	12	10	11	11	28	12	**11**	**11**	**11**	**10**	**24**	**12**
6+	19	21	19	18	...	18	**17**	**17**	**16**	**15**	...	**15**

Source: Jamaica Survey of Living Conditions
r revised
** In 2006 data for 6+ persons per household were not available.*

The relationship between households and the environment must be viewed within the context of household usage of raw materials, energy and water and by the production of emissions and the discharge of wastewater and solid waste. Patterns of household consumption and consumer behaviour are also relevant. The mean per capita household consumption in 2007 at current prices as reported by the 2007 Jamaica Survey of Living Conditions was $165,761, almost double the $82,248 estimated for 2002. Mean per capita household consumption was highest for the KMA in 2007 at $220,214 an increase of about 80 per cent since 2002 and lowest for the rural areas at $121,675 a 95 per cent increase in the five years since 2002.

The link between poverty and the environment is quite clear. Limited financial resources create an overdependence on natural resources for basic needs, such as water, food, fuel and shelter and as a major source of income. For Jamaica, the

Table 1.9
Incidence of Poverty by Region 2002–2007, per cent of households*

Region	2002	2003	2004	2005	2006	2007
KMA	10.4	9.5	14.3	9.6	9.4	6.2
Other Towns	18.7	15.8	7.8	7.2	9.2	4.0
Rural Areas	25.1	24.2	22.1	21.1	19.8	15.3
Jamaica	**19.7**	**19.1**	**16.9**	**14.8**	**14.3**	**9.9**

Source: Survey of Living Conditions
** Adult equivalent*

The poverty line for a family of five was $302,696.07 in 2007. The Adult Equivalent Poverty Line was $80,089.75 per person in 2007.

incidence of poverty is established at the national level by the poverty lines estimated through a consumption expenditure approach. The prevalence* of poverty was estimated at 9.9 per cent in 2007, declining from 19.7 per cent in 2002. The 2007 JSLC reports that the prevalence of poverty in 2007 was the lowest it has been since the inception of the survey. Rural areas continued to record the highest prevalence of poverty (15.3 per cent).

Box 1.1
MDG Indicator 7.10
Proportion of urban population living in slums

To achieve a significant improvement in urban populations with: lack of access to improved water supply and sanitation; overcrowding; and dwellings made of non-durable material.

Housing

Good quality housing is a key element in the determination of living standards. The SLC report presents an assessment of housing quality through the use of a Housing Quality Index (HQI). The HQI examines selected indicators of housing conditions. The components of the index are: materials of outer walls, exclusive use of water closets, dwellings with indoor pipes/taps, electricity for lighting, exclusive use of kitchens and number of persons per habitable room. For each of the components, the

Table 1.10
Housing Quality Index (HQI) 2002–2007 and by Region 2007, per cent households

Indicator of Housing Quality	2002	2004	2006	2007	2007		
					KMA	Other Towns	Rural Areas
Detached units	82.0	84.3	78.6	80.6	63.4	83.4	92.2
Ownership of units	61.2	56.9	60.5	59.8	46.7	63.6	67.9
Walls of block & steel	58.4	64.3	65.1	66.6	74.3	70.0	59.0
Own use of flush toilets	50.5	54.9	57.2	56.8	71.2	67.7	40.5
Indoor taps	45.0	49.3	48.5	50.6	80.5	60.6	22.9
Electricity for lighting	87.1	89.0	90.0	90.3	95.7	93.0	84.9
Own use of kitchen	90.5	90.0	93.6	93.1	89.8	92.9	95.7
No. of persons per room*	50.8	48.7	50.0	51.2	53.3	53.3	48.9
HQI	**67.8**	**69.8**	**70.5**	**71.1**	**74.5**	**75.9**	**66.2**
HQI (Modified)	**63.7**	**66.0**	**67.4**	**68.1**	**77.5**	**72.9**	**58.7**

Source: Jamaica Survey of Living Conditions 2007
** persons per habitable room*

percentage of households is given. The HQI is then calculated as the mean of the percentages for the selected components. Table 1.10 shows that the index has moved from 63.7 in 2002 to 68.1 in 2007 reflecting an improvement in the quality of housing over the period. The largest increases occurred in material of outer walls- walls of block and steel which increased by approximately 8 percentage points from 58.4 per cent in 2002 to 66.6 per cent in 2007, exclusive use of water closet moving up by an estimated 6 per cent from 50.5 per cent in 2002 to 56.8 per cent in 2007 and exclusive use of indoor taps which increased from 45.0 per cent to 50.6 percent between 2002 and 2007, an increase of approximately six per cent.

Household Tenure

In 2007, more than a half, 59.8 per cent of households owned the dwelling in which they lived. This was slightly less than the 61.2 per cent which owned in 2002. The data presented in Table 1.11 show some fluctuations in the years since 2002 as in 2004, the proportion had fallen to approximately 57 per cent, rising again to 60.5 per cent in 2006 before the fall to 59.8 per cent in 2007. The proportion of households which rented or leased in 2002 was approximately 22 per cent falling to an estimated 21 per cent in 2007.

Table 1.11
Tenure Status of Households 2002–2007, per cent

Tenure	2002	2004	2006	2007
Owner	61.2	56.9	60.5	59.8
Rent-free	16.5	19.3	17.6	19
Rented	21.6	22.5	20.7	20.7
Squatted	0.6	1.2	1.2	0.5
Other	0.1	0.2	0.1	0
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Jamaica Survey of Living Conditions

Squatting as a form of tenure has very important implications for the state of the environment. Squatting on land is unstructured and unplanned development and presents problems related to waste and sewage disposal, land use, and unsafe buildings. Informal settlements may also be situated at hazardous locations such as on riverbanks, along gullies or on the slopes of hills that may be affected by flooding and or land slippage. Squatting in dwellings are in many cases occurs where buildings have been left unattended and without the requisite facilities conducive to healthy living. Data on squatting should be interpreted with caution as this form of tenure as it relates to dwellings, is likely to be under-reported. The JSLC data show that only a minimal 0.5 per cent of households reported squatting as a form of tenure in 2007. The highest proportion reported for the period since 2002, is 1.2 per cent for 2004 and 2006. The category rent free represents tenure without payment but with the permission of the owner. It is very likely that some squatting is being reported in this category. Approximately 17 per cent of households reported rent-free status in 2002; by 2007 this had increased to 19 per cent.

Table 1.12
Dwellings by Source of Drinking Water 2002–2007, per cent

Source of Water	2002	2004	2006	2007
Piped Water	64.5	68.2	67.8	70.2
Public Standpipe	12.1	9.5	6.7	6.4
Rainwater (Tank)	15.3	14.3	15.4	14.1
Truck/Bottled Water	1.9	...	2.8	2.1
River/Spring/Pond	3.3	4.1	3.9	4.0
Well/Other	3.0	4.1	3.5	3.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Jamaica Survey of Living Conditions

Source of Drinking Water

The source of drinking water for approximately 70 per cent of all households in 2007 was piped water, an increase of 5 percentage points from the 65 per cent reported in 2002. (Table 1.12). On the other hand, there has been a decrease in the use of public standpipes for drinking water by about 50 per cent from, from approximately 12 per cent in 2002 to approximately 6 per cent in 2007. The source of water for around four per cent of all households in 2007 was from rivers, springs or ponds. Human health may be affected when water is used from these sources (rivers, springs or ponds) as they have the potential to be contaminated from agricultural, industrial and other wastes.

Table 1.13
Dwellings with Access to Piped Water and Flush Toilet by Region 2002–2007, per cent

Region	Piped Water				Flush Toilet			
	2002	2004	2006	2007	2002	2004	2006	2007
KMA	95.8	95.4	93.8	96.7	73.2	88.7	90.9	88.8
Other Towns	69.7	94.3	90.5	89	56.5	69.0	69.3	72.6
Rural	31.5	57.7	52.8	55	33.8	43.5	45.7	41.5
Jamaica	**58.7**	**77.7**	**74.5**	**76.6**	**59.2**	**63.8**	**64.9**	**64.3**

Source: Jamaica Survey of Living Conditions

In 2007, 64.3 per cent of households had access to water closets (flush toilets) with 34.6 per cent having access to pit latrines. An observation of the changes since 2002, show an increase in usage of the water closet occurring simultaneously with declining usage of pit latrines. In 2002, 59.2 per cent of households had access to water closet while 40.6 per cent had access to pit latrines. As perhaps expected there are marked differences in access to flush toilets between the urban and rural areas. In 2007, approximately 90 per cent of the households in the KMA had access to flush toilets. compared to approximately 42 per cent of rural households.

Table 1.14
Households by Type of Toilet Facility 2002–2007, per cent

Type of Facility	2002	2004	2006	2007
Flush toilet	59.2	63.8	64.9	64.3
Pit latrine	40.6	36.1	33.3	34.6
Other	0.1	0.1	1.8	1.1
None	–	–	–	–

Source: Jamaica Survey of Living Conditions

Nine out of ten households, 90 per cent, was receiving electricity in 2007 compared to 87 per cent in 1991 (see Table 1.15). On the other hand, the use of kerosene for lighting dropped from about 11 per cent of households in 2002 to six per cent in 2007.

Table 1.15
Percentage of Households by Source of Lighting, 2002–2007

Source of Lighting	2002	2004	2006	2007
Electricity	87.1	89.0	90.0	90.3
Kerosene	10.8	6.9	7.1	6.3
Other	0.6	1.3	0.9	1.5
None	1.4	2.8	2.0	1.9

Source: Jamaica Survey of Living Conditions
Figures may not total due to rounding.

2 Economy

The economy and the environment are inextricably linked. Continuing economic growth and human welfare are dependent upon the resources provided by the environment. The economy makes use of natural resources such as water, air, land, soil, minerals and petroleum to produce goods and services. However, there has been growing concern about the impact of a country's economic activity upon the global and local environment. Environmental problems arise from economic activities – for example, air pollution from transport, industry and power generation, or water pollution from households, industry and agriculture.

Jamaica's environment is under threat from various sources and the main productive sectors of tourism, agriculture, manufacturing and mining and quarrying are heavily dependent on our natural resources such as the beaches, sea, scenic beauty, land, mountains, fresh water and air. However these environmental and natural resources are deteriorating and if this trend is not halted, preferably reversed, then the industries and the population at large will be jeopardized.

The Gross Domestic Product

The Gross Domestic Product (GDP) is the market value of all goods and services produced by an economy during a specified period *or* the sum of value added at every stage of production in a given period of time. GDP at constant prices reflects changes ingoods and services produced in one period at the prices of another period (the base year). Table 2.1 shows the value added contributions for the years 1998 to 2006 based on the year 2003 prices.

A country's GDP is one way of measuring the size of its economy.

Table 2.1
Contributions of Value Added by Industry at Constant (2003) Prices 1998–2006, per cent

Industry	1998	1999	2000	2001	2002	2003	2004	2005	2006
Agriculture, Forestry & Fishing	6.7	6.8	5.9	6.2	5.8	6.0	5.2	4.8	5.4
Mining & Quarrying	3.9	3.9	3.9	3.9	4.0	4.0	4.1	4.1	4.1
Manufacture	11.3	10.7	10.5	10.3	10.0	9.6	9.6	9.1	8.6
Electricity & Water Supply	3.0	3.1	3.2	3.2	3.3	3.3	3.3	3.4	3.4
Construction	8.0	8.0	7.9	7.8	7.6	7.8	8.3	8.8	8.4
Wholesale & Retail Trade, Repairs & Installation of Machinery	19.8	19.3	19.6	19.3	19.1	18.8	18.8	18.9	18.8
Hotels & Restaurants	4.6	4.7	4.9	4.7	4.7	4.8	4.9	5.1	5.4
Transport, Storage & Communication	9.7	10.3	10.9	11.3	11.8	11.9	11.9	11.9	12.1
Finance & Insurance Services	9.1	9.5	9.8	10.2	10.8	11.1	11.2	11.1	11.0
Real Estate, Renting & Business Activities	10.0	9.8	9.7	9.7	9.6	9.5	9.6	9.6	9.5
Producers of Government Services	12.8	12.8	12.6	12.6	12.6	12.2	12.0	11.9	11.7
Other Services	6.3	6.3	6.3	6.3	6.4	6.4	6.5	6.6	6.7
Less Financial Intermediation Services Indirectly Measured (FISIM)	5.3	5.2	5.1	5.4	5.6	5.3	5.3	5.2	5.1
Total Value Added at Basic Prices	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: National Income and Product 2007

The four largest contributors to Jamaica's GDP for the year 2006 were Wholesale & Retail Trade, Repairs & Installation of Machinery, Transport, Storage & Communication, Producers of Government Services and Finance & Insurance Services as shown in Table 2.1. Among the goods-producing industries, Manufacturing is the largest followed by Construction, Agriculture, Forestry & Fishing and Mining & Quarrying.

The GDP of natural resource-related sectors are depicted in Table 2.2. Of all the natural resource-related sectors, Mining and Quarrying accounted for the largest amount with $14,289 million in 2006. This sector is very lucrative and contributes greatly to the economy. However it has resulted in noise and dust pollution, relocation of communities, loss of biodiversity as well as reduction of forest cover.

Table 2.2
Value Added of Natural Resource-related Industries at Constant (2003) Prices 2000–2006, ($'Million)

Industry	2000	2001	2002	2003	2004	2005	2006
All Industries	**47,021.2**	**48,872.8**	**47,424.2**	**50,043.1**	**47,298.7**	**46,371.3**	**50,603.8**
Agriculture, Fishing	**22,106.3**	**23,743.0**	**21,760.7**	**23,335.4**	**20,246.6**	**18,461.4**	**22,223.6**
Traditional Export Agriculture	**5,675.1**	**5,870.3**	**5,737.9**	**5,524.7**	**4,676.4**	**2,977.8**	**4,840.4**
Other Agricultural Crops	14,792.7	16,150.4	14,222.9	16,035.7	13,752.2	13,585.2	15,463.5
Fishing	1,638.6	1,722.3	1,799.9	1,775.0	1,818.0	1,898.3	1,919.8
Mining & Quarrying	**17,429.3**	**17,942.8**	**18,312.5**	**19,233.6**	**19,659.3**	**20,212.9**	**20,458.9**
Bauxite & Alumina	16,325.8	16,754.1	17,187.7	18,026.3	18,577.3	19,096.5	19,429.1
Quarrying incl. Gypsum	1,103.5	1,188.7	1,124.8	1,207.3	1,082.0	1,116.4	1,029.8
Timber-related Manufacturing	**4,245.9**	**4,069.5**	**4,140.8**	**4,131.4**	**4,164.4**	**4,325.3**	**4,564.5**
Wood Products*	1,559.5	1,519.4	1,501.7	1,469.9	1,461.8	1,488.5	1,646.3
Paper Products	2,686.4	2,550.1	2,639.1	2,661.6	2,702.7	2,836.8	2,918.2
Water & Sanitation Services	3,239.7	3,117.5	3,210.1	3,342.7	3,228.4	3,371.7	3,356.9

Source: National Income and Product 2007
** includes furniture*

The System of National Accounts 1993 (SNA93) is an internationally accepted set of guidelines for preparation of national accounts.

While GDP is the core accounting system of a national economy, it does not take into account the cost of resources and the environment. It only shows the growth or decline in an economy of a country and cannot reflect the consumption of resources and changes in environmental quality. Environmental accounting is a process where the physical and monetary costs of environmental assets and the costs of their depletion and degradation are calculated. In a green GDP accounting system, the environmental costs that occurred during economic activities are deducted from the GDP.

Environmental (Green) Accounting

The national accounts, particularly GDP, are a widely quoted and used economic indicator, used in the development of economic policy. One reason for developing environmental and resource accounts is due to criticisms of the national accounts that do not take into account the deterioration and use of natural resources as well as damage to the environment. An environment and resource account linked to the national accounting framework has seen a rapid growth in developed countries such as Sweden, Germany, Norway, Finland, France, Denmark, the Netherlands, Mexico, Australia and Canada which have implemented this practice.

The SNA93 discusses the incorporation of environmental information into the national accounts system. Two methods of doing this are to incorporate natural resources assets into the accounts; the other is to develop what is called a 'satellite system'. The Statistical Institute of Jamaica has revised the national accounts system to the SNA93 but there are no plans to develop an environmental accounting system, as the establishment of such accounts will be a long and complex process.

Difficulties in measuring environment accounting are: the evaluation of energy, mineral, natural, water and forest resources; measuring depletion and loss of resources; the cost of protecting, restoring or regenerating the loss. Three ways of measuring environmental costs are natural resource stock accounts, input/output (supply and use) accounts and environment protection expenditure.

Natural resource stock accounts measure stocks of natural resources and the changes in stocks due to human or natural acts. *Input/output accounts*, measure the use of energy, water and land, flows of commodities, waste generation and disposal, as well as production, imports and exports, labour and services between the economy and the environment. *Environment protection expenditure* identifies current and capital expenditure by enterprises in an effort to protect the environment. In Appendix 1 are results of a survey undertaken by STATIN in 2004. Results from this survey showed that most enterprises were involved in solid waste management activities while a minority were involved in the proteciton of surrounding air, soil and water.

Measures to Support Sustainable Development

Sustainable development is based on the concept that the quality of people's lives is affected by economic, social and environmental factors and an integrated approach to planning, decision making and development is requires for enhancing quality of life. Continuing steps have been taken to promote the sustainable use and conservation of the country's natural resources through the development of legislation, policies and plans. A few of these are:

- *Watershed Policy*: to foster the sustainable management of the island's watersheds
- *Beach Policy*: regulate the use of the foreshore, beach and floor of the sea
- *Policy on Environmental Stewardship of Government Operations and Guidelines*: to improve the overall efficiency and effectiveness of the public sector while reducing negative environmental effects of government operations
- *Hazardous Substances and Waste Management Policy*: for environmentally sound management of hazardous substances and waste
- *Environmental Management Systems Policy and Strategy*: to foster sustainable production and consumption patterns within government and industry
- *Enforcement Policy*
- *Transport Policy*: to provide a framework within which transportation can be developed and operated in a safe and environmentally friendly manner.
- *Housing Policy*: to provide the enabling framework for the access to affordable, safe and legal housing solutions
- *Energy policy*
- *Upgraded National Water Resources Master Plan*: to guide decision making on investment opportunities for sustainable water resources development
- *Conservation Easement Act*: will support the effective management of public and private lands towards conservation of natural resources
- *Local Sustainable Development Plan*: will serve as a framework for the sustainable development of each parish.
- *National Strategy and Action Plan on Biological Diversity in Jamaica*
- *Protected Areas System Plan*

3 Solid and Liquid Waste

Waste is referred to as material arising from human and animal activities which are discarded as useless or unwanted. As such, the disposal of waste is necessary in modern society. Waste is often grouped according to whether it is toxic or non-toxic; biodegradable or non-biodegradable. Types of waste have changed as society has become more modern; from the mainly organic waste of agricultural economies to the less biodegradable waste of more industrialised economies. There is more use of aluminium, paper and paperboard and plastics along with increased volumes of toxic and hazardous waste. With the change in waste there is the growing volume of it – with a growing population and rising incomes come changing patterns of consumption. Some sectors such as tourism and industry consume more and produce more waste than others.

Waste generation is unavoidable and constant especially in industrialised developing and developed societies. Even where products can be recycled, repaired or reused, they are simply thrown away. Other products are designed for one-time use and are then discarded, e.g. disposable diapers, plastic utensils and paper napkins.

Solid Waste

There are two main types of solid waste – municipal and non-municipal. Municipal solid waste consists of materials thrown away by homes, offices, stores, restaurants, schools and commercial facilities. This is comprised of packaging materials, paper, yard waste, plastics, wood, food, furniture and other materials such as textiles. Non-municipal solid waste includes waste from mining and quarrying, agriculture and industry. Most of this type of waste is managed on site instead of being transported to a conventional disposal facility. It is difficult to estimate the exact amounts generated per year as dumping of waste takes place in gullies, rivers, the sea and open lots.

The administration, collection, transport and treatment of municipal solid waste is the responsibility of the National Solid Waste Management Authority. The NSWMA:

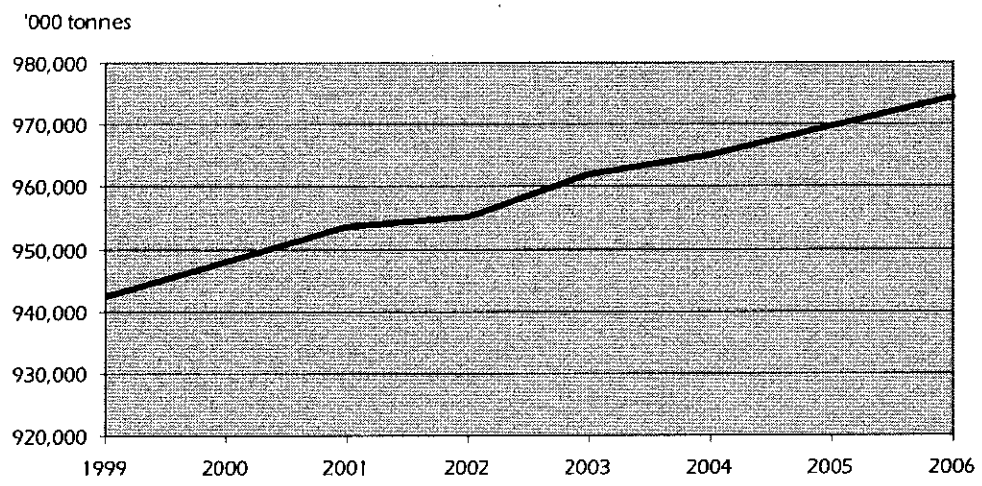
- establishes standards and criteria to be attained by solid waste operators;
- licenses solid waste companies, collection vehicles and disposal site operators;
- contracts solid waste collectors for municipal garbage collection;
- establishes collection zones in collaboration with parish councils and the town planning authority;
- establishes tipping fee structures and rates for industrial and large commercial entities disposing of waste at approved disposal sites; and
- operates solid waste disposal sites.

One goal of solid waste management is to lower the amount of waste in disposal sites and make environmentally safe waste disposal available to the majority of the population. Estimates of annual domestic waste generated in Jamaica and its growth over the years 1999 to 2006 are shown in Figure 3.1.

The NSWMA collects about 80 per cent of municipal solid waste that is collected in Jamaica; private collection agencies collect the other 20 per cent. Estimates of the generation of solid waste in Jamaica and collection by the NSWMA are shown in Table 3.2.

The parishes of Kingston and St Andrew, St Thomas, St Catherine and Clarendon are included in the Riverton wasteshed. Trelawny, St James, Hanover and Westmoreland are covered by the Retirement wasteshed. The Southern wasteshed covers St Elizabeth and

Figure 3.1
Estimated Domestic Waste Generated 1999–2006, 000 tonnes



Source: National Solid Waste Management Authority

It is estimated that over 18,000 tonnes of solid waste per week is generated in Jamaica.

Manchester and the North Eastern wastesheds includes Portland, St Mary and St Ann. Within these wastesheds, there are nine disposal sites in seven parishes (St Thomas, Portland, St Ann, St James, St Elizabeth, Manchester and St Catherine).

Table 3.2
Estimated Solid Waste Generation and Collection 2004

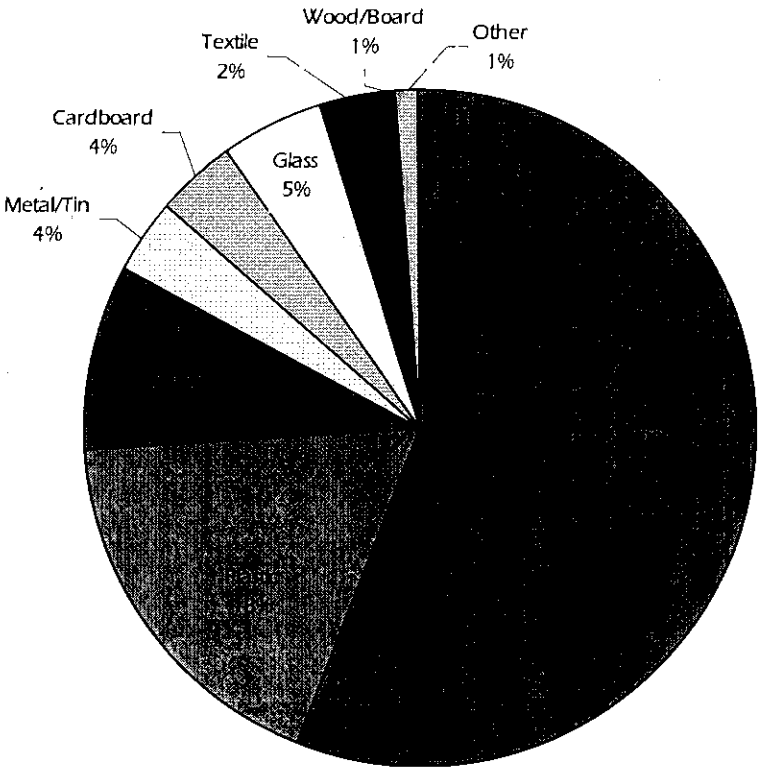
Wasteshed	Generation (tonnes per year)	Collection (%)	Collection Tonnes/yr
Riverton (St. Thomas, St Catherine, Kingston & St. Andrew)	526,403	72	381,106
Retirement (St. James, Trelawny, Hanover, Westmoreland)	166,951	69	115,815
Southern (Manchester, St. Elizabeth, Clarendon)	122,202	48	59,736
North-eastern (St. Ann, St. Mary, Portland)	129,940	56	73,535

Source: National Sanitation Policy for Jamaica

From Table 3.2 we can calculate that approximately 2,500 tonnes of waste is generated daily; of this only 66 per cent is collected (about 1,700 tonnes per day overall). Collection coverage in the southern and north-eastern wastesheds is low at 48 and 56 per cent respectively meaning that much municipal waste generated in those wastesheds is not disposed of properly. The wastesheds at Riverton and Retirement have higher collection coverage (72 and 69 per cent respectively). There are, however, areas which have no refuse collection and others where collection is irregular.

This estimated composition of municipal waste is shown in Figure 3.3. Yard and food waste (also called compostable) is the major form of municipal waste collected by collection agencies (56 per cent of municipal waste). Other main types of waste collected are plastics (18%), paper (9%), metal and tin and paperboard, glass, textiles and wood & board.

Figure 3.3
Estimated Composition of Waste Collected 2006



Source: National Solid Waste Management Authority

The composition of solid waste changes over time as today's waste consists of more plastics and paper but less glass or metal. There are various types of material not shown in the Figure 3.3 which are becoming more important as lifestyles and consumption patterns change. They are discussed below.

Computers are made up of high-quality plastics and metals such as aluminium, copper, tin, nickel, palladium, silver and gold. They also contain toxic heavy metals (lead [computers may contain 1–4 kg], cadmium, mercury and chromium) which could leach into soil and groundwater as they are frequently thrown away and end up in landfills.

Disposal

Two methods of burying solid waste are in a dump or landfill. A dump is an open hole in the ground where trash is buried. However, a landfill is designed with a bottom liner of clay or plastic and its layers are covered by soil. A landfill is designed so that the garbage is isolated from groundwater, i.e. it will not pollute the air, water or soil. Disposal sites are the main method of solid waste disposal in Jamaica and final disposal of waste is by open dumping or burning. One main site is the Riverton waste disposal site which sits on about 119 hectares and receives about 60 per cent of waste collected in the island.

Pollution of air, soil and water are the main problems created by using dumps to dispose of solid waste. Disposal sites produce methane gas which may seep through the solid waste and accumulate in underground pockets, with the potential of creating an explosion.

Another problem is the potential for contamination of surface and groundwater resources as household trash contains pesticides, heavy metals and organic compounds.

Illegal dumping takes place in rivers and streams, drains, wetlands and mangroves, alleys and land depressions. This makes it difficult to know the extent of waste produced in the island and the health and environmental damage taking place because of lack of knowledge on the level of generation of the different types of waste.

Hazardous and Toxic Waste

Hazardous and toxic wastes are any discarded chemical that threatens humans or the environment. Materials such as acids, chlorofluorocarbons (CFCs), dioxins, heavy metals, lead, mercury, polychlorinated biphenyls (PCBs), pesticides, arsenic and cadmium among others are a part of the solid waste stream.

Dioxins are formed as unwanted by-products during the combustion of chlorine compounds. Some sources are medical waste, cement kilns, pulp and paper plants that use chlorine for bleaching, waste incinerators and chemical accidents. Dioxins are emitted in smoke, settle on plants, soil and water and become incorporated into the food web. PCBs have been used as cooling fluids in vacuum pumps, electrical transformers and gas-transmission turbines and used in hydraulic fluids, fire retardants, adhesives, lubricants, inks and other materials. PCBs are improperly disposed of by dumping in landfills and sewers where they can seep into water resources. Often referred to as persistent organic pollutants (POPs), they remain intact for long periods of time.

Toxic waste is often disposed of in landfills and dumps because of the absence of toxic waste facilities. Waste such as chemicals, animal carcasses and manure from the agricultural sector is often not disposed of properly. Other waste such as household appliances, furniture, derelict vehicles, metal wastes and construction material often end up in illegal dumping areas. Medical waste from hospitals, clinics, pharmacies and veterinary practices can also cause injury to animals and the environment if disposal is improper.

Under the Natural Resources (Hazardous Waste) (Control of Transboundary Movement) Regulations 2002, the importation of hazardous waste into Jamaica is prohibited. The export of hazardous and other wastes for final disposal is restricted but there are no restrictions on export of hazardous and other wastes for recovery and on the transit of hazardous wastes and other wastes. In 2006, NEPA reported that 1,565 tonnes of hazardous wastes were exported from Jamaica.[1]

Jamaica ratified the Basel Convention on hazardous waste on 23 January 2003.

Recycling

The process of collecting, cleaning, treating and reconstituting materials and returning them as raw materials is called recycling. These materials would otherwise become solid waste. Reuse refers to using something that was not broken down into a raw material but remained in its original form.

Recycling is always preferred over landfill disposal as it conserves natural resources and is more environmentally friendly. Materials recycled in Jamaica for the export market are: lead acid batteries, scrap metal including copper wire. There is limited opportunity for recycling products in Jamaica. Where there is a lack of recycling and

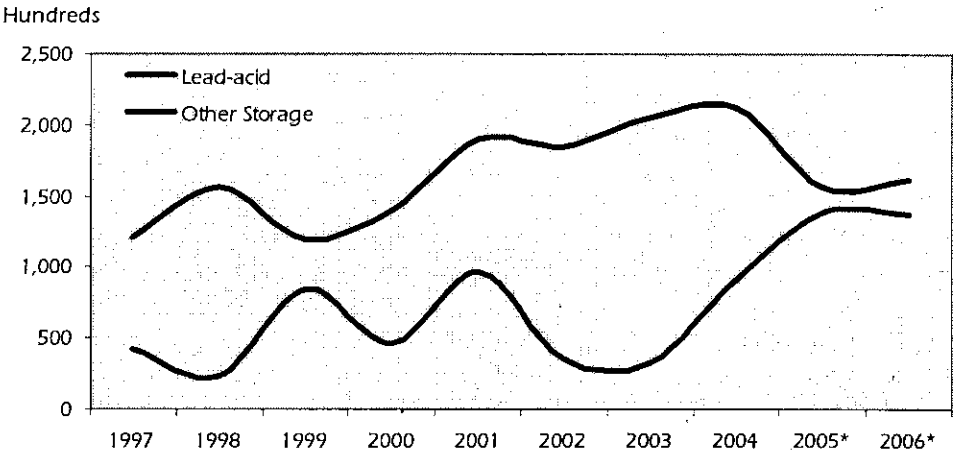
[1] *www.basel.int/natreporting/cfs.html*

reuse initiatives the minimisation of waste generation will fail as it becomes necessary to collect more and more waste.

Imports of Potential Waste Products

One method of estimating the volume of particular types of waste is to look at the importation of products which, because of their nature, eventually become waste material. Batteries of all types are imported into Jamaica – batteries to operate motor vehicles, flashlights, portable radios, mobile telephones, etc. Disposal of such batteries can be dangerous to the environment as leakages can drain into groundwater systems and contaminate the soil. Import data on batteries and cellular telephones can be seen in Figures 3.4 to 3.6.

Figure 3.4
Imports of Storage Batteries 1997–2006



Other storage batteries includes nickel, cadmium, nickel-iron and rechargeable batteries.

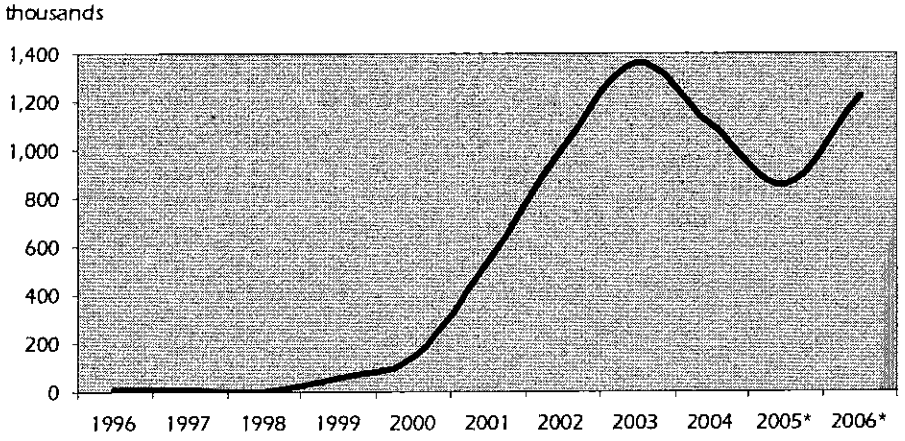
Source: Statistical Institute of Jamaica

Lead acid batteries contain lead and sulphuric acid and are dangerous to health of humans (especially children under 12 years old) and to the environment if not disposed of properly. These batteries are those used in motor vehicles, in the mobile telephone industry, and in power supply units. Importation of lead acid and other batteries are shown in Figure 3.4.

Figure 3.5 shows the volume of mobile telephone imports which have grown by almost 2,000 per cent between 1999 and 2006. Data for 2005 and 2006 are estimates; therefore there is no ready explanation for the decline seen in 2005.

Plastic waste is growing faster than any other and the majority of this comes from packaging material such as bags, containers and drums. Most plastics are stable and do not break down or decompose readily. Plastics can also cause harm to animals and birds that mistake the material for food. Some plastic containers carry food and beverages but others hold oil, pesticides and other hazardous materials. Plastic bags are generally made of polyethylene and are often used in the home for garbage bags but many are seen littering the streets. During beach clean-up exercises the most common materials collected are made from plastic which inevitably end up in marine environments. Sea creatures such as fish and turtles can die from accidentally ingesting plastic bags floating

Figure 3.5
Imports of Mobile Telephones 1996–2006

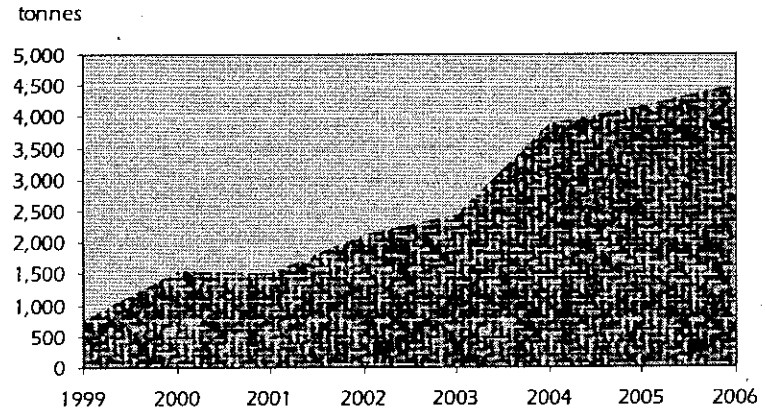


Source: Statistical Institute of Jamaica
** Estimates*

in the sea. An indication of the level of imports of plastic bags, sacks and cones, including those for agriculture, is shown in Figure 3.6.

Some plastics such as PET and HDPE plastics are recycled but the rate is very low and most end up in landfills. However, polyvinyl chloride (PVC) (or vinyl), present in shower curtains, tiles, toys, piping and automobile interiors, can be difficult to recycle as they contain chemicals such as heavy metals that may leach into groundwater over time. A large fire at a landfill can cause PVCs to release carcinogenic dioxins and other contaminants into the air.

Figure 3.6
Imports of Plastic Sacks and Bags 1999–2006, tonnes



Source: Statistical Institute of Jamaica

Total importation of plastic bags, sacks and cones increased from 780,000 kilos in 1999 to over 4.5 million kilos in 2006. Imports of plastic made of polymers of ethylene were 379,000 kilos in 1999, grew to a high of 1.4 m kilos in 2004 but declined to 609,000 kilos in

2006. Other imports of plastic sacks, bags and cones, however, are increasing and rose by 866 per cent between 1999 and 2006.

A total of 6,560 tonnes of plastic products, including PET bottles were manufactured in Jamaica in 2006.[2]

As waste generation increases, the capacity of current facilities is strained and there is pressure on land resources to create new waste disposal facilities. For sustainable development there is a need for waste minimisation through recycling, re-use, recovery, waste prevention and changes in consumption patterns.

Recycling

The process of collecting, cleaning, treating and reconstituting materials and returning them as raw materials is called recycling. These materials would otherwise become solid waste. Reuse refers to using something that was not broken down into a raw material but remained in its original form.

Recycling is always preferred over landfill disposal as it conserves natural resources and is more environmentally friendly. Materials recycled in Jamaica for the export market are: lead acid batteries, scrap metal including copper wire. There is limited opportunity for recycling products in Jamaica. Where there is a lack of recycling and reuse initiatives the minimisation of waste generation will fail as it becomes necessary to collect more and more waste.

Wastewater

Wastewater, including sewage, is carried by drains and sewers and contains human wastes from toilets, kitchens, washing machines and showers. Sewage is measured in terms of their biological chemical demand (BOD) also known as biochemical oxygen demand. This is the amount of oxygen needed by micro-organisms to decompose the wastes from CO_2, water and minerals.

Municipal sewage treatment

Wastewater, including sewage, is treated at sewage treatment plants to remove contaminants in wastewater in order to prevent health and environmental problems. This treated wastewater can then be reused as irrigation water, on golf courses or discharged into waterways or the sea. There are three types of wastewater treatment processes.

Primary treatment is the separation of particles such as sand and silt from the wastewater. This uses mechanical methods such as filters to remove pollutants and allow solid material to settle. This treatment does not eliminate the inorganic and organic compounds in the water.

In *secondary treatment*, micro-organisms are used to decompose the suspended organic material. This biological process generally removes 80 to 95 per cent of the BOD and suspended material. One common type is *trickling filters* in which wastewater trickles through aerated rock beds that contain bacteria and other micro-organisms which degrade the organic material in the water. In another type, *activated sludge*, wastewater is aerated and circulated through bacteria-rich particles forming secondary sludge. The sludge formed in both primary and secondary treatment methods must be treated and disposed of in a safe and effective manner.

[2] PIOJ, *Economic and Social Survey Jamaica 2006*

After going through primary and secondary treatments, wastewater still contains pollutants such as dissolved minerals, heavy metals, viruses and organic compounds. *Tertiary treatment* is the most advanced wastewater treatment method utilising biological, chemical and physical processes, e.g. sand filtration and 'lagooning', to remove further organic and inorganic substances. This produces a high quality of effluent and is the least used process in Jamaica.

Most wastewater treatment facilities are run by the National Water Commission (NWC). In 2006, the NWC had 68 facilities using ten different types of processes. The location and types are shown in Table 3.7 below. The most common were 21 oxidation ditches, 14 stabilization ponds and ten contact stabilization facilities. In 1999 there were 53 public sewage treatment plants compared to 68 in 2006.

Table 3.7
National Water Commission Wastewater Facilities, by Location, 2006

Type of Facility	Location					Total
	KMR	Southern	Central	Northern	Western	
Aerated Lagoon	1	2	3	–	–	6
Contact Stabilization	6	2	1	–	1	10
Extended Aeration	5	3	–	–	1	9
Oxidation Ditch	1	7	3	6	4	21
Stabilization Pond	1	5	4	1	3	14
Tile Field	1	–	–	–	–	1
Primary + Cl2	3	–	–	–	–	3
Sand Filter & Septic Tank	–	2	–	–	–	2
RBC*	–	1	–	–	–	1
Trickling Filter	–	–	–	–	1	1
Total	**18**	**22**	**11**	**7**	**10**	**68**

Source: National Water Commission
* RBC – rotating biological contactors

Box 3.1
MDG Indicator 7.9
Proportion of population using an improved sanitation facility

Halve, by 2015, the proportion of people iwthout sustainable access to safe basic sanitation.

Many private homes and apartments use individual septic systems for sewage disposal. Organic material in these systems is broken down by the bacteria within and the purified wastewater percolates into groundwater or evaporates from the soil. It is important, therefore, that use of bleach and drain cleaners be limited as they will kill the necessary bacteria. The sludge which collects at the bottom of the septic tank, after the liquid has percolated through, should be removed for proper disposal in a municipal sewage treatment plant.

Along with wastewater treatment plants of the NWC, there are about another 100 plants in Jamaica, some operated by the Urban Development Corporation. Of all treatment plants, activated slush process plants account for 79 per cent, waste stabilisation ponds for 15 per cent. As these plants do not all work, untreated wastewater often ends up in rivers or the sea polluting water and marine resources and ultimately damaging the coral reefs.

Liquid Industrial Waste

NEPA periodically visits selected industries to monitor their liquid wastes while other industries report on tests on their effluent. Data on industries that report on industrial effluents is shown in Tables 3.8 and 3.9. Effluents from three groups of industries were tested. None of the five chemical, pharmaceutical and cosmetic industries of the group 1 provided any data. There are 26 food and agricultural product industries in group 2 and nine power plants and mining industries in group 3. Overall 16 industries reported on their effluents and three were visited.

Table 3.8
Industrial Effluents in Selected Industries 2005–2006

Parameter	Group 1		Group 2		Group 3	
	Number of Industries with Data	Number Meeting Standards	Number of Industries with Data	Number Meeting Standards	Number of Industries with Data	Number Meeting Standards
BOD	–	–	9	1	4	3
TSS	–	–	9	1	4	2
NO_3-N	–	–	8	3	4	3
PO_4-P	–	–	8	3	4	4
Faecal coliform	–	–	9	1	4	–

Source: NEPA

NEPA made 24 visits to 19 sewage treatment plants to obtain the data shown in Table 3.8. None of these plants reported to NEPA. Tests were made for biochemical oxygen demand, total suspended solids, nitrates, phosphates and faecal coliform. Only the level of nitrates and phosphates met NEPA standards 100 per cent of the time. BOD levels met the standard only half of the time and tests for TSS and faecal coliform met the standards in 75 per cent of the tests.

Table 3.9
Industrial Effluents in Group 5 2005–2006

Parameter	Immediate Technology Base Standards	Group 5	
		Number of Data Sets	Number Meeting Immediate Standards
BOD	20	24	12
TSS	30	20	15
NO3-N	30	23	23
PO4-P	10	24	24
Faecal coliform	1,000	24	18

Source: NEPA

4 Land and Mineral Resources

The use of land is often dependent on its capacity to sustain various activities. Agriculture is dependent on soil structure and the type of soil; construction dependents on the condition of the soil, e.g. whether it is stable or there is good drainage. Other activities that depend on the land and its soil are forestry, mining, industrial activity and biodiversity, human settlements and recreation. While agriculture, forestry and the natural environment attempt to retain the characteristics favourable to plant growth, mining and quarrying operations remove the soil and later may attempt to rehabilitate it and re-establish the native flora, use it for agriculture or for housing. Attempts may also be made to contain or extract toxic materials used or deposited during the mining processes.

Land Use

The way land is used is important for development as land use affects natural resources, forestry, agriculture, biodiversity and human settlements. Much land is unsuitable for development, for example, steep slopes and other topographic considerations may make erosion a problem. Other areas that are low-lying are susceptible to flooding and may not be suitable for development. Development in watersheds, mangroves and swamps is not suitable as these are sensitive areas.

Table 4.1
Percentage Land Use 1989 and 1998

Land Use	1989	1998
Built up land	4.83	5.20
Buildings/Other infrastructure	4.72	4.75
Bauxite	0.11	0.45
Agricultural land[a]	37.76	36.63
Fields	24.85	24.97
Plantations	7.56	7.49
Other agricultural land[b]	5.34	4.16
Other non-forest areas	1.24	1.24
Bare rock	0.08	0.08
Small islands	0.01	0.01
Herbaceous wetland	0.99	0.99
Water	0.15	0.14
Total non-forest land use/cover	43.83	43.07
Forest[c]	31.29	30.95
Mixed land use/cover[d]	24.64	25.73
Total Land	**10,991.0**	

Sources: National Forest Management and Conservation Plan 2000 and Census of Agriculture 1996

a) Excluding wooded lands on farms.
b) Census of Agriculture 1996. In the Forestry data, this category is included under mixed land.
c) Details of the forest land are found in Table 6.3.
d) The mixed land use/cover is partly forested and partly bauxite lands, while agricultural parts are presented separately as other agricultural lands.

Land resources are finite.

There is competition among various land uses (e.g. urban expansion into agricultural areas).

Information on land use is usually derived from agricultural censuses, land cover information, aerial photographs and satellite pictures. The general land use categories are shown in Table 4.1. The latest land use data for 1998 show urban lands at 5.2 per cent of total land area. This can be compared to the 4.8 per cent of built-up land in 1989. The 0.4 per cent of bauxite lands in 1998 represented an increase of 312.5 per cent when 1998 is compared to 1989 (from 12 km^2 in 1989 to 49 km^2 in 1998). Agricultural land historically has the majority share of land in Jamaica, at 37 per cent of land use in 1998, a small decline from the 1989. The share of land for 'other non-forest areas' remained the same when the two years are compared. On the whole, total non-forest land use declined by 1.7 per cent and forest area by 1.1 per cent. Mixed land use saw an increase of 4.5 per cent.

Land use information is vital for physical planning and land management and more generally for policies on the use of resources and the management of such resources. These policies should cover the protection of the environment and projections of possible land use.

Box 4.1
Legislation related to planning
Parish Council Act, 1901
Local Improvement Act, 1914
Wildlife Protection Act, 1945, amended 1998
Beach Control Act, 1956
Town and Country Planning Act, 1958
Watershed Protection Act, 1963
Urban Development Act, 1968
Housing Act, 1968
Quarries Act, 1984
Natural Resources Conservation Authority Act, 1991
Forestry Act, 1996
Mining Act, 1947

Legal background

The National Land Agency's goal is 'to streamline the land titling process and modernise land registration systems'; this includes a mapping programme for the island. This, along with other objectives, will provide 'a sound basis for planning and development'.

The aim of the Town and Country Planning Authority (TCPA), a department of the National Environment and Planning Agency (NEPA), is to maintain efficient land use across the island and ensure the effective use of both urban and rural lands. The TCPA was re-established in January 2006, under the Town and Country Planning Act of 1958; one aim is to lower the incidence of unregulated construction of buildings in urban areas through a more efficient service for processing applications for development. Another aim of the agency is to ensure that all needs for land are satisfied in accordance with the Town and Country Planning Act and the Local Improvement Act. The department also aims to provide a more efficient service for assessing and processing development and sub-division applications. Along with NEPA, the agency prepares development orders for each parish. Development orders for Manchester and Negril (a special order as Negril is in both parishes of Hanover and Westmoreland) are presently being developed and plans are in place for a new development order for Kingston and St Andrew. A development order for St Ann was confirmed in 2000.

Factors taken into consideration by TCPA when processing applications for subdivision of land: existing conservation areas; slope of land; proximity to gullies, streams, the coast; and any reports of flooding. During the 16-month period January 2006 to May 2007, the TCPA received 266 planning and development applications including hotels, residences, cellular towers and commercial buildings. Of these, 233 were processed; 198 were approved and 35 refused.

Soil and Land Degradation

Soil is a necessary resource for agriculture and horticulture and has taken many thousands of years to develop. It is not an unlimited resource; is easily destroyed if mismanaged or misused. Land degradation refers to the reduction or loss of the biological or economic productivity and complexity of rain-fed lands; a decrease in the carrying capacity of a particular area of land. This may be due to a decrease in the fertility of the soil, an increase in soil erosion, removal of vegetation cover, changes in land use due to changes in the supply and quality of water, in biodiversity and air quality. Reduced soil fertility from the removal of top layers of soil leads to land degradation as can happen during mining operations.

It is difficult to quantify losses attributed to land degradation.

Soil erosion is a naturally occurring process but certain practices and events can increase the level of erosion. Natural processes remove loose soil at about the same rate at which soil is formed. However, loss of soil faster than the rate at which it is formed is due to human actions such as unsuitable farming practices, deforestation and overgrazing. Soil erosion is a major issue in Jamaica especially in instances where sloping marginal lands are cleared for cash crops. The minimal soil cover coupled with high rainfall leads to soil erosion and from there to depletion in soil nutrients.

Soil erosion has been hastened by the clearance of forests and dense natural vegetation for agriculture, along with unsuitable agricultural practices (overgrazing as well as the 'slash and burn' practice can leave the soil exposed). Eroded soils cannot retain water and are less efficient in filtering pollution. These soils are also less likely to be able to capture and store carbon. Eroded soils can cause landslides; accumulate in rivers and streams; cause flooding and damage to aquatic creatures and plants; and cause damage to bridges, crossings and roads. When silt gathers in reservoirs it leads to a loss of water storage capacity.

Soil erosion is often caused by the removal of protective layers above the soil.

Human activities that remove vegetation can make the soil easily eroded. For example, logging and heavy grazing can reduce vegetation enough to cause erosion; the introduction of roads leads to removal of ground cover and changes in drainage patterns.

Soil compaction occurs when particles of soil are pressed together reducing pore space between them. Heavily compacted soils have poor drainage and water infiltration rates.

Other forms of soil degradation are through salinisation, nutrient loss and compaction. Salinisation, the accumulation of soluble mineral salts on or near the surface of soil, is often caused by saline water seeping into ground water. It can also result from poor irrigation practices and can lead to the soil being completely unproductive. Soil salinisation is a problem in the irrigated areas of south St Catherine and Clarendon where large areas became saline and had to be taken out of production.

Humans and smaller organisms such as vegetation, worms, reptiles and birds rely on soil for their food supply and land for their habitat. Organisms live in the soil, contributing to its biodiversity. Data on soil flora and fauna in Jamaica is incomplete, so too is the rate of soil erosion.

Mineral Resources

Minerals are the raw material input for many industries and activities; they are finite and non-renewable natural resources. Any extraction of minerals and other related resources leads to changes in the landscape, air and water quality, production of waste and the ecosystem. Mining in Jamaica is mainly surface mining which, by its nature, leaves visual scarring on the landscape. Not all surface mining, however, causes land degradation.

Mining involves the extraction from land and the processing of mineral deposits. At the end of this process the mining site is closed, abandoned or the land reclaimed for alternative uses. Apart from disturbing the land, mining can cause damage to the air, water and natural habitats. The main groups of ores extracted from the earth are energy, industrial and construction minerals and metals.

Reserves

Estimates of mineral stocks are necessary for mining companies to have an idea of the size of deposits. The depletion (or replenishment) rates of minerals give an estimate of the volume of reserves of the resource. Types of minerals and mineral-based products found in Jamaica are bauxite, limestone, marble, sand and gravel, gypsum and shale, volcanic materials such as pozzolan, gold, clay and dolomite. Tables 4.2 to 4.6 below give estimates of the volume of some mineral deposits being mined in Jamaica.

Table 4.2
Estimated Alluvial Sand and Gravel Deposits 1982, million tonnes

Parish	Location	Replenishment Rate	Extraction Rate
St Andrew/St Mary	Wag Water River	n.a.	14,348
St Thomas	Yallahs	17.1 – 24	915,002
	Morant River	n.a.	13,446
Portland	Rio Grande	n.a.	14,348
St Mary	Dry River	n.a.	17,796
	Flint River	n.a.	1,011
Clarendon	Rio Minho	24.0 – 29.8	352,272
St Catherine	Rio D/Oro	n.a.	4,334
St Catherine	Rio Pedro	n.a.	3,922

Source: National Minerals Policy

Data on reserves of sand and gravel are difficult to measure as the reserves can change from year to year. Replenishment rates also differ in each river due to the level of rainfall. Ranges in rates of replenishment can be low in extreme floods to higher rates during smaller flooding. Constant mining in riverbeds may change the features of the river and create increased flood risk.

Six parishes have been identified as having clay deposits suitable for mining. The largest volumes appear in Westmoreland (152 million tonnes).

White limestone is found all over the island and make up most of the reserves of aggregate and industrial limestone. Other reserves are of the yellow and other limestone. Data on reserves of whiting grade limestone deposits have not been reliably quantified but estimates of 11.15 billion tonnes have been inferred. Total types of limestone, industrial, chemical and metallurgical grade limestone (calcium carbonate), have been inferred at 57.5 billion tonnes throughout the island. Reserves of dolomitic limestone deposits have been inferred for two locations in the island and are shown in Table 4.6 above. Limestone can be gradually converted to dolomite when water containing magnesium penetrates a limestone bed.

Table 4.3
Estimates of Clay Deposits 1982, million tonnes

Parish	Location	Estimated Reserves
St Andrew	Above Rocks	n.a.
	Golden River	0.002
	Liguanea	n.a.
St Mary	Jobs Hill	0.007
St Ann	Cave Valley	0.762
Westmoreland	Frome Plains	152.400
St Elizabeth	Black River Valley	0.508
	Holland	0.254
	Frenchman's	0.030
	Cow Market	0.304
	Nassau and Essex Valley	2.540
St Catherine	Bog Walk	2.150

Source: National Minerals Policy

Table 4.4
Estimates of Limestone Deposits 1982, billion tonnes

Name of Deposit	Volume
Stewart Bay/White Bay, Trelawny	2,632
Port Henderson, St Catherine	150

Source: National Minerals Policy

Table 4.5
Estimates of Gypsum Deposits 1982, million tonnes

Name of Deposit	90% Gypsum	80% Gypsum	70% Gypsum	Anhydrite
Brooks	1,299,770	1,524,200	1,645,100	3,097,400
Bito	1,539,400	2,060,700	2,229,900	2,154,600
Halberstadt	3,663,500	3,668,600	3,668,600	2,366,900
Total Reserves	6,502,670	7,253,500	7,543,600	7,618,900

Source: National Minerals Policy

Gypsum is one valuable resource and mineral export and deposits have been found at three locations in the island. Total reserves of gypsum deposits total 21 billion tonnes. Anhydrite reserves have been estimated at seven billion tonnes. Anhydrite is formed when water is evaporated from gypsum and is a harder and rarer mineral than gypsum.

Table 4.6
Estimates of Silica Sand Deposits 1982, million tonnes

Name of Deposit	Sand	Iron	Titanium Oxide
Alligator Pond (W)	3,356,640	241,678	46,267
Alligator Pond (E)	11,249,280	1,723,680	308,448
Sand Hill	1,767,040	277,213	59,194
Total	**16,372,960**	**2,242,571**	**413,909**

Source: National Minerals Policy

The largest silica sand deposits in Jamaica are in St Elizabeth with a smaller deposit in St Catherine.

Bauxite

Bauxite reserves of Jamaica are estimated to be two billion tonnes. As some bauxite is not accessible due to the high cost of mining, only one billion tonnes are economically viable. Bauxite is used to produce alumina which in turn is made into aluminium. About one tonne of red mud is produced from each tonne of alumina. The disposal of waste from bauxite production called tailings or alkaline mud is an ongoing one. The waste was first disposed of in red mud lakes which resulted in the seepage of the caustic residue into underground aquifers. However, mining companies have become more environmentally aware and have built lined ponds to hold this waste. These ponds, which are large areas of many acres, use up arable lands and do not necessarily dry out after they are filled.

An estimated four per cent of Jamaica's lands are 'bauxite lands' (420,000 has)

Production

While there are quarries in all parishes the majority of sand and stone quarries are in the eastern part of the island mainly along the Rio Minho in Clarendon and in St Catherine; limestone quarries are mainly in the western parishes. Most quarries are in rural areas. At the end of 2005, 218 quarries with licences had disturbed or mined on approximately 1,298 hectares of land. Thirty-two per cent of the quarries are situated in the parishes of St Catherine and Clarendon. Additional sites quarried in the past, some of which have been abandoned, are not included in the data in Table 4.7.

The majority of quarries – marl and fill (113) – produced material used mainly in the construction industry for roads and buildings. The two gypsum and shale quarries produce material for the production of cement; 72 sand and gravel quarries produced material mainly for the construction industry but with small quantities for the production of blocks (see Table 4.8). There are two igneous rock quarries which were not active during 2005.

Table 4.7
Number of Quarries by Parish 2005

Parish	Number
Kingston	1
St. Andrew	9
St. Thomas	19
Portland	10
St. Mary	18
St. Ann	16
Trelawny	10
St. James	15
Hanover	6
Westmoreland	16
St. Elizabeth	17
Manchester	11
Clarendon	37
St. Catherine	33
Total	**218**

Source: Minerals Policy and Development Division

Table 4.8
Number of Quarries by Material Produced, 2005

Material	Number	Quantity (tonnes)
Gypsum/Anhydrite	1	302,066
Igneous Rock	2	0
Limestone/Crushed Stone	29	2,610,000
Marl & Fill	113	5,310,000
Sand & Gravel	72	2,392,000
Shale	1	72,362

Source: Minerals Policy and Development Division

Table 4.9
Uses of Quarry Materials 2005, % of total produced

Material	Manufacture of			Construction of		
	Cement	Blocks	Lime	General/Buildings	Roads	Other
Limestone	28	10	11	30	20	1
Gypsum	96	0	0	0	0	4
Sand & Gravel	0	10	0	86	2	2
Marl & Fill	0	0	0	35	65	0
Shale	100	0	0	0	0	0

Source: Minerals Policy and Development Division

During 2006 some mineral deposits reported increased production: 2.8 million tonnes for limestone; 2.8 million tonnes for sand and gravel; and 180.0 thousand tonnes for shale; and 102.6 thousand tonnes for clay. Production for marl and fill quarries, however, fell by 43 per cent to 3.0 million tonnes when compared to the previous year. There was also a decline in the production of silica sand. Table 4.10 below shows production figures for a five-year period. Pozzolan is present on the earth's surface mainly as volcanic ash and is used to produce hydraulic cement.

Under the Quarry Control Act minerals are known as quarry materials while gypsum is defined as a quarry mineral.

Table 4.10
Production of Industrial Minerals 2002–2006, '000 tonnes

Mineral	2002	2003	2004	2005	2006[p]
Limestone	2,430.0	2,483.0	2,500.0	2,610	2,801
Marl/Fill	5,693.0	6,376.0	5,900.0	5,310	3,001
Pozzolan	–	–	–	79.0	149.3
Silica sand	9.40	12.80	11.20	14.30	9.60
Marble	0.16	0.16	0.12	0.12	0.10
Sand and gravel	2,249	2,316	2,362	2,392	2,760
Shale	...	217	185	164	180
Clay	...	81.0	525.0	45.0	102.6

Source: Mines and Geology Division & PIOJ
p preliminary

The volume of mineral production depends on the construction industry and demand for exports.

It is estimated that 20 per cent of the real demand for sand and about 10 per cent of limestone for construction purposes is supplied through illegal quarrying. These illegal activities contribute to land degradation through the removal of material by tractors and bulldozers.

Table 4.11 shows production of three minerals, bauxite, alumina and gypsum. The volume of bauxite mining grew by five per cent to 14.8 million tonnes; alumina produced from the mined bauxite grew only marginally. Gypsum, on the other hand, had a 24 per cent increase in production to 375,000 tonnes.

Table 4.11
Production of Minerals 2002–2006, '000 tonnes

Mineral	2002	2003	2004	2005	2006[p]
Bauxite [a]	13,119.5	13,444.5	13,296.5	14,118	14,851
Alumina	3,630.6	3,843.6	4,022.7	4,085.6	4,099.5
Gypsum	165.0	249.0	283.0	302.0	375.0

Source: Mines and Geology Division & PIOJ
a) defined as bauxite equivalent of alumina produced (about 2.5 times the alumina production) + crude bauxite.
p preliminary

The effects of mining and quarrying on the environment are pollution from dust and noise on nearby communities; waste such as from red mud residues; the reduction of forest cover and biodiversity and habitats, the degradation of watersheds from clearing areas for mining; and sediment loads to surface, coastal and marine waters. Open pit mining creates large holes that may prove difficult to rehabilitate when the mine is closed.

Rehabilitation

Before bauxite mining operations begin topsoil is removed from the land and stored for later replacement. However, after the bauxite is extracted, the soil is less suitable for agriculture as the water retaining capabilities have been compromised due to the removal of the underlying layers of soil and minerals. Approximately 64 per cent of mined areas, which were granted special mining leases, in four parishes have been reclaimed with all mined areas in St Elizabeth being rehabilitated in 2006 (see Table 4.12).The reclaimed rehabilitated lands have been used for pasture (67 per cent), agriculture (22 per cent), resettlement housing (10 per cent) and playfields, basic schools and communities (1 per cent).

Table 4.12
Reclaimed Mined Area 2006, hectares

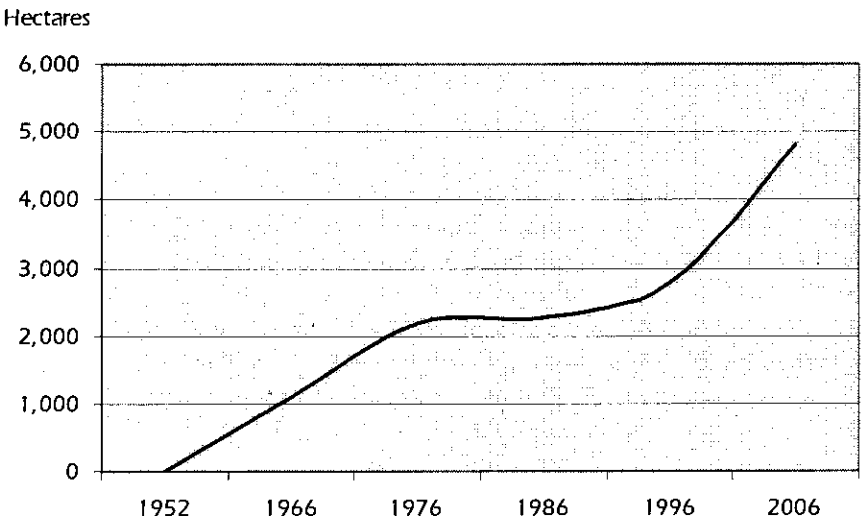
Parish	Mined Area	Area Reclaimed	%
St Ann	3,486	2,421	69.4
St Elizabeth	385	385	100.0
Manchester	3,085	1,691	54.8
Clarendon	517	307	59.4
Total	**7,473**	**4,803**	**64.3**

Source: Jamaica Bauxite Institute

Bauxite mining operators have been granted mining licences to 107,780 hectares (ha) of land up to the end of 2006. Up to that date, seven per cent or 7,473 ha of those bauxite lands had been mined or otherwise disturbed. Bauxite mining began in 1952

and the volume of land reclaimed since then is shown in Figure 4.13 below. Since 1966, over 13,000 ha of land has been rehabilitated, 7,600 ha in the ten years between 1996 and 2006.

Figure 4.13
Bauxite Land Reclamation 1952–2006, hectares



Source: Jamaica Bauxite Institute

Quarried lands are also rehabilitated but at a lower rate than in the case of bauxite lands. In the case of river-based quarries rehabilitation is not necessary and in some cases replenishment of the material is noted. Another reason for the low incidence of rehabilitation is that some quarry sites may be earmarked for other development after quarrying activities are over. It is estimated that up to 2005 about 20 hectares of quarried lands had been rehabilitated.

Two major pieces of legislation related to the mining sector are the Mining Act and the Quarries Control Act. Other regulations and policies are the Mining and Quarries Acts and Regulations, the Quarries Act and the Mineral Policy. Bauxite, gold and high purity limestone are covered under The Mining Act while the Quarries Control Act governs sand, gravel, marl and fill and stone. The mineral and non-mineral processing sectors are also required to comply with the Ambient Air Quality Regulations and Guidelines (2006) requiring monitoring, assessment and verification of emissions for each major facility. Other forms of legislation for which compliance are required are the Natural Resources Conservation Authority Act, the Wild Life Protection Act and, where port facilities are used, the Beaches Control Act.

The Mines and Geology Division and the Jamaica Bauxite Institute oversee the administration and implementation of several laws and regulations relating to the mining and quarrying sectors.

5 Agriculture

The essential role of agriculture is to meet the growing demand for food and other agricultural products. This is especially so in many developing countries like Jamaica where official policy is focused on stimulating agricultural growth in order to reduce the dependency on imported foodstuff. In terms of its relationship with the environment, agriculture plays an important role in storing carbon, managing watersheds and preserving biodiversity. On the other hand, agriculture is also the major user of natural resources contributing to underground water depletion, agrochemical pollution, soil exhaustion and global climate change.

Agricultural Land

The most recent census of agriculture for Jamaica conducted in 2007 identified approximately 319,000 hectares of land in farms. This represents 29 per cent of the total land area of approximately 1.099 million hectares. The pattern is one of a consistent decline in farmland in the nearly thirty years since the agricultural census of 1978 when 49 per cent of the land area of the country was devoted to farming. In absolute terms, the 319,000 hectares represents a decline of approximately 102,400 hectares in agricultural land since 1996 and an estimated 215,000 hectares since 1978.

Table 5.1
Land in Farms ('000 hectares): 1978–2007

Census Year	Total Land Area	Land in Farms	
		Total Area	% of Land Area
1978	1,099.00	533.8	48.6
1996	1,099.00	421.6	38.4
2007	1,099.00	319.2	29.0

Source: Statistical Institute of Jamaica

Approximately 61 per cent of the farmlands identified in the 2007 census may be classified as active farmland; that is, land allocated to crops and pasture. The proportion of this land type increased from about 58 per cent of the land in agriculture in 1978 to an estimated 65 per cent in 1996 but declined by four percentage points to approximately 61 per cent in 2007 (see Table 5.2). The table shows that in actual land area, the pattern is one of shrinkage of area in crops and pasture. The total area in crops in 2007 was 149.7 hectares, a reduction of just over 81.0 hectares, more than one third (37 per cent) of the land in crops in 1978 while pasture land was reduced by 43 per cent, from 80.8 hectares in 1978 to 45.8 hectares in 2007.

Farming in Jamaica is dominated by small holders. Occurring simultaneously with the decline in the area in farms is the increase in the number of farms, from 187,791 in 1996 to 228,610 in 2007. The increase is largely attributable to a rise in the number of landless farms and farms of less than one hectare in size (Table 5.3). The number of landless farms

Table 5.2
Utilization of Land in Farms: 1978, 1996, 2007

Item	1978	1996	2007
	Area in thousand hectares		
Land in Farms	**533.8**	**421.5**	**319.2**
Active Farmland	311.6	273.2	195.5
Crops	230.8	177.6	149.7
Pasture	80.8	95.6	45.8
Inactive Farmland	222.2	134.2	114.4
Use Not Reported	–	14.1	9.2
	Per Cent of Total		
Land in Farms	**100.0**	**100.0**	**100.0**
Active Farmland	58.4	64.8	61.2
Inactive Farmland	41.6	31.8	35.8
Use Not Reported	–	3.4	3.0

Source: Statistical Institute of Jamaica

has almost doubled since the last census. There were 28,070 landless farms in 2007 compared to 14,980 in 1996. Landless farms are typically those farms in which the minimum criteria for the land are not satisfied but the holder is in possession of the number of animals required to satisfy the criteria to be considered as a farmer. Between 1996 and 2007, the number of farms of under one hectare in size increased by 36,664, a rise of about 32 per cent.

Table 5.3
Number of Farms by Size, 1996 and 2007

Size of Farm	1996	2007	Change 1996–2007	
			Absolute Change	Percentage Change
All Farms	**187,791**	**228,610**	**40,819**	**21.7**
Landless	14,980	28,070	13,090	87.4
Under 1 ha	115,267	151,931	36,664	31.8
1 to under 2 ha	28,548	25,072	-3,476	-12.2
2 to under 5 ha	22,332	18,661	-3,671	-16.4
5 to under 10 ha	3,886	2,922	-964	-24.8
10 to under 25 ha	1,351	1,018	-333	-24.6
20 to under 50 ha	795	568	-227	-28.6
50 to under 100 ha	263	159	-104	-39.5
100+ ha	369	209	-160	-43.4

Source: Statistical Institute of Jamaica
Note: Based on farms reporting

An examination of the pattern in terms of size groups (Table 5.4) shows that about three quarters of farms account for only 15 per cent of area in farm land. A total of 151,931 farms of under one hectare were reported with total area of 47,713 hectares. Farms of 50 hectares and more totalled 368 (0.2 per cent of all farms), but occupied 125,578 hectares.

Table 5.4
Area in Farms by Size Group: 2007

Size Group of Farms	Number of Farms		Area in Farms	
	Total	Per Cent of Total	Total	Per Cent of Total
All Farms	**200,540**	**100.0**	**309,124**	**100.0**
Under 1 ha	151,931	75.8	47,713	15.4
2 to under 5 ha	18,661	9.3	52,697	17.0
5 to under 10 ha	2,922	1.5	19,720	6.4
10 to under 20 ha	1,018	0.5	13,404	4.3
20 to under 50 ha	568	0.3	16,694	5.4
50 + ha	368	0.2	125,578	40.6

Source: Statistical Institute of Jamaica
Note: (i) landless farms excluded
(ii) Based on farms reporting

Declining land area and increasing number of farms has resulted in a decline in the average farm size, from 2.4 ha in 1996 to 1.6 ha in 2007 (Table 5.5).

Table 5.5
Area in Farms and Average Size by Size Group: 1996 and 2007, hectares

Size of Farm	Area in Farms		Average Size	
	1996	2007	1996	2007
All Farms	**407,434**	**309,124**	**2.4**	**1.5**
Under 1 ha	43,459	47,713	0.4	0.3
1 to under 5 ha	101,977	86,015	2.0	2.0
5 to under 50 ha	67,723	49,818	11.2	11.1
50 + ha	194,275	125,578	307.4	341.2

Source: Statistical Institute of Jamaica
Note: (i) landless farms excluded
(ii) Based on farms reporting

Small farmers typically engage in subsistence farming, growing a variety of crops not primarily for sale. Farming practices would generally involve what is termed

'shifting cultivation' which consists of burning and clearing of vegetation, cultivating a plot of land, exhausting its fertility before moving on to another location. Historically, these small farms occupy the less productive hillsides, and are not mechanized. The larger farms tend to occupy the best lands on the plains, are engaged in the growing of one crop, in most instances, sugar cane and bananas and employ more mechanized and energy-consuming farming methods. These large farms also often apply more fertilizers and pesticides, generate more waste and produce more emissions than the small units.

Use of Pesticides and Fertilisers

While the use of chemicals in agriculture is beneficial in securing increased crop yields and improved quality, by controlling insects, weeds and disease-causing organisms, large scale uncontrolled use can be detrimental to the environment. Pesticide use produces air pollution while untreated fertilizers and pesticides can cause water pollution, thereby reducing biological diversity.

The benefits of applying pesticides include the prevention, destruction or control of pests and diseases and for administering to unwanted plants or animals and their insects.

In Jamaica, the Pesticide Control Authority is the agency of government charged with the responsibility for regulating pesticide use in the country. According to a Ministry Paper tabled in Parliament on October 31, 2006[1], the Authority exceeded its registration target for various types of pesticides by about 24 per cent in the 2004/2005 financial year. In relation to the importation of pesticides, it was noted that a total of 2,686 tonnes with a value of US$12.5 million was imported into the island during 2004/2005. The main imported pesticides comprise herbicides, fungicides, insecticides, nematicides and rodenticides.

Table 5.6
Quantity of Imported Pesticides by Type: 2000, 2005 and 2006, '000 tonnes

Type of Pesticide	2000		2005		2006	
	Quantity	% of total	Quantity	% of total	Quantity	% of total
Herbicides	724.3	46.7	763.1	48.7	923.3	58.0
Fungicides	417.1	26.9	354.2	22.6	434.9	27.3
Insecticides	274.2	17.7	234.3	15.0	161.4	10.1
Rodenticides	98.7	6.4	64.5	4.1	68.8	4.3
Other	35.8	2.3	150	9.6	4.7	0.3
Total	**1,550.00**	**100.0**	**1,566.10**	**100.0**	**1,593.10**	**100.0**

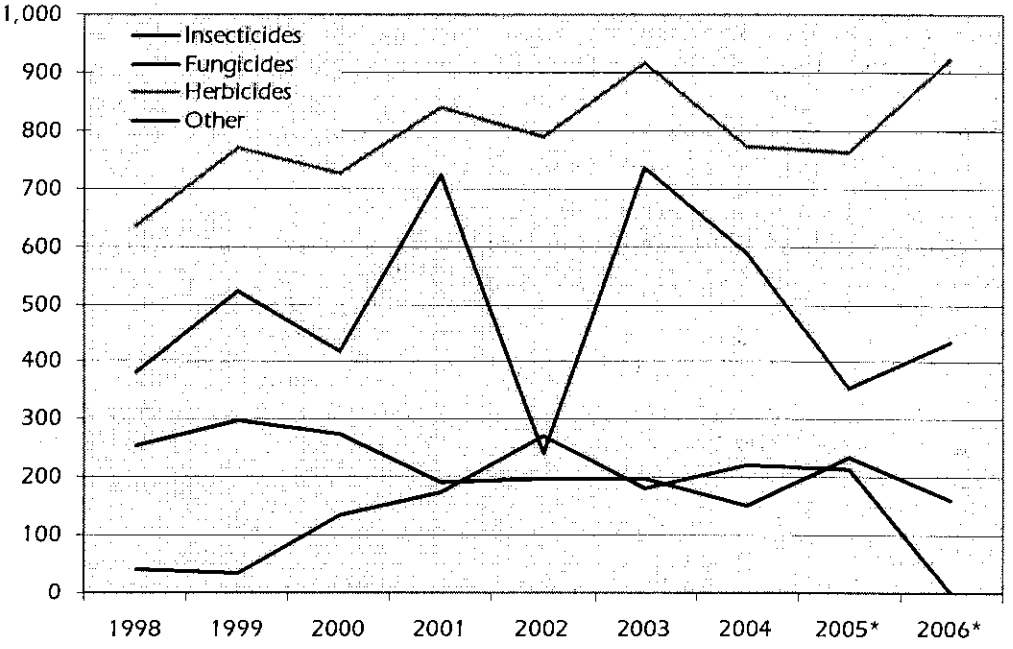
Source: Statistical Institute of Jamaica

Table 5.6 presents data showing the quantity of pesticides imported into Jamaica in 2000, 2005 and 2006. In 2006, herbicides accounted for more than a half (about 58 per cent) of the approximately 1.6 million tonnes of pesticides imported. In the same year about 435,000 tonnes of fungicides, about 27 per cent of the total were imported. Smaller proportions of insecticides (10 per cent) and rodenticide (four per cent) were imported during 2006.

[1] Retrieved 1 April 2009 from http://www.jis.gov.jm/parliament/htm/2006

Figure 5.7
Quantity of Imported Pesticides 2000–2006

'000 kgs



Source: Statistical Institute of Jamaica
** Estimates*

Chemical fertilisers upset the natural balance in soils and destroys natural soil micro-organisms necessary for healthy plant growth.

Figure 5.7 which covers the same period is based on the quantities imported for each year between 2000 and 2006. The pattern seen is one of an increasing trend in the importation of herbicides and fungicides at the same time as the quantity of insecticides and rodenticides being imported declined.

Table 5.8
Quantity of Fertiliser Imported and Produced 2002– 2006, tonnes

Fertiliser Imported	2002[r]	2003	2004[r]	2005[p]	2006[p]
Ammonium sulphate	13,711.9	17,249.9	16,583.1	13,723.1	10,499.1
Ammonium nitrate	535.5	539.4	819.3	1,150.3	1,233.0
Diammonium phosphates	8,516.9	10,040.6	12,511.4	10,047.1	4,025.6
Potassium chloride	225.3	324.2	19.6	0.1	0.1
Urea	6,988.4	7,937.1	7,132.9	2,855.2	3,142.6
Other fertilisers	10,996.5	15,730.4	20,641.3	8,053.5	11,110.3
Total	**40,974.6**	**51,821.5**	**57,707.7**	**35,829.4**	**30,010.7**
Production of fertiliser	40,013.0	45,871.0	45,890.0	n.a.	n.a.

Source: Statistical Institute of Jamaica
p preliminary

While organic fertilisers, which are mainly taken from plant and animal sources, are safer there continues to be a heavy dependence on fertilisers of the inorganic type, derived mainly from petroleum and natural gas. If applied excessively, inorganic fertilisers not only burn and totally destroy plants but are detrimental to earthworms and micro organisms in the soil that help in the plants' growth. Applied excessively or too liberally also, inorganic fertilisers can be washed and transported by rain into water sources (such as rivers and lakes) and end up polluting them. If this happens, it may result to an increase in growth of several aquatic plants which can then substantially lessen the supply of oxygen in water and kill fish.

Organic farming, a method of growing agricultural and horticultural crops, is being encouraged by government. This method uses no easily soluble fertilisers and no pesticides therefore products on which these are used are considered to be healthier.

Much of the fertiliser used in Jamaica is imported. Table 5.8 presents data showing the quantity of the product imported by type, for the period 2002–2006. Data on local production are limited and are also included in the table.

Use of Irrigation

Irrigation becomes necessary in areas where rainfall is insufficient to supply crop needs, but there are several negative effects of dams and irrigation systems. Water logging, salinity, disruption of water tables and damage to fisheries, plant, wildlife and water supply systems are some of the more damaging consequences of the practice.

Development and management of efficient irrigation systems in Jamaica is the responsibility of the National Irrigation Commission (NIC). The NIC explains that:

"Water is essential in the movement of plant nutrients from the soil to the growing crop and in maintaining turgidity in plant cells. Given the right amount of irrigation, plant growth and crop yields are assured. No irrigation is required if effective rainfall (total rainfall minus run-off) is sufficient to supply crop needs. Effective rainfall is therefore that which is absorbed in the soil and excludes that portion lost from the crop's rooting zone by deep percolation, is available for plant growth until depleted to the wilting point for the particular soil. Since a crop requires the right proportions of air and water in the soil for optimum growth, drainage is beneficial in heavy soils with slow internal movement of water. Removal of this excess water also flushes out dissolved salts which may be harmful to plant growth."[2]

Waterlogging and salinity can be caused by the overuse and/or poor management of irrigation water.

The efficient irrigation practices identified by the NIC are careful analysis of the soil intake and proper scheduling of irrigation. As the rate of water intake of soils varies with the soil type, irrigation should not be applied at rates which exceed the rate of absorption of the soil as this causes loss through surface run off and/or evaporation resulting in a low irrigation efficiency, and possibly salination of the soil. Proper scheduling of irrigation ensures that the supply of water which is readily available for plant growth is replenished.

The National Irrigation Development Master Plan for Jamaica proposes 51 projects for construction, for implementation by the year 2015. In general, the objective of the Master Plan is to promote a sustainable approach to Irrigated Agricultural Development. Consequently, a number of environmental factors (listed below) were taken into account in the selection of the projects for inclusion.

- Does the project lie within a protected area?
- Is the water quality within irrigation standards?
- Does the project present opportunity for wastewater reuse?

[2] National Irrigation Commission Jamaica retrieved 6 April 2007 from http://www.nicjamaica.com/

- Does the project present opportunity for irrigation water reuse?
- Is the project likely to present unacceptable soil erosion rates?
- Will the project convert non-agricultural land into irrigated agricultural land?

The 51 projects identified cover approximately 20,702 hectares of land concentrated primarily on the southern plains of the southern parishes of St Catherine and St Elizabeth. Table 5.9 shows the parish distribution of these projects and the area covered. The table shows that the parishes of St Catherine and St Elizabeth account for about 42 per cent and 20 per cent respectively of the total area of land covered by the projects.

Table 5.9
Table National Irrigation Development Plan-Projects

Parish	Hectares	% of total
St Thomas	1,672	8.1
Portland	560	2.7
St Mary	594	2.9
St Ann	134	0.6
Trelawny	421	2
St James and Hanover	369	1.8
Westmoreland	1,770	8.5
St Elizabeth	4,132	20
Manchester	512	2.5
Clarendon	1,909	9.2
St Catherine	8,629	41.7
Total	**20,702**	**100**

Source: National Irrigation Commission retrieved 6 April 2007 from http://www.nicjamaica.com/

The 2007 census of agriculture included a question on the use of irrigation in the calendar year preceding the census and the methods used. The instruction manual for interviewers defined irrigation as "purposely providing land with water, other than rain, for improving pastures or crop production". The instructions further explained that "irrigation usually implies the existence of infrastructure and equipment for applying water to crops, such as irrigation canals, pumps, sprinklers or localized watering systems. *However it also includes manual watering of plants using buckets, watering cans or other devices.*" Uncontrolled land flooding by overflowing of rivers or streams was not to be considered irrigation.

A total of 14,699 holders representing about six per cent of the total number reported having used irrigation (as defined) in 2006. The majority of these holders, more than 90 per cent, were operators of farms of less than 10 hectares in size. Use was reported for 50 farms of 100 hectares and over.

Regarding the methods used, Table shows that a total of 12,383 farmers reported on the method of irrigation used, with more than a half of these (approximately 55 per cent) reporting other methods. Just over a quarter (an estimated 26 per cent) reported using the sprinkler system.

Table 5.10
Use of Irrigation by Method 2007

Method of Irrigation	Number	Per cent
Total holders reporting method	**12,383**	**100**
Drip/Trickle	1,099	8.9
Sprinkler	3,205	25.9
Flooding	734	5.9
Furrows	553	4.5
Other	6,792	54.8

Source: Statistical Institute of Jamaica

Box 5.1
Irrigation Methods

Sprinkler system – an irrigation system in which water is conveyed to the area to be irrigated usually through a system of moveable aluminium pipes fitted with sprinklers or 'rain-birds'. This system is less efficient than the drip/trickle system in terms of the volume of water needed for increased production and productivity.

Flooding – an irrigation system in which the area to be irrigated is flooded with water. This water is usually conveyed to the site by a system of irrigation canals, and after the site is flooded, specially constructed drains drain excess water away. This system requires the site to be levelled or planed and graded by land levellers or some other mechanical equipment. Flooding is a very inefficient system in terms of irrigation water usage.

Furrows – an irrigation system that in some respects is similar to flooding, but uses less water than flooding. The field to be irrigated is planed and graded, and a system of furrows is installed that allows water to flow freely from the top of each furrow to the bottom. The crop is planted beside the furrows and is irrigated by water, which moves laterally and vertically to the root zones of the plants.

Other – any other type of irrigation system that is not mentioned earlier. This includes manual watering of plants using buckets, watering cans or other devices.

Source: 2007 Census of Agriculture Jamaica. Enumeration Manual

Historically, agriculture has had a positive affect on landscapes and biodiversity but intensive agriculture is often a threat to plants and animals through its use of marginal lands and pollution of air, water and soil. The variety of tree and vegetable food crops cultivated necessitates that proper crop cultivation is used on arable land, an important consideration for soil conservation.

6 Forestry & Watershed Management

Forests are known for their economic functions such as production of timber, firewood, food, medicine, employment and recreation. However, they also provide a habitat for animal and plant life, protect soils and regulate water flows and carbon cycles. Forests on hillsides and slopes provide protection from flooding of lowlands by trapping and absorbing rainfall. When woodlands are cut down the soil cannot retain water as well and any heavy rainfall will cause runoff from the exposed barren hillsides. Built-up areas of buildings and paved roadways do not absorb water so that runoff is even greater. Nowadays, forests are under great pressure as demand for products and services can lead to their conversion or degradation into forms of land use that are unsustainable. Trees are also useful for reducing noise pollution and acting as windbreaks. Root systems of trees trap pollutants that could contaminate waterways.

More than two-thirds of Jamaica's land mass is above 300 metre high so the forest cover is important in protecting the soil from damage by rainfall and conserving surface and groundwater resources. In addition, forests are valued for their recreational and economic uses.

Three broad groups of forest occur in Jamaica: limestone forests, predominantly shale forests and alluvial and wetland forests of the coastal plains. Two forest areas are thought to be

Table 6.1
Forest Estimates 1989–2005, '000 ha

Class	1989	1998	1990	2000	2005
Forest land use					
Bamboo	2.8	3.0	2.8	3.0	3.1
Mangrove	9.8	9.7	9.8	9.7	9.6
Closed broadleaf	88.7	88.2	88.9	88.3	88.0
Disturbed broadleaf	177.2	174.8	177.3	174.7	173.3
Short open dry	12.1	12.1	12.1	12.1	12.1
Swamp	2.4	2.2	2.4	2.2	2.0
Tall open dry	42.1	42.0	42.2	42.1	42.0
Total	**335.1**	**332.0**	**335.5**	**332.1**	**330.1**
Mixed land use					
Bamboo and fields	29.8	29.0	29.8	28.9	28.4
Bamboo and disturbed broadleaf	12.3	12.7	12.4	12.8	13.0
Bauxite and disturbed broadleaf	1.6	2.9	1.7	3.2	3.9
Fields and disturbed broadleaf	118.9	118.0	119.1	118.0	117.5
Fields/Disturbed broadleaf and pine plantation	8.9	8.2	8.9	8.2	8.2
Disturbed broadleaf and fields	166.8	166.0	167.1	166.2	165.7
Total	**338.3**	**336.8**	**339.0**	**337.3**	**336.7**
Non-forest land use					
Non-forest land use	407.0	411.6	408.5	413.6	416.2
Water	16.0	16.0	16.0	16.0	16.0
Total	**423.0**	**427.6**	**424.5**	**429.6**	**432.2**
Grand total	**1,096.4**	**1,096.4**	**1,099.0**	**1,099.0**	**1,099.0**

Source: Forest Resources Assessment Programme, Forestry Department
Note: the class fields/disturbed broadleaf and pine plantation comprises pine and hardwood plantations.

critical for endemic plant species. They are the limestone forests of the Blue and John Crow Mountains and the Cockpit Country which consist of an evergreen seasonal forest, mesic limestone forest and degraded mesic limestone forest.

The FAO estimates that there are 722 varieties of tree species in Jamaica. Of these, 15 are considered to be critically endangered.

One definition of forest is 'lands with trees whose crowns cover more than 20 per cent of the land area'. Another simple definition, and one that is used here, is 'land with a canopy cover of more than ten per cent and an area of more than half a hectare. These areas can include both natural forests and forest plantations (Forest Resources Assessment, FAO 2000). The Forestry Department's estimate of forested areas for the years 1989 to 2005 in Jamaica is shown in Table 6.1. Forested areas are classified as bamboo, mangrove, broadleaf, open dry and swamp forests. Mixed land use is forested areas with fields or mined areas. Non-forest land use is comprised of plantations, buildings, roads, fields, mined lands, bare rock and water.

Box 6.1
Variety of tree species

Native	722
Critically endangered	15
Endangered	27
Vulnerable	62

Source: FAO, Global Forest Resources Assessment 2005

The FAO estimates that there are 722 varieties of tree species in Jamaica. Of these, 15 are considered to be critically endangered.

The 330.1 thousand hectares of forest land in 2005 was distributed between bamboo, mangrove, broadleaf, swamp and open dry forests. The largest accumulated area of forest was of the disturbed broadleaf variety was 173,000 hectares (52 per cent of forest area and 16 per cent of total land area). Closed broadleaf forest covered 88,000 hectares (26.7 per cent of forest). Under the mixed land use category, the combined 'fields and disturbed broadleaf' and 'disturbed broadleaf and fields' accounted for 84 per cent of mixed land category. In 2005, estimated total forested area of Jamaica was 30 per cent of total land

Table 6.2
Forest Reserves by Parish, ha

Parish	Reserves	Crown Lands	Total
St Andrew	1,552	152	1,704
St Thomas	567	413	980
Portland	42,870	1	42,871
St Mary	691	101	792
St Ann	14,036	810	14,846
Trelawny	26,119	638	26,757
St James	2,156	329	2,485
Hanover	190	736	926
Westmoreland	1,413	554	1,967
St Elizabeth	1,192	–	1,192
Manchester	472	623	1,095
Clarendon	3,375	5,612	8,987
St Catherine	5,102	133	5,235
Total	**99,735**	**10,102**	**109,837**

Source: Jamaica Gazette

area; mixed land use of disturbed forests, fields and bamboo accounted for 31 per cent of land area. Other non-forest land use was 39 per cent of land area.

The Forestry Department of the Ministry of Agriculture is responsible for the conserving and developing of government-owned forests; the department also encourages private forest activities. Forest reserves are created and protected under the Forest Act of 1996. An inventory of Jamaica's forest is kept by the department in order to measure the rate of deforestation and the degradation of the forest reserves. Most of these reserves are located in the more inaccessible areas of the John Crow and Blue Mountains and the Cockpit Country and in dry, hilly upland in the south, west and north-west of Jamaica. Despite this, analyses of forest cover and land use have shown that forest reserves have been exploited by humans converting land to agricultural and residential use without permission.

Forest reserves and Crown lands by parish as listed by the Jamaica Gazette are shown in Table 6.2. The largest area of reserves is in Portland (42,870 ha), where there are very little Crown lands. There are also large tracts of reserves in St Ann and Trelawny. The smallest areas of reserves are in Hanover and Manchester. St Elizabeth has no Crown lands; Clarendon has the largest area of Crown lands (5,600 has).

Forest Department data show that the agency manages over 110,000 hectares of forest reserves and Crown lands. Differences in estimation and assessment by the Jamaica Gazette and the Forestry Department caused these differences in calculation of land area.

Under the Forest Act, agencies which have roles in the management of Jamaica's forests are the Forestry Department through the Ministry of Agriculture, the Water Resources Authority, the National Environment and Planning Agency, the Rural Agricultural Development Authority, the Rural Physical Planning Unit, the Commissioner of Lands, the Mines and Quarries Division and the National Water Commission

The importance of forests and forest resources for the development and preservation of the environment are based on the functions of forests, such as:

- ***production of water*** – forested areas in watersheds and near rivers allow percolation and reduce runoff thus providing a regular flow of water to reservoirs. Forests also hold and slowly release water, protecting watersheds.
- ***support of biodiversity*** – many plant and animal species depend on forested and woodland areas for their habitat
- ***soil conservation*** – tree cover in forests decrease the force of rain on land and slows the flow of water and helps to reduce soil loss especially on steep slopes. Tree roots hold the soil in place thus reducing erosion and landslides
- ***serving as carbon sinks*** – forests remove carbon dioxide from the atmosphere – absorbing and storing it – and contribute to climate protection. Photosynthesis by trees removes heat-trapping CO_2 and releases oxygen into the atmosphere.

Other forest functions are:

- as a source of timber to provide fuel and raw materials
- trees are recyclable and renewable
- trees provide paper made from wood fibre.

Carbon Dioxide Sequestration

As trees grow they absorb carbon dioxide from the air and replace it with oxygen, storing carbon in their leaves, branches and trunks. When forests are damaged, CO_2 is released into the atmosphere; when restored, forests help to remove (or sequester) CO_2 from the

air. Forests therefore play a large part in reducing the levels of CO_2 in the atmosphere. Once this wood in forests is not burnt or decomposes the carbon remains. Forests can be sources, sinks or reservoirs of CO_2, the major factor in creating the 'greenhouse effect' as CO_2 levels may be causing climate change by increasing global warming.

Deforestation

Deforestation is a worldwide problem with causes ranging from population and livestock growth. Deforestation can occur when trees are felled to create agricultural land, for mining activities, housing or commercial activities; when wood is used for fuel and yam sticks; by deaths of trees caused by droughts, disease, floods, fires and pollution.

Box 6.2
MDG Indicator 7.1
Proportion of land area covered by forest

Reverse loss of forests

One of the most significant agents of deforestation in Jamaica is thought to be the bauxite mining sector through their mining activities and through the associated development of roadways. Damage to forested areas usually occurs in limestone areas near to bauxite deposits.

Jamaica's small sawmilling industry produces timber but most wood and pulp and paper products are imported. Yam sticks used in the cultivation of yam are usually cut in hardwood forests. This can, along with other unregulated logging activities, lead to deforestation and other associated problems of watershed degradation and land slippage.

Estimates of the rate of deforestation in Jamaica have ranged from one to 11.3 per cent (FAO, 1995). However, more recent efforts by the Forestry Department have shown that the actual rate of deforestation is 0.1 per cent per annum. The cause for this has been attributed to different definitions of forest cover.

Loss of trees results in loss of animal and plant habitats and species as well as soil erosion. Forests contain the capacity to regulate water flows and carbon cycles; the loss of tree cover can affect atmospheric and hydrosphere cycles. When wood is burned, stored carbon is released into the atmosphere where it combines with oxygen to form carbon dioxide and contributes to the global warming.

Due to a lack of data on cutting of wood for legal and illegal purposes, the magnitude of deforestation cannot be quantified. At the same time, use of fuel wood and charcoal is declining as the use of cooking gas increases.

Table 6.3
Targets of Reforestation 2001–2005, hectares

Item	2001	2002	2003	2004	2005	Total
Government Planting	200	190	180	170	150	890
Pine	24	23	22	20	18	107
Hardwood	176	167	158	150	132	783
Private Planting	300	460	720	1,030	1,350	3,860
Pine	67	92	126	155	169	609
Hardwood	233	368	594	875	1,181	3,251
Total	**500**	**650**	**900**	**1,200**	**1,500**	**4,750**

Source: National Forest Management and Conservation Plan

Reforestation

A five-year Forest Plan covering 2001 to 2005 and proposed by the Forestry Department, estimated a total area of 4,750 hectares to be reforested (see Table 6.3). Pine and hardwood for timber production would cover 15 and 85 per cent respectively. The Forestry Department would be responsible for replanting 19 per cent of the total area with the private sector reforesting the rest.

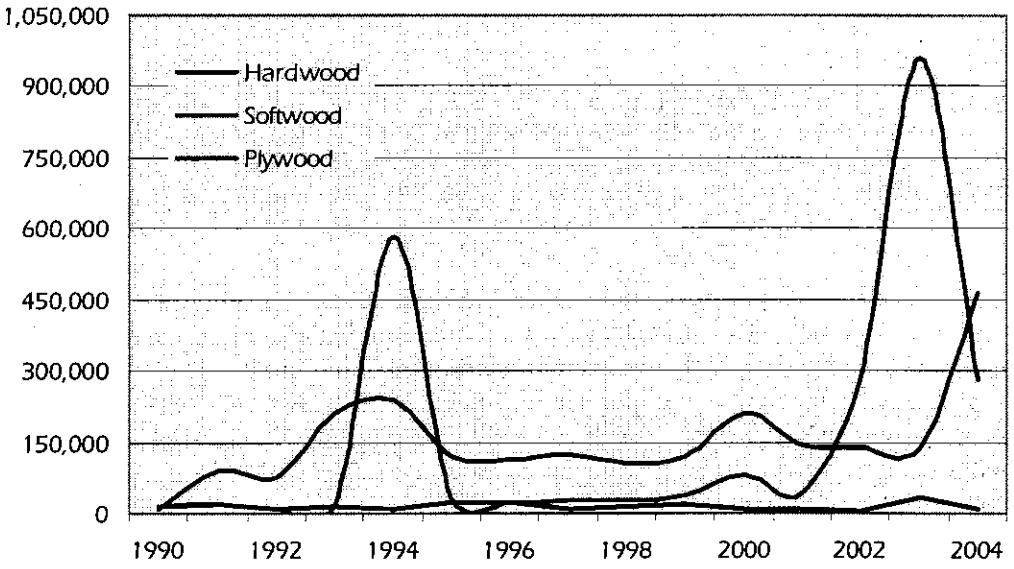
Forest Products

Non-timber forest products include medicinal plants, rattans, mushrooms, resins and other non-wood products.

Lumber or timber is one main product of forests. Besides pulpwood for paper products, timber is used to make furniture, in the construction industry for flooring, houses, roofs, frames, etc.

Jamaica is a net importer of timber and other forest products. Increased imports of softwood between 1993-94 and 2000-01 and imports of plywood which peaked in 1994 and 2003 could be due to increased construction activities (see in Figure 6.4). Hardwood imports remained fairly constant over the 15-year period.

Figure 6.4
Lumber Imports 1990–2004, m^3

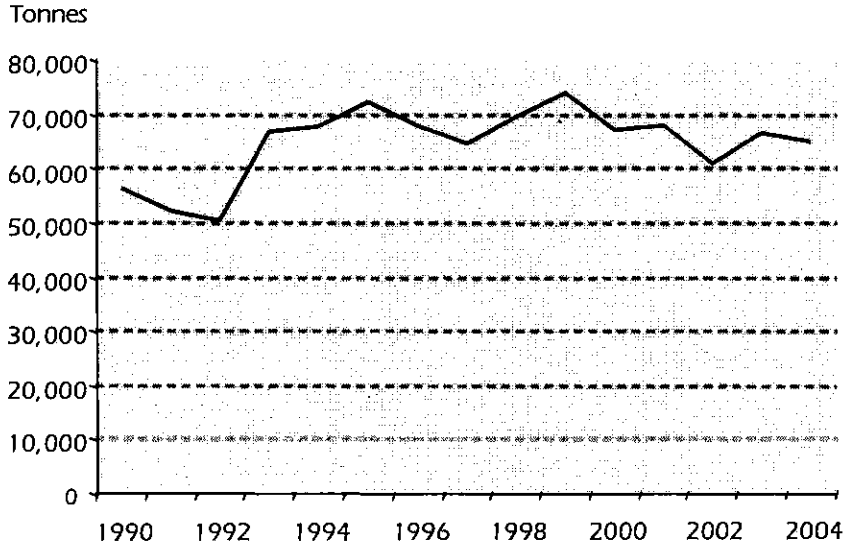


Source: Statistical Institute of Jamaica

Pulp and paper are by-products of forests. Pulpwood is timber grown for making paper but is also used for production of some wood products. Paper from wood is used in the making of newsprint, toilet paper, books, Kraft paper (used for paper bags, envelopes and other packaging. Pulpwood is estimated to account for 90 per cent of all pulp.

In 1990, over 48,000 tonnes of paper, pulp and paperboard articles were imported into the island. During the years until 2004, the highest volumes of imports were in 1995 (72,000 tonnes) and 1999 (74,000 tonnes). By 2004, the level of imports had fallen to 65,000 tonnes (see Figure 6.5).

Figure 6.5
Imports of Pulp, Paper and Paperboard Articles 1990–2004, tonnes



Source: Statistical Institute of Jamaica

Watersheds

The movement of water from land to waterways and the sea is called runoff; the area of land being drained by runoff is called a watershed. A watershed or drainage basin is an area of land that is drained by a single river or stream. The trees in a watershed covered by forest makes it possible for more water to be absorbed by the soil which also filters out many contaminants. Without forest cover most rainfall will wash into rivers without the flow being regulated and not being filtered.

Jamaica is hilly and mountainous with sloping land greater than 20 degrees over 50 per cent of its land area. Thus the island is susceptible to degradation in its 10 hydrologic basins or watersheds which have been divided into 26 watershed management units. A watershed management unit is one or more watersheds that have been grouped together for management purposes. Some portions of the hydrologic basins are considered to be degraded and deforestation is a major contributor through loss of nutrients from soil and reduced water retention capacity of the land.

The area of the ten basins and the 26 watershed management units (WMU) within are listed in Table 6.6. The map in Figure 6.7 shows the boundaries of the WMUs. The WMU with the largest land area is the Black River WMU (No 23, 1,698.3 km^2), the smallest the New Savanna River (No 26, 76.3 km^2). Each of the WMUs have portions which are considered to be degraded through reduced tree and vegetation cover due to unsuitable farming practices. Other problems found in the WMUs are

- siltation of rivers, reservoirs, beaches and harbours
- increase in runoff due to loss of vegetation cover and clearing of slopes
- reduced ability to store water
- flooding resulting in loss of life, agricultural crops, damage to property and roads
- loss of habitats for wild plant and animal life
- marine and coastal contamination and degradation.

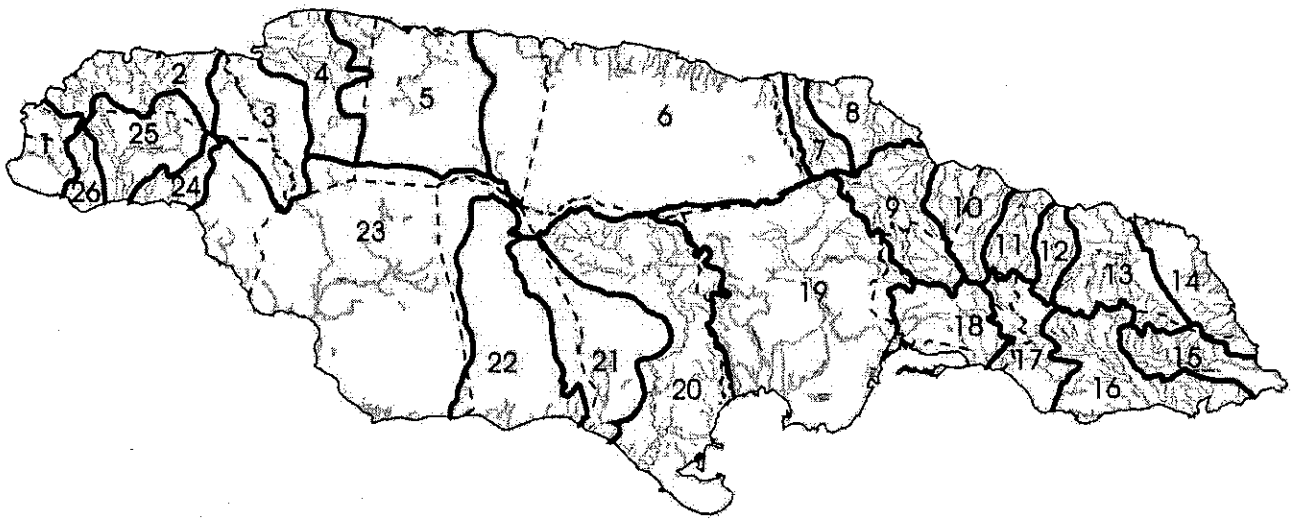
Table 6.6
Area of Basins and Watershed Management Units

Basin/Watershed		Management Unit	km²
Great River	2	Lucea River	253.2
	3	Great River	327.7
	4	Montego River	283.3
Martha Brae	5	Martha Brae River	622.2
Dry Harbour Mountains	6	Rio Bueno-White River	1,563.1
Blue Mountains South	7	Rio Nuevo	111.1
	8	Oracabessa-Pagee River	169.5
	9	Wagwater River	315.1
	10	Pencar-Buff Bay River	202.1
	11	Spanish River	121.6
	12	Swift River	97.2
	13	Rio Grande	302.4
	14	Drivers River	210.9
Blue Mountain South	15	Plaintain River	186.7
	16	Morant River	375.7
	17	Yallahs River	200.4
Kingston	18	Hope River	241.4
Rio Cobre	19	Rio Cobre	1,256.5
Rio Minho	20	Rio Minho	789.3
	21	Milk River	882.1
	22	Gut-Alligator Hole River	142.9
Black River	23	Black River	1,698.3
Cabarita River	24	Deans Valley River	96.1
	25	Cabarita River	284.3
	26	New Savanna River	76.3
	1	S Negril-Orange River	139.9
Total			**10,949.3**

Source: Water Resources Development Master Plan, Water Resources Authority

Two major roles of watersheds other than collecting water are: cleaning water and stablising its flow. As rainfall is usually uneven, the watershed will automatically compensate by releasing its water gradually. Trees play an important part in the process by holding soil in place. The soil acts as a filter and purifies the water through its interaction with fungi and micro-organisms in the soil.

Figure 6.7
Watershed Management Units



Source: National Environment and Planning Authority

Jamaica's forests are typical of tropical forests and consist of a mixture of mainly evergreen and broad-leaved trees with a few more valuable species. Tropical forests produce 40 per cent of Earth's oxygen despite covering less than six per cent of Earth's land surface. There is a mutual existence between plants and animals – plants producing oxygen and breathing in CO_2, animals breathing in oxygen and breathing out CO_2.

7 Biological Resources

Biological resources refer to the resources used or can be used by humans. Clean air, water, food cycles, flood and pest control, pollination of plants, new medicines are linked together with human well being. Biodiversity or biological diversity is the variety of living organisms – the variations in species, between species and their ecosystems. The value of biodiversity is not only for its intrinsic value but for the ecosystem services it provides. Any loss of species or invasion of alien species may threaten an ecosystem's health or its biological diversity.

Small islands are at increased risk for their local habitats and the species that feed and shelter there. Although the number of endemic species is small, per unit of land area the level of biodiversity is hig h. Plants and animals are scattered over smaller areas and natural disasters add other stress factors. The population of Jamaica is averaging a one per cent annual growth. The land and resources used by rising populations added to the threatened global climate change, pollution and the introduction of invasive alien species threaten the island's species. The Convention on Biological Diversity states that of the 724 known animal extinctions over the past 400 years; about 50 per cent have been island species.

Of the islands in the world, Jamaica has been ranked as fifth in terms of the volume of endemic plants to the size of the island. Three thousand or more species of plants grow on the island, 28 per cent of which are endemic.[1] The varieties of plants include 200 species of flowering plants (230 species of orchids, 60 endemic), 580 types of ferns, 64 endemic. Cedar, mahogany, logwood, rosewood, ebony, palmetto palm, coconut palm and pimento trees are indigenous.[2]

Ecosystems

Ecosystems that occur in forests, mountains, lakes, rivers, deserts and agricultural landscapes are a variety of biodiversity. All living creatures in an ecosystem interact with one another and the air, water and soil around them. It is this interaction with life forms and the ecosystems in which they live which makes the Earth habitable. Jamaica is a mountainous island with coastal lowland areas, forests, mangroves and coral reefs. This variety results in several ecosystems and the biological diversity present in the island. There is no generally accepted classification of Jamaica's ecosystems but some general broad categories are: montane forest, limestone forest, woodland, wetlands, riparian forest and ponds/lakes/other freshwater habitats.

The main types of forest in Jamaica are: the dry limestone forest in the south; intermediate limestone forest in the central uplands; the montane forests of the Blue and Port Royal Mountains; and the wet limestone forests in the Cockpit Country, Dolphin Head and the John Crow Mountains. The forests provide water, food, medicines, shelter and livelihoods for the communities in and around them. Forests also regulate temperatures by absorbing and storing carbon dioxide, thus helping to mitigate the effects of global warming. The Blue and John Crow Mountain area is the island's largest intact closed canopy rain forest. The Cockpit Country's hillocks and valleys, called karst topography, make it one of the densest terrains to penetrate.

[1] *National Strategy and Action Plan on Biological Diveristy in Jamaica*, NEPA

Woodland or savannah areas are too dry to support forest and are found the dry south of the island. Wetland areas include swamps (mainly confined to western Jamaica), mangroves (found where salt and fresh water meet, on both south and north coasts) as well as lowland rivers, lagoons estuaries and salt marshes. Jamaica's wetlands include the Black River Lower Morass, the Negril Morass, the Cockpit Salt Marsh, Mason River (inland), Portland Bight and Paradise. Riparian forests are found along waterways but have largely been destroyed. The few remnants are found along the Black River and White River. Jamaica's freshwater ecosystems may be the most severely degraded; it is estimated that 20 per cent of freshwater fish species have become extinct, are threatened or are endangered. Ponds (some of which are seasonal) and lakes are the least studied ecosystems and contain several rare plants and animals.

Animal Species

Jamaican animals include the iguana, the American crocodile, the Jamaica coney or hutia, the West Indian manatee, turtles, lizards, bats and birds, some of which are endemic to the island or the Caribbean. With regard to endemism in animal species, 98 per cent of the 514 indigenous land snails are endemic to Jamaica; all of the 22 amphibians are endemic[2]. Other sources (Gary Rosenberg, 2005) have found 561 species of snails, 505 or 90 per cent which are endemic and 25 which were introduced by humans. Included in the over 100 different types of butterflies is the endangered giant swallowtail butterfly. Jamaica's 20 species of tree frogs are endemic; there are 21 species of bats, two of which are found nowhere else (see Table 7.1).

Table 7.1
Selected Invertebrates and Vertebrates of Jamaica

Terrestrial Fauna	Indigenous Species	Endemic Species	% Endemic Species
Rotifers	211	<21	<10
Land snails	514	505	98
Grapsid crabs	9	9	100
Jumping spiders	26	20	77
Fireflies	48	45	94
Butterflies	133	20	15
Ants	59	6	10
Amphibians	22	22	100
Reptiles	43	33	77
Shore and sea birds	39	1	3
Land birds	67	30	45
Bats	21	2	10
Other mammals	2	2	100

Source: Terrestrial Animal Assessment Report, 1999

Rotifers are microscopic animals, most of which grow in fresh water.

The 200 species of birds include 106 indigenous to Jamaica as well as migratory birds. There are two parrots endemic to Jamaica: the yellow-billed and the black-billed parrot. Other birds are: the Jamaican petrel, pauraque, Jamaican blackbird; and the ring-tailed pigeon, three of the 31 bird species found nowhere else. The streamer tail hummingbird

[2] www.cbd.int/countries/?country=jm

Box 7.1
MDG Indicator 7.7
Proportion of species threatened with extinction

Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss.

Table 7.2
Number of Marine Species, by Type

Biodiversity	No. of species
Hard corals	64
Soft corals	43
Black corals	8
Fish	572
Molluscs	825
Echinoderms	88
Crustaceans	455
Polychaetes	100
Cetaceans	27
Sharks/rays	32
Sponges	194
Bryozoans	64
Zoanthids	17
Coralliomorphs	6
Seagrass	3
Macroalgae	386

Source: NEPA

is the national bird and is found only in Jamaica. All birds are protected under the Wildlife Protection Act, with the exception of alien pests which may be hunted with a permit from NEPA.

The Jamaican iguana is in a unique group of species which inhabit tropical dry forests and is considered to be one of the most endangered lizards in the world. The iguana is herbivorous; therefore playing its part in the regeneration of plants, seed germination and dispersing of seeds. The reptile is threatened because of human development in its habitat as well as by animals that prey on the iguana and its eggs.

There are three endemic freshwater fish species in Jamaica. They are the Jamaica killifish (*Cubanichthys pengellyi*) and striped gambusia (*Gambusia melapleura*) and the blackbelly limia (*L. melanogaster*). Information on these species is limited.

The Indian mongoose (*Herpestus griseus* or *H. mungo-grown*) is an introduced species which has been naturalised in Jamaica after being carried from India in the 19th century.

Marine Species

Jamaica has a variety of corals, sea anemones, molluscs, fish and other marine creatures in its waters. The three types of sea grass found in the shallow coastal waters of Jamaica are turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*). The sea grass beds serve as feeding areas for marine turtles and manatees and nursery areas for commercial fish. They are also used in traditional or folk medicine.

Many species of flora and fauna have already gone extinct and others are threatened with extinction. Over-exploitation of our resources, destruction of many habitats and the introduction of invasive species as well as all kinds of pollution are a threat to our biodiversity.

International Union of Conservation and Natural Resources (IUCN)

The IUCN provides a listing of particular species which may be at risk of extinction, those endangered and vulnerable. The list also includes species which, it is felt, are in danger of being threatened. The IUCN Red List provides an approach to evaluating conservation status of plant and animal species. One goal is to 'Provide a global index of the state of degeneration of biodiversity.' The Red List has nine categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient, and not evaluated. The threatened categories – vulnerable, endangered and critically endangered – are biologically based, relate to the risk of extinction risk and include rate of decline, population size and area of distribution.

Table 7.3 gives a comparison of the number of threatened species in 1996 and 2006 as recorded in the Red List. There have been increases in the number of threatened fish, mammals, birds and amphibians; no molluscs are thought to be threatened in 2006. In 1996 there was no information on plants and other invertebrates. In Table 7.4, the number of animals and plants in danger total 600; five animals and two plants are extinct; the 270

Table 7.3
Threatened Species 1996 and 2006

Specie	1996	2006
Mammals	4	5
Birds	7	10
Reptiles	8	8
Amphibians	4	17
Fish	–	16
Molluscs	5	–
Other invertebrates	...	5
Plants	...	209
Total	**...**	**270**

Source: IUCN
Note: – none; ... not known

Table 7.4
Number of Animals and Plants in Danger 2006

Status	Animals	Plants
Extinct	5	2
Extinct in the Wild	–	–
Critically Endangered	15	40
Endangered	17	53
Vulnerable	29	116
Lower Risk/Conservation Dependent	3	–
Near Threatened	31	73
Data Deficient	22	5
Least Concern	188	1
Total	**310**	**290**

Source: International Union for Conservation of Nature

referred to in Table 7.3 are in the categories critically endangered, endangered and vulnerable.

The Red List has listed between 52 and 55 critically endangered animals in Jamaica (see Tables 7.4 and 7.5). These include the Jamaican ground lizard (*Ameiva dorsalis*), Jamaican iguana (*Cyclura collei*), leatherback turtles (*Dermochelys coriacea*), goliath grouper (*Epinephelus itajara*), hawksbill turtle (*Eretmochelys imbricata*), Jamaican petrel (*Pterodroma caribbaea*) and Jamaican pauraque (*Siphonorhis americanus*). There are between 67 and 70 animals and plants on the endangered list, including the loggerhead (*Caretta caretta*) and green sea turtles (*Chelonian mydas*), Nassau grouper (*Epinephelus striatus*), lignum vitae (from the genus *Guaiacum*), Jamaican blackbird (*Nesopsar nigerrimus*), yellow bromeliad, and green bromeliad, frogs, giant swallowtail butterfly (*Papilio homerus*), Jamaican flower bat (*Phyllonycteris aphylla*) and black-capped petrel (*Pterodroma hasitata*), hammerhead shark (*Sphyrnidae*) and varieties of mahogany trees.

The staghorn and elkhorn corals which dominated Jamaican reefs in the early 1960s have recently been listed as endangered as hurricanes and anthropogenic impacts have made them virtually non-existent in most areas.

Table 7.5
Endangered Species by Type 2006

Specie	Critically Endangered	Endangered	Vulnerable	Total
Amphibians	3	–	5	8
Birds	2	–	8	10
Velvet worm	1	1	–	2
Fish	4	2	7	13
Plants	38	59	36	133
Mammals	–	1	5	6
Insects	–	2	1	3
Reptiles	4	2	3	9
Total	**52**	**67**	**65**	**184**

Source: International Union for Conservation of Nature

Other endangered and critically endangered coastal and marine species of Jamaica are the Caribbean manatee (*Trichechus manatus*), black corals of the family *Antipathidae*, green conch (*Strombus gigas*), spotted spiny lobster (*Panulirus argus, P. guttulus*).

Plants

Over 25 per cent of the over 3,000 vascular plants in Jamaica are endemic to the island. Table 7.6 lists decorative plants but many other types such as algae, fungi, mosses, and slime-moulds are present along with freshwater plants such as the bulrush (*Typha sp.*) water lily (*Nymphaea sp.*) reed (*Phragmites sp.*) and the water hyacinth (*Eichhhomia sp.*).

Box 7.2

Two plants endemic to Jamaica, (Isoetes jamaicensis and *Malpighia proctorii*), were recently discovered to have value for scientific research. Both plants are on the proposed endangered plants list for the amended Wild Life Protection Act and on the Fourth Schedule of the Endangered Species (Protection, Conservation and Regulation of Trade) Act.

Table 7.6
Plant Species by Type 2006

Plant Species	Indigenous	Endemic	% Endemic
Bromeliads	60	22	36.7
Orchids	230	60	26.1
Ferns	579	67	11.6
Cacti	20	10	50.0
Palms	10	7	70.0
Grasses	~200	1	0.5

Source: Institute of Jamaica, 2000 cited in National Strategy and Action Plan for Biological Diversity in Jamaica

Two plants endemic to Jamaica, (*Isoetes jamaicensis* and *Malpighia proctorii*), were recently discovered to have value for scientific research. Both plants are on the proposed endangered plants list for the amended Wild Life Protection Act and on the Fourth Schedule of the Endangered Species (Protection, Conservation and Regulation of Trade) Act.

The IUCN Red List cited certain types of Jamaican plants species which are endangered. Of the 289 species evaluated, 209 were in danger: 40 were critically endangered; 53 were endangered; and 116 were vulnerable.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was the first global agreement on conservation and sustainable use of diversity; it was opened for signatures in June 1992 and entered into force in December 1993. This convention creates a framework on which countries can implement laws, policies and administrative measures. Three goals of the Convention are

- to promote conservation of biodiversity;
- the sustainable use of the components of biodiversity; and
- the sharing of benefits arising from use of genetic resources, in a fair and equitable way.

All ecosystems, species and genetic resources are covered and, when signed, the Convention is legally binding; the countries which sign are obliged to implement the provisions under the Convention. The government of Jamaica ratified the CBD on 6 January 1995.

The primary instrument to guide implementation of the CBD in Jamaica is the implementation of a national biodiversity strategy and action plan produced by the National Environment and Planning Agency.

Biosafety Protocol

Biotechnological advances have enabled scientists to cross species barriers by transferring genes from one species to another. Potato and corn varieties have been modified to receive genes from a bacterium enabling them to produce their own insecticide; genetically modified organisms are a part of some foods, food additives, beverages, drugs and fuels. However, there are concerns about side effects to humans and the environment, including the risk to biological diversity. These concerns led to the Cartagena Protocol on Biosafety, a subsidiary agreement to the CBD which will allow countries, through a Biosafety Clearing House, to indicate whether or not they will be willing to accept imports of agricultural products which contain genetically modified organisms. This protocol was entered into force in September 2003. Jamaica, although not a member, signed to the protocol and has established a National Biosafety Committee.

National Biodiversity Strategy and Action Plan

The *National Strategy and Action Plan on Biological Diversity in Jamaica (NBSAP)* was completed in July 2003. Its main goals are: to assess Jamaica's biodiversity; to provide legal and policy framework for the conservation and sustainable use of biodiversity; a national biodiversity strategy and an action plan; to promote public awareness and education; and to ensure .

Other international conventions and protocols implemented in Jamaica are the Convention on International Trade in Endangered Species (CITES) and Protocol Concerning Specially Protected Areas and Wildlife (SPAW).

Legislation

The main piece of legislation relating to biodiversity is the Wild Life Protection Act which protects designated species of animals and regulates hunting in Jamaica. The provisions of the act relate to: protected species; game sanctuaries and reserves; hunting; river fishing and pollution; use of dynamite; and game wardens. An additional 52 pieces of legislation have aspects that bear on the conservation and sustainable use of biological resources. As seen in the list in Table 7.7, very few deal comprehensively enough with the protection of biodiversity.

Imports and Exports

Trade in live species is controlled under the Endangered Species (Protection, Conservation and Regulation of Trade) Act, 2000 in compliance with international trade obligations under CITES. The act lists species which are in danger of being exploited and attempts to control, restrict or prevent such exploitation. In the list are 12 birds, 27 reptiles and amphibians, one fish, 10 invertebrates and 204 plant species.

Imports and exports of plants and animals, especially exotic species is regulated but there are still concerns about accidental introduction of invasive species which can compete with and eradicate indigenous species. Jamaica imports animals such as goats, fowl and horses for breeding; live plants such as banana and coconut plants and fresh flowers. There is also trade in ornamental fish for breeding and other live fish.

Table 7.7
Selected Biodiversity-related Legislation

Legislation	
Animals (Disease) and Importation Act, 1969	Allows for controlling the spread and treatment of diseases within the island via importation controls on animals, and the eradication and disposal of infected animals or where such infection is suspected.
Black River (Upper Morass) Reclamation Act, 1941	Empowers the Black River Drainage and Irrigation Board to regulate and maintain water courses and damming structures; keep the Black River clean, clear and navigable to a certain point; and can require landowners to clean canals, trenches, etc. located on their lands.
Clean Air Act, 1964	Makes provision for the prevention of the discharge of noxious or offensive gases into the air including fumes and dust from alumina, cement, lime, petroleum and gypsum works.
Harbours Act, 1874	Regulates activities within harbours through the Marine Board by regulating the movement of boats and vessels in harbours, channels or approach thereto; the placement of buoys and removal of sunken structures from harbours; penalties for depositing refuse and waste matter from vessels; and removal of sand, stone, ballast, etc., from harbours, reefs or shoals. Institute of Jamaica Act, 1978.
Jamaica National Heritage Trust Act, 1985	Establishes a statutory body to protect Jamaica's national heritage, including any place, animal or plant species or object/building.
Litter Act, 1985	Defines what constitutes litter on private and public property and prescribes penalties for offences against the Act and the provision of receptacles for proper disposal.
Local Improvements Act, 1914	Governs all development of lands within Kingston or other such Ministerial prescribed areas via the requirement for subdivision approval from the relevant local authority.
Morant and Pedro Cays Act, 1907	Affirms the status of the Morant and Pedro Cays and prohibits fishing inside certain limits, slaying or catching of birds on the Cays or the catching of turtles within the territorial limits of the Cays.
Petroleum Act, 1979	Vets all petroleum in the State and makes provisions for the creation of Regulations which prevent pollution and orders remedial action where this takes place, as well as the protection of fishing, navigation, etc.
Plants (Importation) Control Regulation, (1997)	Outlines the role of the National Biosafety Committee in monitoring and regulating the importation of living modified organisms for research only.
Plant Quarantine Act, 1993	Provides protection for Jamaica's flora from imported diseases or pests transported via plants, plant products, and soil or via other means as well as the course of action to be taken when these are discovered within the island.
Public Health Act, 1985	Allows for the establishment of Local Boards to regulate activities carried out in private or public buildings or properties where such activities prove injurious to public health.
Urban Development Corporation Act, 1968	Establishes the Urban Development Corporation as a statutory body which has, amongst its functions, the duty to carry out construction, maintain public parks, car parks, etc. in such manner to ensure preservation of architectural or historical objects or sites.
Institute of Jamaica Act, 1978	Promotes literature, science and art, with responsibility for national museums.
Fishing Industry Act (1975)	Controls exploitation of organisms defined as 'fish', as well as their protection through such measures as establishing fish sanctuaries, closed harvest seasons and use of appropriate gear.

Source: National Strategy and Action Plan on Biological Diversity in Jamaica

Table 7.8
Imports and Exports of Cutflowers, 2002–2006, kilo

Flower	2002	2003	2004	2005[p]	2006[p]
Imports					
Roses	8,390	13,224	12,340	18,442	11,054
Orchids	40	–	–	175	109
Other fresh flowers	98,090	91,506	60,518	84,554	66,470
Other cutflowers and buds	8,080	2,295	2,255	11,514	2,054
Mosses & lichens	200	7,460	1,057	605	53
Foliage & branches	1,700	16,559	4,323	38,698	13,610
Exports					
Anthuriums	20,980	16,421	12,009	104	...
Ginger lilies	2,840	4,265	4,295	4,296	6,254
Heliconias	3,080	2,115	3,932	1,622	1,344
Orchids	5,940	2,886	1,132	250	89
Other fresh flowers	720	1,072	1,192	979	185
Other cutflowers and buds	300	8	6	777	1,249
Foliage & branches	1,450	780	492	1,101	1,999

Source: Statistical Institute of Jamaica
p preliminary

The importation and exportation of horticultural plants for use in floral arrangements for period 2002 to 2006 is shown in Table 7.8. Roses, orchids and other fresh, cut flowers and foliage and branches are imported into the island despite their being grown in the country. Exports of anthuriums, heliconias, orchids and other fresh flowers have declined while those of ginger lilies have increased.

The interrelationship between plants and animals is complex and it is important to understand them in order for conservation to work effectively as animals rely on components in their environment for food, shelter and breeding. For humans, the many and varied ecosystems also provide the resources by which we live, eat, house, clothe and medicate ourselves.

8 Protected Areas

Protected areas are generally created in order to conserve species and ecosystems and the goods and services contained within and to provide areas for recreation and tourism. As in all small islands, Jamaica has a fragile ecological system and many problems for environmental management. Its economic activities – tourism, agriculture, forestry and mining – rely on the natural environment and the establishment of areas where these activities are prohibited is necessary.

Many countries continue to add to the number and range of protected areas, which range from national and marine parks, to fish sanctuaries, forest reserves, game reserves, beaches, open areas and national monuments, over many years. The main purposes of protected areas and the importance for management are for: *scientific research, protection of wilderness areas and specific natural and cultural features; preservation of species; environmental*

Table 8.1
IUCN Protected Areas Management Categories

Category	Description
I Strict Nature Reserve/Wilderness Area	Protected area managed mainly for science or wilderness protection.
Ia Strict Nature Reserve	Area of land and/or sea possessing some outstanding or representative ecosystem, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Ib Wilderness Area	Large area of unmodified or slightly modified land and/or sea, retaining its natural character and influence, without permanent or significant habitation which is protected and managed so as to preserve its natural condition.
II National Park	Natural area of land and/or sea, designated to: a) protect the ecological integrity of one or more ecosystems; b) exclude exploitation or occupation inimical to the purpose of designation of the area; and c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities which are environmentally and culturally compatible.
III Natural Monument	An area containing one or more specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
IV Habitat/Species Management Area	An area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or meet the requirements of specific species.
V Protected Landscape/Seascape	An area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value and often with high biological diversity.
VI Managed Resource Protected Area	Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing a sustainable flow of natural products and services to meet community needs.

Source: International Union for Conservation of Nature

services; tourism and recreation; education; the sustainable use of resources in natural ecosystems; and for the cultural and traditional attributes within specific areas. In protected areas, land uses such as cultivation, grazing, cutting of trees, clearing of vegetation and burning are prohibited or strictly regulated.

The International Union for Conservation of Nature and Natural Resources (IUCN), also known as the World Conservation Union, defines a protected area as *'An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.'* The IUCN has defined six protected area management categories, shown in Table 8.1, as protected areas are managed differently depending on type of area and purpose of the area.

In Jamaica various organisation are responsible for protected areas under different types of legislation. The National Environment and Planning Agency, along with the Forestry Department, the Fisheries Division and the Jamaica National Heritage Trust operate under a combination of acts such as the Natural Resources Conservation Authority Act, the Wild Life Protection Act, the Forest Act, Tree Preservation Orders, the Beach Control Act, Fishing Industry Act and the Jamaica National Heritage Trust Act. Other legislation includes the Morant and Pedro Cays Act and the Watershed Protection Act.

Table 8.2 lists the different types of protected areas and the number of areas designated as such. Over 100 other areas have been identified as possible and proposed additions and include beaches, cliffs, waterfalls, rivers, bays, swamps, caves, islands and an extinct volcano. Proposed protected areas include six national parks, five marine parks, 12 fish sanctuaries, two game reserves and 14 wildlife sanctuaries.

Table 8.2
Protected Areas in Jamaica 2006

Type	No.
National parks	1
Marine parks	3
Protected areas – NRCA Act	4
Protected areas – Beach Control Act	2
Fish sanctuaries	2
Forest reserves	96
Game reserves[a]	13
Game sanctuaries	5
National monuments	92
Protected national heritage sites	7
Public gardens	4
Public bathing beaches	87
Fishing beaches[b]	181
Private reserves	16
Environmental protection areas[c]	1

Sources: NEPA, UNEP
a) in addition, all 96 forest reserves are also game reserves
b) designated under Fisheries Industries Act. Of these, 123 are considered to be active.
c) declared under section 33 of the NRCA Act.

National and Marine Parks

National parks are useful for protecting plants and wildlife, for tourism and recreation and to inform and educate on biodiversity and conservation. There is one national park in Jamaica which is managed by the Jamaica Conservation and Development Trust (JCDT) under agreements with NEPA and the Forestry Department.

Another six national parks including Canoe Valley, the Cockpit Country and Dolphin Head Mountain covering an area of 37,000 hectares have been proposed.

The ***Blue and John Crow Mountains National Park,*** which is also a forest reserve, covers 78,212 ha in the parishes of St Andrew, St Thomas, Portland and St Mary. Data from NEPA puts the protected area of the park at 49,500 ha (see Table 8.4). The park is actually composed of the Blue, John Crow and Port Royal Mountains with the highest point on the island, Blue Mountain peak at 2,256 metres. Over 500 species of flowering plants have been recorded in the mountains, 40 per cent of which are endemic to the island. Although the Blue and John Crow mountains are side by side, their geology, soil and vegetation are different; they are separated by the Rio Grande valley.

The mountain area contains the largest area of closed broadleaf forest in Jamaica and is recognised globally for its high biological diversity. The forests are noted for being:

- the habitat of the giant swallowtail butterfly (*Papilio homerus*)
- an important habitat for many Jamaican birds such as the Jamaican blackbird (*Neospar nigerrimus*) and the habitat for many migratory birds
- a wildlife refuge for fauna such as the Jamaican boa (*Epicrates subflavus*) and hutia (*Geocapromys brownii*)
- the home of endemic orchids, bromeliads, fern and other plants, some on the IUCN red list
- important in providing water as the upper regions of the park include ten of the 26 watershed management areas
- vital for preventing soil erosion and landslides
- a cultural area including the indigenous Maroons.

A marine park is an area of coastal waters with geographical boundaries that has been declared of such ecological importance as to deserve protection under national law. Regulations describe activities which may or may not be allowed within its boundaries so as to protect the habitats and the species within the park.

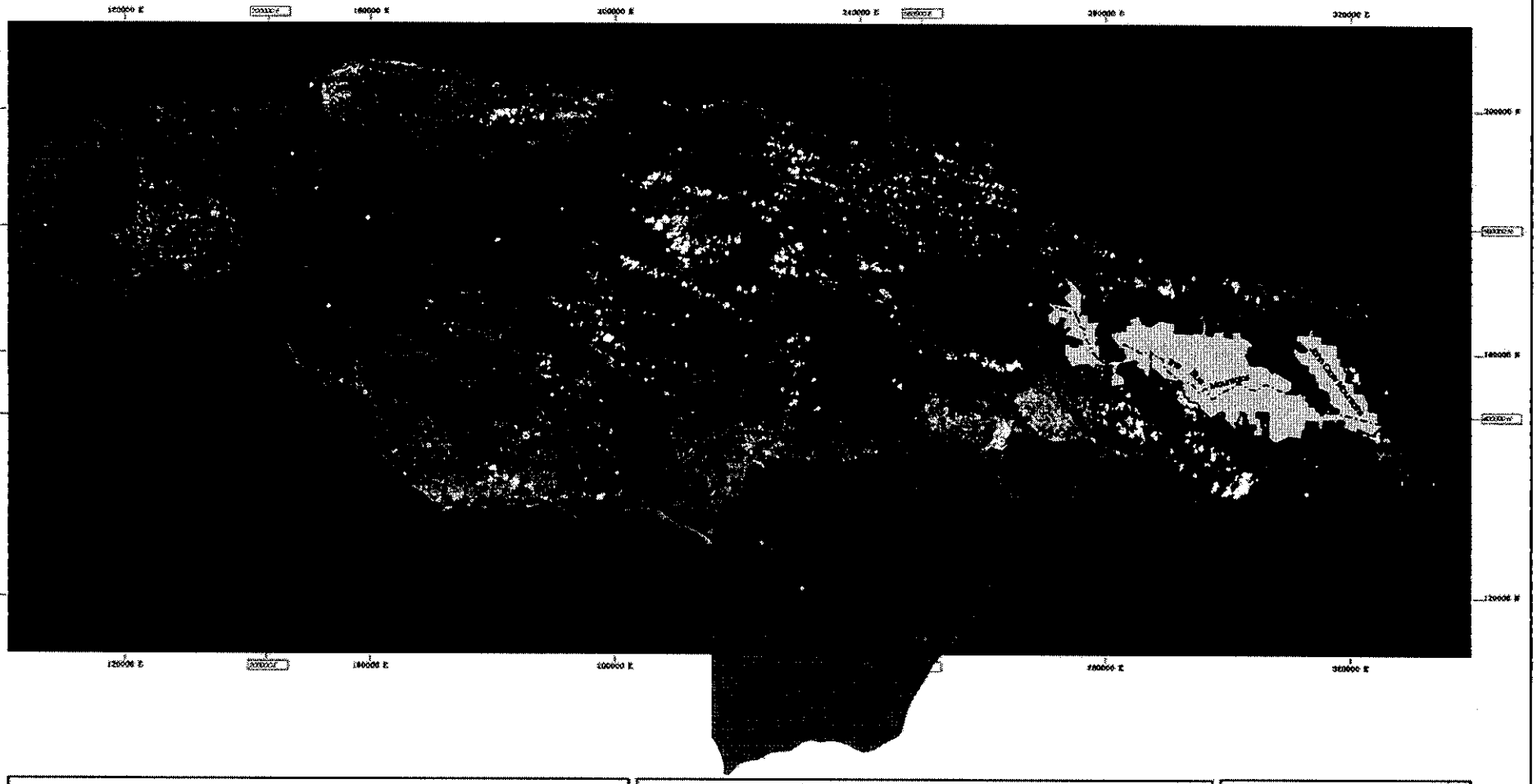
The area of the ***Montego Bay Marine Park*** stretches from the high-tide mark on land to the 100-metre depth at sea. Its eastern and western boundaries are Tropical Beach and Rum Bottle Bay, close to the Great River. The area has mangrove forests, islets, beaches, river estuaries, sea grass beds and corals. Activities at the park include the assessment of fish and coral, monitoring of beach erosion, water quality testing and rescuing injured marine animals.

The ***Negril Marine Park*** is situated on the westernmost end of the island in the area from the Davis Cove River in Hanover to St John's Point in Westmoreland with its boundary 3.2 km out to sea. The park's natural resources include coral reefs, mangroves, beaches and sea grass beds.

The ***Ocho Rios Marine Park*** began as a small area on the coast of Ocho Rios in 1966 and was expanded to cover an area extending from Mammee Bay and Drax Hall in the west to Frankfort Point in the east and out to 1,000 metres deep at sea. The area includes coral reefs and sea grass beds.

On the following page is Figure 8.3 Protected Areas System.

PROTECTED AREAS SYSTEM



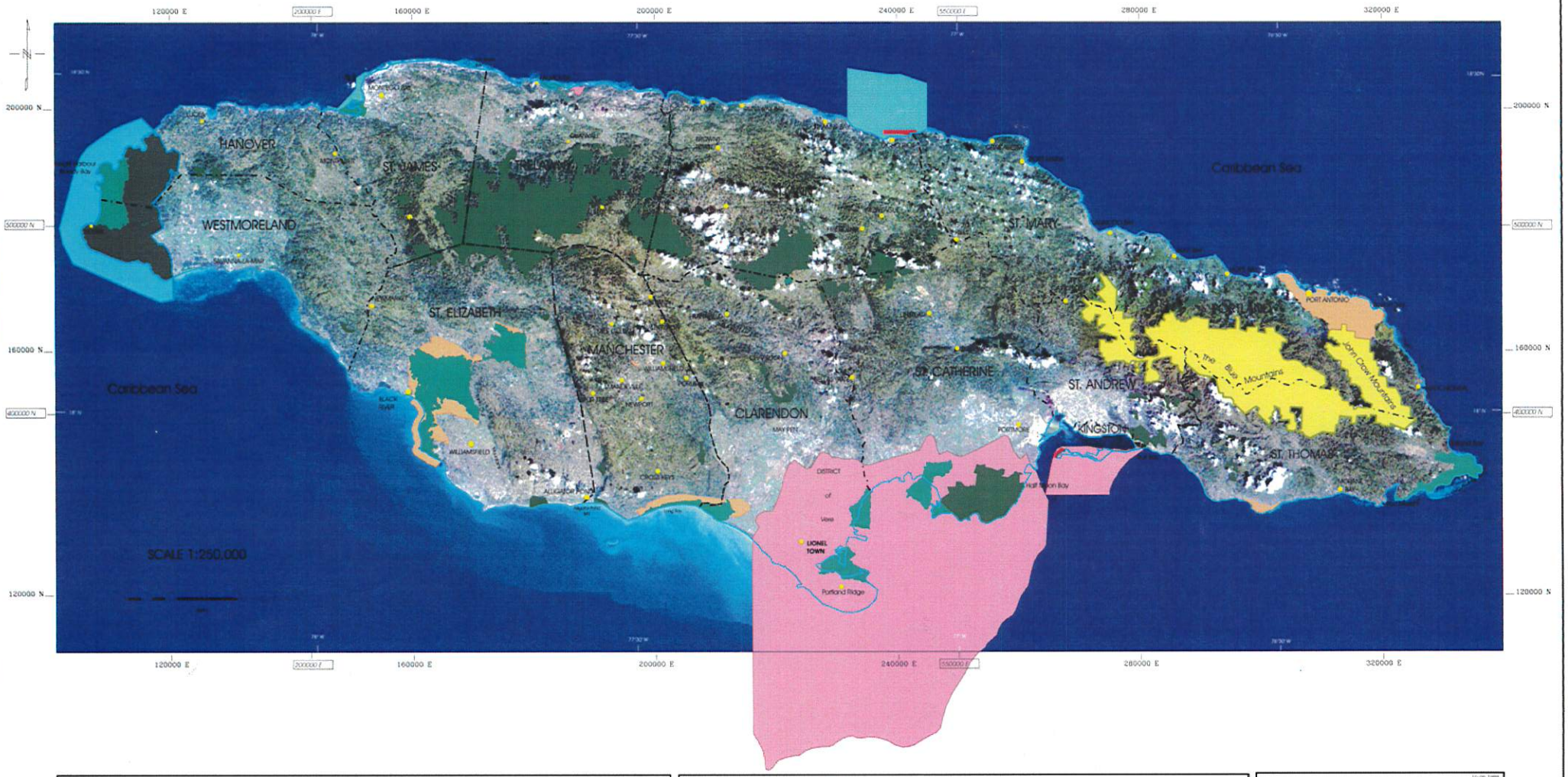
National Parks

These are lands and/or seas managed mainly for the conservation of the ecological integrity of ecosystems. They are also managed for scientific research, education and recreation.

Protected Areas

An area of land and/or sea dedicated to the protection and maintenance of natural and cultural values, and managed through legal or other effective means. These areas do not necessarily exclude industrial or or any other type of economic activity.

PROTECTED AREAS SYSTEM



National Parks

These are lands and/or sea managed mainly for the conservation of the ecological integrity of ecosystems. They are also managed for scientific research, education and recreation.

Protected Areas

An area of land and/or sea dedicated to the protection and maintenance of natural and cultural values, and managed through legal or other effective means. These areas do not necessarily exclude industrial or or any other type of economic activity.

Marine Parks
National Parks & Forest Reserve
Protected Area
Proposed Protected Areas
Negril Environmental Protection Area
Forest Reserves
Parish Boundaries
Town
Game Sanctuaries/Reserves
Protected Areas Under Beach Control Act

Coordinates in Jamaica Imperial System: 550000 E
Coordinates in Jamaica Metric Grid (JMG) System: 240000 E

Projection: Lambert Conical Orthomorphic
Central Meridian 77 W, False Easting 250 000 m
One Parallel 18 N, False Northing 150 000 m
Spheroid Clark 1866

nepa

Protected Areas under the NRCA Act

Situated along the north coast, the Coral Spring/Mountain Spring area is a dry limestone forest. The Portland Bight includes both land and marine areas, is an important fishing area with areas of forests, mangroves, cays and islands. The Palisadoes-Port Royal area is an important historical site on land and sea and includes mangroves, coral reefs and cays. The Mason River Reserve in Clarendon contains Jamaica's only inland bog. The Negril protected area, also called Negril Royal Palm Reserve, is situated on the western point of the island

Box 8.1
MDG Indicator 7.6
Proportion of terrestrial and marine areas protected

To prevent any further reduction in the loss of biodiversity, the ratio of area protected to surface area should be maintained.

Table 8.4
Protected Areas by Type and When Declared

Protected Areas	Declared	Area, ha	
		Land	Marine
National Parks			
Blue & John Crow Mountains	1993	78,200	–
Marine Parks			
Montego Bay	1992	–	1,400
Negril	1998	–	18,500
Ocho Rios	1999	–	13,300
Protected Areas (NRCA Act)			
Negril	1997	25,900	16,000
Palisadoes–Port Royal	1998	800	6,000
Coral Spring/Mountain Spring	1998	163	–
Portland Bight	1999	55,000	142,300
Mason River	2002	49	–
Total area		**160,112**	**197,500**
Per cent of total land area		14.6	
Ramsar Sites			
Black River Lower Morass	1997	5,700	
Palisadoes–Port Royal	2005	7,523	
Portland Bight Wetlands and Cays	2006	24,542	

Source: NEPA

Ramsar Sites

The Ramsar Convention on Wetlands of International Importance has been ratified by Jamaica and three sites in the island have been designated as Ramsar sites (see Table 8.4). The convention, which focuses on conservation of wetlands worldwide, holds no legal status. The Black River Lower Morass is the largest wetland area in Jamaica. Ninety-two species of flowering plants have been found in the wetland, 23 of which are considered rare and eight which are endemic to Jamaica.

National Heritage Sites

The Jamaica National Heritage Trust defines protected national heritage as *'Any place name; any species of animal or plant life; any place or object (not declared by the Trust to be a national monument) designated by the Trust as protected national heritage.'*

Table 8.5
National Heritage Parks and Botanical Gardens

Parish	Park/Garden	Established
Kingston	National Heroes Park	1973
	St William Grant Park	...
St Andrew	Cinchona Botanical Garden	1868
	Hope Botanical Garden	1881
	Clydesdale National Forest Park	...
	Hollywell National Park	...
	Nelson Mandela Park	...
	Long Mountain	...
St Andrew, St Thomas & Portland	Blue Mountains	n.a.
St Mary	Claude Stuart Park	1977
	Castleton Botanical Garden	1862
St Ann	Seville Heritage Park	...
St Elizabeth	Independence Park	...
St Catherine	Wynter's Park	...
	Serenity Park	...

Source: Jamaica National Heritage Trust

The Trust was set up to promote the preservation of national monuments and protected heritage; to record any artefacts or art work to be preserved; and to record flora and fauna to be protected. Among the national heritage sites are forts, lighthouses, court houses, churches, schools, great houses, statues, cemeteries, mineral baths, a fountain and free villages. Tables 8.5 and 8.6 present lists of national parks and gardens and national heritage sites and monuments by parish. There are 212 heritage sites; 28 are great houses and include many national monuments. Some national monuments are not listed as heritage sites. Fourteen national monuments are on the protected list of the Jamaica National Heritage Trust.

Table 8.6
Heritage Sites by Parish 2006

Parish	Heritage Sites	National Monuments	Great Houses
Kingston	25	31	–
St Andrew	24	19	3
St Thomas	10	7	1
Portland	11	11	1
St Mary	13	7	3
St Ann	21	18	9
Trelawny	13	11	2
St James	20	21	2
Hanover	3	6	1
Westmoreland	8	4	–
St Elizabeth	13	10	–
Manchester	13	7	3
Clarendon	8	5	1
St Catherine	30	15	2
Total	**212**	**172**	**28**

Source: Jamaica National Heritage Trust

Many historical sites are less sturdy than others and require renovation work. In the event of a natural disaster these monuments and sites can be extensively damaged and require even more work. Earthquakes can cause cracks in the structures and undermine foundations of buildings; trees can fall and cause damage; roofs may lose shingles and other types of roofing in a hurricane or storm. It is estimated that total damage to historic sites after hurricane Ivan in 2004 was $51.5 million, see Table 8.7.

Table 8.7
Damage to Historical Sites Due to Hurricane Ivan 2004, $ million

Location	Site	Direct damage $m
Spanish Town, St Catherine	Spanish Town Square Barracks Building Manchester House Iron Bridge	12.0
Port Royal, Kingston	Naval Cemetery Old Coaling Wharf Historical Naval Hospital H Block and Fort Charles	32.0
Seville, St Ann	Taino hut African hut Caretaker's cottage Headquarters House and annex	7.5
All locations		**51.5**

Source: ECLAC from information from the Jamaica National Heritage Trust

Conservation of ecosystems and biodiversity depends on the maintenance and management of protected areas. Benefits people obtain from ecosystems include food and water, flood and disease control, cultural services; aesthetic and economic benefits are also dependent on protected areas. While mountains, forests, deserts, rivers, seas, savannahs and pastures are well known, gardens, parks and zoos, although making a small contribution, are also important.

9 Freshwater Resources

The planet Earth is unique in our solar system – it is a predominantly blue planet with water covering 75 per cent of its surface. Water helps to shape continents and islands, moderates our climate and is a basic element for all forms of life. However, much of this abundance of water is salt water (97 per cent) and the available fresh water is unevenly distributed. Human life depends on fresh water (70 per cent of our body weight is water) which is used for drinking, cooking, washing and waste disposal and is vital for social and economic activities. However, this resource is threatened by expanding population and humans' demands for high quality water for personal use and for other activities.

Water Balance

A water balance describes the flow of water in and out of a hydrological domain such as a watershed or country. Input, output and changes in storage of water are quantified in the accounting balance. The major input is precipitation; output is runoff and evapotranspiration. Water balances may be used to predict where there may be water shortages and is used to manage water supplies.

Precipitation comes in the form of rain, snow, sleet, hail and in some cases, dew and fog and is the primary source of water supply. Water resources of small island states, such as Jamaica, are vulnerable to changes and variations in climate, especially rainfall which is the only source of fresh water.

Evapotranspiration is water that is released into the air by evaporation and transpiration. A liquid from a wet surface changes to a gas through evaporation while transpiration occurs when plants release water into the air. Evapotranspiration depends on available water in the atmosphere, in water bodies or in the soil. Water loss from runoff occurs when rivers and streams take water to the sea. Other rain water may percolate to groundwater resources.

Table 9.1
Average Annual Water Balance, 1990 and 2005, million m^3/year

Item	1990	2005
Rainfall	21,212	21,080
Evapotranspiration	11,945	10,051
Surface water runoff	5,576	6,530
Groundwater discharge	3,691	4,499
Exploitable Water Resources		
Reliable surface water yield	666*	1,490
Safe groundwater yield	3,419	3,725
Total	**4,085**	**5,215**

Source: Water Resources Authority
* The surface flow in some basins was moved to the category of groundwater resources..

The average annual rainfall for Jamaica is about 21,000 million m^3. Of this, in the 2005 water balance, 48 per cent was lost through evapotranspiration. Thirty-one per cent of rainfall was lost through surface water runoff and 21 per cent from groundwater discharge (see Table 9.1). Total exploitable water resources refer to reliable and readily available surface and groundwater resources. This was 5,215 million m^3 in 2005, a 28 per cent increase over estimates of exploitable water resources in 1990.

Water Demand and Supply

An estimate of annual water use/demand by sector for two periods is shown in Table 8.2. The agricultural sector is the main user of water, mainly for irrigation purposes, although estimates are that over the fifteen years there has been a 36 per cent decline in water demand from that sector. Between 1990 and 2005, estimated annual water demand by the domestic sector rose 114 per cent to 273 million m3. Environmental flows refer to the volume and flows needed to maintain rivers and their ecosystems.

Table 9.2
Estimated Annual Water Demand, 1990 and 2005, million m^3

Sector	1990	2005
Non-agricultural sector	231	363
Domestic rural	21	89
Domestic urban	138	184
Industrial	72	86
Hotels	...	4
Agricultural sector	682	439#
Environmental flows	–	510
Total	**1,144**	**1,312**

Source: Water Resources Authority
irrigation and aquaculture
Note: Domestic demands include commerce and offices.

Water Supply

A watershed is a geographical land area where rainwater drains to particular streams, rivers, ponds or lakes.

Watershed management is essential to ensure continued good and reliable water supplies. There are 26 watersheds management units in Jamaica, which fall into ten hydrological basins. Tables 9.3 to 9.5 show the water balance, supply and demand for water in Jamaica's hydrological basins. The hydrological basins contain over 100 streams and rivers, as well as several subterranean waterways, ponds, springs and blue holes.

A hydrological basin has various terrestrial environments with both surface and underground waters and encompasses several watersheds.

Precipitation is highest in the Blue Mountain North basin (4,553 10^6 m^3) and lowest in the Kingston basin (302 10^6 m^3). The Blue Mountain North basin also has a high evapotranspiration rate but with internal resources of 2,968 million m^3 and no marine discharge has the greatest volume of fresh water resources in the island. Internal resources of 11,030 million m^3 give an indication of the volume of rainwater that is not lost through evapotranspiration. Of total internal resources, much is lost through

surface outflows and marine discharges to give a groundwater yield of 3,725 million m^3 of water. Total fresh water resources in all hydrological basins totalled 14,755 million m^3. The Kingston, Martha Brae River and Cabarita River basins have the lowest levels of fresh water resources.

Table 9.3
Annual Water Resources by Hydrologic Basin 2005, million m^3

Hydrologic Basin	Precipi-tation	Evapo-transpi-ration	Internal Resources	Surface Outflow	Marine Discharge	Ground Water Yield	Total Fresh Water Resources (1-2+6)
	1	2	3 (1-2)	4	5	6 (3-4-5)	(mio m^3)
Blue Mountains, South	1,735	885	850	555	4	291	1,141
Kingston	302	162	140	51	21	68	208
Rio Cobre	1,747	935	812	401	73	338	1,150
Rio Minho	2,646	1,416	1,230	210	288	732	1,962
Black River	3,318	1,686	1,632	771	154	707	2,339
Cabarita River	1,249	624	625	281	42	302	927
Great River	1,862	838	1,024	675	35	314	1,338
Martha Brae River	1,055	521	534	429	15	90	624
Dry Harbour Mountains	2,613	1,398	1,215	704	143	369	1,584
Blue Mountains, North	4,553	1,585	2,968	2,453	–	514	3,482
Total	**21,080**	**10,050**	**11,030**	**6,530**	**775**	**3,725**	**14,755**

Source: Water Resources Authority

Surface water is obtained from open bodies of water, such as streams, rivers or reservoirs, on the Earth's surface. Groundwater is water that is either stored underground in rocks or flows through the rocks, supplying springs and wells. Table 9.4 shows the total

Table 9.4
Annual Water Resources, Surpluses/Deficits by Basin 2005, million m^3/year

Basin	Resources			Demand			Surplus
	Surface	Ground	Total	Irrigation	Other	Total	
Blue Mountains, South	83.9	290.4	374.3	6.8	31.5	38.3	336.0
Kingston	5.4	69.1	74.5	0.1	87.5	87.6	-13.1
Rio Cobre	146.0	337.7	483.7	189.9	115.3	305.2	178.5
Rio Minho	31.6	732.5	764.1	212.9	70.1	283.0	481.1
Black River	287.3	706.5	993.8	12.4	156.7	169.1	824.7
Cabarita River	118.8	302.7	421.5	3.0	32.7	35.7	385.8
Great River	70.9	315.1	386.0	0.9	51.4	52.3	333.7
Martha Brae River	149.8	89.4	239.2	6.6	49.7	56.3	182.9
Dry Harbour Mountains	273.1	368.7	641.8	3.2	156.2	159.4	482.4
Blue Mountains, North	323.3	512.4	835.7	3.0	121.9	124.9	710.8
Total	**1,490.1**	**3,724.5**	**5,214.6**	**438.8**	**873.0**	**1,311.8**	**3,902.8**

Source: Water Resources Authority

exploitable water resources (i.e. water that is available for use) and demand for water by hydrological basin. Most regions have a surplus of water with the exception of the Kingston basin. The largest surpluses are in the Black River and Blue Mountains, North basins.

Table 9.5
Water Demand by Sector, 2005 million m^3/year

Basin	Household	Commercial	Hotels	Irrigation	Industry	Environmental Flow	Total
Blue Mountains, South	7.0	1.7	0.012	6.8	1.5	21.3	38.3
Kingston	60.5	15.1	0.289	0.1	9.2	2.3	87.5
Rio Cobre	50.7	12.7	0.014	189.9	14.1	37.8	305.2
Rio Minho	28.2	7.0	0.047	212.8	28.8	5.8	282.6
Black River	12.6	3.2	0.080	12.4	23.5	117.3	169.1
Cabarita River	7.9	1.9	0.965	3.0	-	22.0	35.8
Great River	17.8	4.5	0.776	0.9	2.7	25.7	52.4
Martha Brae River	3.7	0.9	0.306	6.6	-	44.8	56.3
Dry Harbour Mountains	15.6	3.9	0.904	3.2	6.2	129.6	159.4
Blue Mountains, North	15.1	3.8	0.192	3.0	-	102.9	125.0
Total	**219.1**	**54.7**	**3.585**	**438.7**	**86.0**	**509.5**	**1,311.6**
% Demand	**16.7**	**4.2**	**0.3**	**33.4**	**6.6**	**38.8**	**100.0**

Source: Water Resources Authority

Total water demand in 2005 was estimated at 1,312 million m^3 per year. In 2005 irrigated areas in Jamaica totalled 25,360 ha and it is estimated that these lands required 438.7 million m^3 or 33 per cent of fresh water available in that year. The other large user of water was the household or residential sector (17 per cent). Many farmers, however, irrigate their holdings from the domestic water supply as well as local springs or stored rainwater. There is also a growing use of fresh water by the aquaculture sector.

Water Production

Access by a population to safe drinking water is important for both health and development. The National Water Commission (NWC) provides the majority of fresh water to households, industries and in some cases agriculture, as indicated above. Approximately 70 per cent of potable water in Jamaica is provided by the NWC. Table 9.6 provides data on the average daily volume of fresh water produced by the NWC over a six-year period. Parish councils also provide potable water in some rural areas using springs, rainwater and wayside tanks. Private suppliers of water include the bauxite companies, some private estates and a few private water companies which account for only a small portion of potable water produced.

Average plant capacity exceeds average water production for most parishes, the exception being St Ann and Hanover (data on some parishes were not available). Average water production fell from 860 million litres in 2000 to 845 million litres in 2005.

Table 9.6
Average Production of Water by the NWC, by Parish 2000–2005, million gallons per day

Parish	Plant Capacity	2000	2001	2002	2003	2004	2005
Kingston & St. Andrew	62.81	49.26	52.34	55.18	56.34	51.01	53.45
St. Thomas	9.47	6.28	6.17	5.34	4.77	4.06	4.18
Portland	7.53	5.02	4.58	3.40	2.68	2.54	2.74
St. Mary	8.76	4.37	5.19	5.92	6.49	6.61	8.21
St. Ann	13.71	12.27	12.72	12.29	12.52	12.77	14.88
Trelawny	21.91	10.35	10.26	10.00	9.91	9.44	9.54
St. James	19.72	14.25	14.39	15.88	16.49	16.17	17.84
Hanover	1.85	5.56	5.64	5.25	6.33	6.80	5.69
Westmoreland	..	5.30	6.00	5.56	5.61	7.40	5.10
St. Elizabeth	..	8.26	8.21	8.34	8.85	8.04	8.65
Manchester	..	12.53	8.13	9.09	11.87	7.18	7.59
Clarendon	..	16.70	15.45	16.47	17.91	17.00	17.30
St. Catherine	43.42	32.11	28.11	24.50	29.21	27.43	30.63
Total	**189.18**	**182.26**	**177.19**	**177.22**	**188.98**	**176.45**	**185.81**

Source: National Water Commission

Other data from the NWC shows the volume of water produced for domestic consumption over a five-year period (see Table 9.7). Between 2002 and 2006, total domestic water production grew by six per cent while consumption increased by less than one per cent. Water production in the Kingston/St Andrew/St Thomas areas declined; as did

Table 9.7
Water Production and Consumption, 2002–2006

Item	2002[r]	2003[r]	2004[r]	2005	2006[p]
Water produced (megalitres)	**276,836**	**293,382**	**280,308**	**296,454**	**294,384**
Kingston/St. Andrew/St. Thomas	80,384	89,637	76,667	79,995	74,207
Other parishes	196,452	203,745	203,641	216,459	220,177
Consumption (megalitres)	**95,094**	**96,329**	**94,729**	**94,416**	**95,318**
Kingston/St. Andrew/St. Thomas	33,480	33,599	33,345	33,959	33,182
Other parishes	61,614	62,730	61,384	60,456	62,136
No. of active accounts	**375,431**	**388,460**	**400,102**	**410,286**	**418,347**
Kingston/St. Andrew/St. Thomas	95,368	96,611	98,321	99,484	100,496
Other parishes	280,063	291,849	301,781	310,802	317,851
No. of connections	...	**388,460**	**400,102**	**410,286**	**418,344**
Kingston/St. Andrew/St. Thomas	...	96,611	98,321	99,484	118,235
Other parishes	...	291,849	301,781	310,802	300,109

Source: National Water Commission
p preliminary r revised

consumption. Most of the increased water production, 12 per cent, in other parishes was reflected in the 13 per cent rise in connections in other parishes. Water losses from the NWC continue to be high at about 68 per cent of total water produced in 2006.

Most water for irrigation purposes is provided by the National Irrigation Commission (NIC). With an estimate of the potential land for irrigation at 188,000 hectares, in 2006/07 the NIC reported that it had 1,331 active customers with an area of 8,085 ha. That means that about four per cent of irrigable land is being provided with water by the NIC. Sugar cane fields account for around 75 per cent of the irrigated lands; other crops are bananas, fruits such as citrus and mangoes, and vegetables. The majority of these irrigated areas are subject to inadequate rainfall for economic agricultural production. The NIC uses mainly surface systems of irrigation while private irrigation systems favour drip and sprinkler systems.

Box 9.1
MDG Indicator 7.5
Proportion of total water resources used

Reduce the rate of loss of fresh water.

Table 9.8
Annual Irrigation Water Production (April 2003-March 2006)

Location	Water Pumped (m^3)		
	(April 2003-March 2004)	(April 2004-March 2005)	(April 2005-March 2006)
Yallahs	375,541	443,298	406,110
St. Dorothy	4,562,610	6,421,175	5,228,311
Blocks & Spring Village	3,327,251	5,543,151	4,498,455
Total (Esn. Region Pmp)	8,265,401	12,407,624	10,132,876
Canal flow (Esn. Region)	59,396,261	71,428,771	63,566,545
Total (East Region)	67,661,662	83,836,395	73,699,421
Mid-Clarendon (DW)	22,320,702	20,273,224	14,169,524
River	...	11,902,917	17,293,154
MCID (DW + River)	22,320,702	32,176,141	31,462,678
Hounslow	2,341,820	2,826,883	2,874,652
Braco	634,177	632,608	648,212
Total (Western)	2,975,997	3,459,491	3,522,864
Overall			
Pumped	33,562,101	36,140,340	27,825,264
River Flow	59,396,261	83,332,688	80,859,699
Grand Total	**92,958,362**	**119,473,028**	**119,473,028**

Source: National Irrigation Commission

Table 9.8 shows data from the NIC's water production in its locations around the island. Water pumped has grown from 93 million m^3 in 2003/04 to 109 million m^3 in 2006/07 although the latter year saw a fall of two per cent when compared to 2005/06. This decline was due to falling water production in the eastern region. Water invoiced refers to the volume of water actually sold – 81 per cent of total water in 2006/07 and 61 per cent in the previous fiscal year. However, while volume of water produced in 2006/07 fell by two per cent, water invoiced grew by 31 per cent. This means that loss of water from the NIC's system fell from 39 per cent to 19 per cent of water produced in 2005/06 and 2006/07 respectively.

Water Quality

The quality of water can be affected by contamination by bacteria and chemicals, turbidity, colour and acidity caused by physical or chemical changes. Changes to water quality are often caused by agricultural runoff, household waste and industrial discharges as well as by the chlorine used in the treatment of water. There is also danger to freshwater resources when contaminants seep from unlined waste disposal systems, soak-away pits, bauxite waste and underground petroleum storage tanks.

Water quality monitoring is done by several agencies including the Ministry of Health, the Water Resources Authority, NEPA and the National Water Commission (NWC). Different agencies monitor for different parameters but the usual ones include BOD, pH, total coliform, faecal coliform and nitrate-nitrogen. The levels of heavy metals, pesticides and fertilisers are not usually monitored.

Table 9.9
Water Quality Criteria

Use	Parameter	Acceptable Limit	Source
Drinking	Faecal coliform cts/100 ml	0/100	
	pH	6.5–8.5	
	Hardness mg/l $CaCO_3$	300	World Health
	Nitrate mg/l	<50	Organisation
	Sulphate mg/l	<250	Drinking Water
	Chloride mg/l	<250	Guidelines, 2004
	Fluoride mg/l	1.5	
	Sodium mg/l	<200	
	Total dissolved solids (TDS) mg/l	<1000	
Irrigation	Conductivity	<3000 µS/cm	National Irrigation Commission 1998

Source: World Health Organisation and the Water Resources Authority

It is important to measure changes in the quantity and quality of surface and groundwater and changes in river flow. Such data is not readily available; therefore water use and the level of extraction are measured.

Drinking water quality guidelines and standards are used to determine water quality by comparing the guidelines to the physical and chemical characteristics of a water sample. Five principal contaminants and their recommended parameters for drinking water chosen by the WRA (nitrate, chloride, sodium, sulphate and TDS) as well as other recommended by the WHO are shown in Table 9.9. For irrigation water, the recommended limit of one parameter is as recommended by the NIC.

An explanation of some of the chemical properties limits set are:

- faecal coliform – bacteria introduced into water chiefly through human and animal faeces;
- pH values –the acidity or alkalinity of water. Levels below 7 indicate acidic water; measurements above 7 imply high alkalinity;
- total hardness – the concentration of calcium and magnesium ions;
- nitrates (NO_3) and fluorides –found in groundwater and usually caused by human and animal waste and decaying plants;
- total dissolved solids – an indication of the salinity of water;

Other parameters are turbidity which is the clarity of water and the volume of suspended particles and metals such as silica, aluminium, iron, lead and manganese.

Changes to water quality can usually be attributed to human generation of water pollutants or activities that alter the availability of water. Work on global climate change indicates that changing precipitation patterns may cause or contribute to changing water quality and availability.

Potable Water

Turbidity affects the efficiency of the disinfection agent. It is measured to determine what type and level of treatment is needed for the water.

Untreated water in rivers, springs and aquifers are not good enough for household purposes especially for drinking. This water contains bacteria and other micro-organisms and chemicals which may lead to water-borne diseases such as cholera, typhoid, dysentery and gastroenteritis. For drinking purposes NWC treats water while it is being passed through their water treatment plants. Treatment involves the removal of debris and the introduction of oxygen to remove odours; filtration; and disinfection where chlorine is added to kill any bacteria or germs. This process can be shortened, however, depending on the source of water to be treated.

In 2006, the NWC analysed over 61,000 samples of water in its plants and distribution points; water is sampled for traces of coliform and residual chlorine. The points which exhibited the highest values for coliform were in rural St Andrew, St Thomas, Portland and St Mary. The lowest values were in Trelawny, Hanover, Westmoreland and St

Residual chlorine cannot be assessed by taste alone as it is not reliable. This is tested in the field.

Box 9.2
MDG Indicator 7.8
Proportion of population using an improved drinking water source

Halve proportion of population without improved drinking water

Table 9.10
NWC Drinking Water Quality Results 2006

Parish	No. of samples analysed for the year	% treated water samples with coliform	% treated water with residual chlorine
Standard (NWC)		**5%**	**95%**
Kingston & St. Andrew	*11,163*	2 – 8	99.0
Rural St. Andrew	*7,149*	16 – 27	99.1
St. Thomas	*4,042*	7 – 18	99.8
Portland	*5,268*	6 – 19	99.5
St. Mary	*3,071*	6 – 23	99.7
Trelawny	*3,333*	1 – 9	99.0
St. James	*4,729*	2 – 10	98.5
Hanover	*1,872*	0 – 5	99.3
Westmoreland	*3,982*	2 – 9	99.4
St. Elizabeth	*4,915*	1 – 4	98.8
Manchester	*1,574*	0 – 12	98.9
Clarendon	*5,784*	5 – 14	94.9
St. Catherine	*4,508*	2 – 11	99.3
Jamaica	***61,390***		

Source: National Water Commission

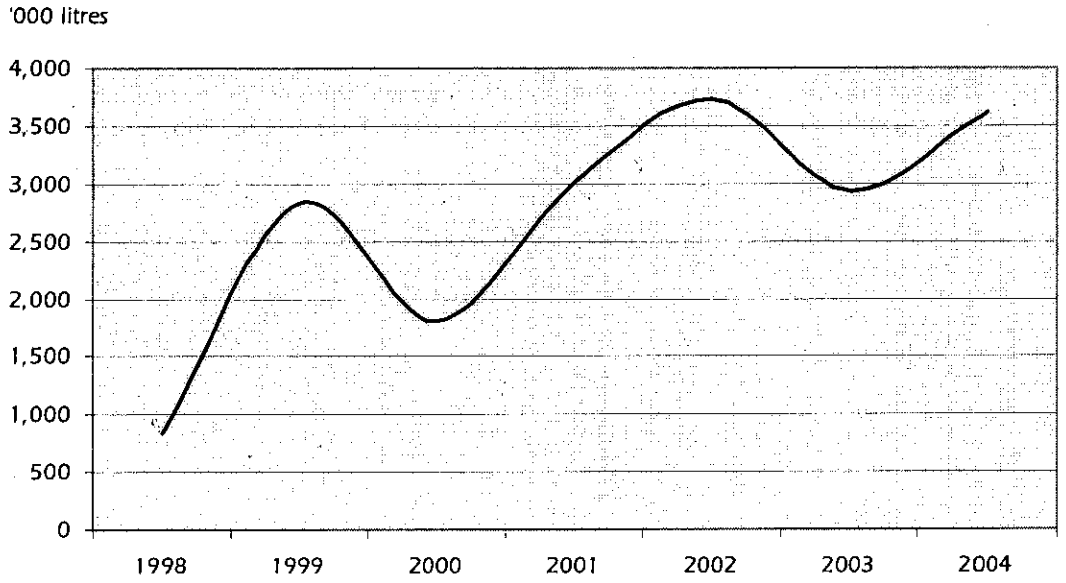
Safe drinking water can be defined as water that is safe to drink and enough for hygienic purposes.

Elizabeth. Results from testing for residual chlorine were above the 95 per cent standard set by the NWC (see Table 9.10).

Bottled Water

Bottled water consumption has become popularly worldwide and Jamaica is no exception. Data on production of local bottled water is not available but imports show a 330 per cent increase over a seven-year period (see Figure 9.11). These data show imports of bottled water not containing sugar or other sweeteners or flavoured water and does not include aerated water.

Figure 9.11
Imports of Bottled Water 1998–2004, litres



Source: External Trade Reports, Statistical Institute of Jamaica
Note: Bottled waters not containing sugar or other sweeteners, nor flavoured.

Bottled water produced in Jamaica is often purported to be spring or mineral waters, however, excessive withdrawal of natural mineral or spring water to produce bottled water may threaten local streams and groundwater. The production and shipping of bottled water also consumes energy while oil-derived plastics, e.g. polyethylene terephthalate (PET), are used to make the water bottles which are not recycled.

Climate Change

Predictions by scientists working on climate change show changes in rainfall – less rain in the rainy season with more rain in the dry season – as well as rising temperatures. If that is the case, changes to water resources will include:

- less water for groundwater recharge
- a reduction in drought conditions
- shortages in domestic water supplies
- and sea level rise possibly leading to salt water intrusion in groundwater supplies.

10 Coastal Zone and Marine Resources

Coastal and marine areas, while being among the most productive, are also one of the most highly threatened areas in the world. The growth in population in coastal regions and technological advances has added to the exploitation of coastal resources in this century. The health of many types of coastal ecosystems – mangroves, estuaries, coral reefs, marshes, sea grass beds and kelp forests – has declined. The effects of human proximity to the coast has had varied effects such as eutrophication, the introduction of invasive species, over-fishing and coastal development for tourism and housing, habitat loss, altered sedimentation patterns, climate change and degradation of land from agriculture. The accumulated effects of all these will eventually degrade the ecosystem.

The Coastline

Jamaica has an irregular coastline and varying figures on its length have been reported – from 795 km in Jamaica's Beach Policy (2000) to 1,009 km in the Coastal Zone Resource Atlas (1998). Different sections of the shoreline can be classified as rocks and gravel, white and brown sand beaches, mangrove swamps and other types of vegetation. About 30–49 per cent of the coastline of Jamaica is characterised as sandy beach; less than one per cent of this is designated as public and fishing beach areas. The rest of the developed beaches are confined to hotels and other tourist attractions.

The cays and islands around mainland Jamaica are mainly off the south coast. They offer a habitat for flora and fauna, and are important for fishing and recreation.

Beach erosion affects both fishing and recreational use. Dangers to beaches come from erosion caused by storm surges, sea level rise, hurricanes and discharges from rivers. Human activities such as illegal sand mining, dumping of mangroves and swamps and construction along the shoreline also cause erosion of beaches.

Table 10.1
Number of Beaches by Parish

Parish	Public	Hotel	Fishing	Total
Kingston	2	–	–	2
St Andrew	2	–	5	7
St Thomas	5	–	14	19
Portland	15	4	17	36
St Mary	7	4	9	20
St Ann	9	15	9	33
Trelawny	7	4	10	21
St James	10	12	7	29
Hanover	6	11	11	28
Westmoreland	6	10	16	32
St Elizabeth	9	1	9	19
Manchester	3	–	3	6
Clarendon	2	–	8	10
St Catherine	4	–	3	7
Total	**87**	**61**	**121**	**269**

Source: NEPA

There are 87 public bathing beaches throughout all parishes (see Table 10.1), 18 of which are commercial recreational beaches. Some of the issues affecting non-commercial public bathing beaches are: waste disposal, sometimes inadequate; and squatting on beach lands. Beaches associated with hotels number 61 and there are 121 fishing beaches. Another 275 beaches are associated with guest houses and villas.[1]

Beaches and cays are also nesting sites for turtles, birds and other animals and destruction of habitats has lead to a decline in wildlife. Litter on beaches as well as offshore can obstruct wildlife and their procreation.

The major urban centres of Jamaica have developed along the coast with the capital city, Kingston, situated on a natural harbour, the seventh largest in the world. Other urban areas are tourism-related towns such as Montego Bay, Ocho Rios, Port Antonio and Negril.

Wetlands

Coastal wetlands including mangroves and sea grass beds provide breeding, feeding and nursery grounds for fish, shrimp, birds and other animals. Wetlands along the shore are important for the stability of the shoreline as they act as buffers against waves and storm surges, protecting beaches from erosion. They help to detoxify pollutants and control erosion along coastlines and are a source of fuel wood and timber. Wetlands once comprised about two per cent of the total surface area of the island but this has been reduced mainly due to filling in of and modifications to the areas.

Table 10.2
Major Wetlands of Jamaica

Parish	Name	Size (ha)	Type
Kingston	Kingston Harbour	200	Marine/estaurine, mangal
St Thomas	The Great Morass	1,600	Marine, mangal
	Cow Bay	146	Estaurine, marsh
St Ann	Pear Tree Bottom	80	Riverine, marsh
Trelawny	Falmouth and Salt Marsh	1,070	Marine/estaurine, mangal and marsh
Hanover	Negril Great Morass	2,400	Estaurine, marsh and swamp forest
Westmoreland	Cabarita	240	Estaurine, mangal and marsh
St Elizabeth	Black River Morass	6,000	Riverine/estaurine, marsh with swamp, forest and mangal
Manchester	Canoe Valley	1,200	Riverine/estaurine, marsh with swamp, forest and mangal
Clarendon	West Harbour	1,600	Marine, mangal
	Cockpit–Salt River	160	Riverine/marine, marsh and mangal
	Mason River	80	Palustrine, highland marsh
St Catherine	Amity Hall	480	Marine, mangal
	Great Salt Pond	448	Marine, estaurine, mangal
	Manatee Bay	370	Marine, mangal and marsh

Source: Mangrove and Coastal Wetlands Protection Draft Policy and Regulation, NEPA
Note: Mason River in Clarendon is the only inland wetland area.

[1] *Beach Policy 2000*. NEPA.

Other notable wetland areas are located throughout the island, many of which are under private ownership. These are the Hart Hill & Windsor Castle, St Margaret's Bay and Orange Bay swamps in Portland; Frontier in St Mary; Bush Cay in Trelawny; Carlisle Bay-Jackson Bay, Portland Ridge and McCarry Base swamps in Clarendon.

Mangroves are salt tolerant trees found in saline coastal waters. Four types of mangroves grow in Jamaica, they are the red (*Rhizophora mangle*), black (*Aricemia germinans*), white (*Laguncularia racemosa*) and button (*Corrocarpus erectus*). Threats to mangroves are from reclamation of the land for development and agriculture; by fires and by the harvesting of timber. Other threats come from man-made changes in wetland rivers (widening and deepening) and pollutants such as sewage, agricultural run-off, industrial waste and oil spills. It is estimated that about 106 km^2 (less than 1%) of Jamaica is still covered in mangrove forests.

Mangroves and sea grass beds filter sediment and nutrient coming from the land and their loss makes it easier for coral reefs to be contaminated by sediment, etc.

Kingston Harbour

This harbour is naturally formed and sheltered by a peninsula. It has port and airport facilities, is a fishing area, is bordered by industrial and commercial enterprises and is densely populated. As an area for fishing, the harbour has deteriorated in past decades due to the volume of effluent discharged into its waters.

Mangroves are still present in the harbour and are in an area where pollution levels are lower than in the main area. The mangroves are important for protecting the coastline and assimilating waste.

Kingston Harbour's problems stem from the inflow of poorly treated or untreated sewage, the discharge of industrial effluents as well as agrochemicals which are dumped into the harbour on a daily basis. Ships that come into the harbour add to the pollution through their discharge of ballast water, oily waste and garbage. Despite this the harbour is still an area for limited recreation and fishing.

Coastal Water Quality

The quality of coastal and marine waters is affected by discharge of sewage, urban runoff, agricultural and industrial effluent. Recreational activities with its concomitant discharge of wastes into the sea also affect the quality of coastal water.

Table 10.3 shows data on water quality for selected sites on the north coast. Samples taken from 2001 to 2007 were collected and analysed for nitrates, phosphates and total suspended solids (TSS) to determine the level of contaminants in marine ecosystems. High levels of nitrates and phosphates accelerate the growth of algae which can smother coral reefs. TSS levels indicate the amount of sedimentation coming from land- and shore-based activities.

The results obtained are compared to interim water quality standards proposed by NEPA. Sampling is sporadic, therefore, although standards have been exceeded, it cannot be an indication of the quality of water at all times.

The Fishing Industry

The Fisheries Division of the Ministry of Agriculture is engaged not only in the development of inshore but inland (freshwater) fishing as well, providing fishermen with training and technical advice. With changing technology and difficulties in

Table 10.3
Water Quality Data: North Coast 2001–2007

Location	NEPA Interim Standard					
	Nitrate (mg-N/L)		Phosphate (mg-P/L)		Total Suspended Solids (mg/L)	
	0.0001–.0081		0.0001–.0081		10	
	Min.	Max.	Min.	Max.	Min.	Max.
Portland						
Rio Grande	0.354	3.543	0.028	0.398	<10	500
Orange Bay Beach	0.022	9.743	0.015	0.153	10	44
St Ann						
Dunn's River Beach #1	0.236	6.170	0.003	0.215	<10	24
Dunn's River Beach #2	2.100	9.821	0.003	0.640	<10	96
White River #3	0.476	8.279	0.003	0.089	<10	84
Trelawny						
Burwood Beach	0.086	3.599	0.003	0.242	<10	74
Silver Sands	0.004	1.200	0.003	0.245	<10	60
Martha Brae River	0.943	5.750	0.003	0.245	<10	60
Montego Bay						
Montego River #1	0.171	6.210	0.003	3.104	<10	140
Montego River #2	0.471	4.626	0.021	1.587	<10	515
Walter Fletcher Beach	0.004	2.961	0.003	0.141	<10	82
Hanover						
Lucea East River	0.021	0.435	0.037	4.934	376	742
Lucea West River	0.129	1.363	0.032	0.444	158	472
Westmoreland						
Bloody Bay #2	0.004	0.943	0.003	0.156	<10	342
North Negril River	0	2.498	0.028	2.991	6	96
South Negril River	0.21	7.829	0.083	2.053	<10	96

Source: NEPA from 'North Coast Highway Corridor Study Project'

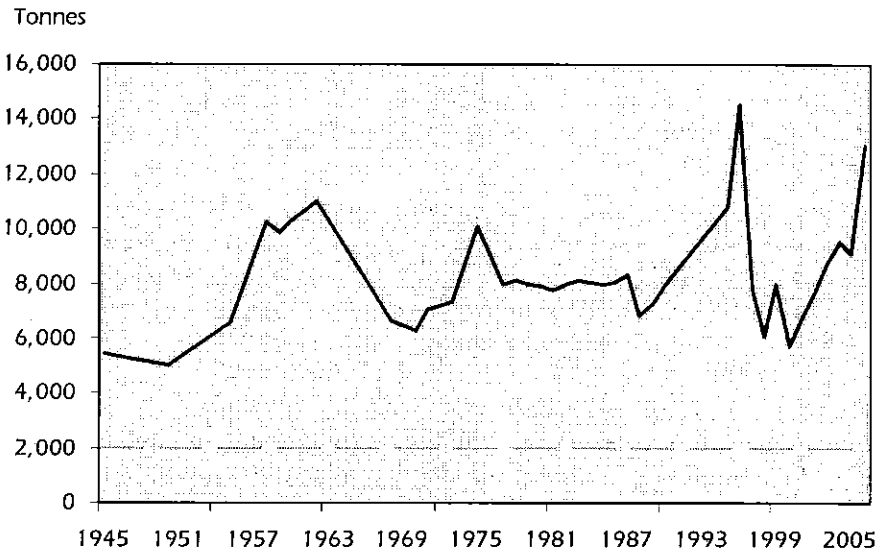
obtaining wood from cotton and guango trees to make canoes, fishermen are now utilising fibreglass, a more environmentally friendly choice.

Hurricanes, pollution and unsustainable fishing practices have resulted in a lack of habitat for fish. This, along, with the overfishing of near shore or reef fish, has caused fishermen to fish as far as 480 km away from Jamaica. Artisanal fishermen operating from open canoes either with outboard motors or oars are the main types of fishers in Jamaica. There are some, a small number, who engage in industrial fishing for conch, spiny lobster and reef fish. Fishing is also a tourism-related activity, albeit small, along with some recreational fishing.

Fishing beaches are designated by the Fisheries Division and licensed by NEPA under the Beach Control Authority (Licensing) Regulations of 1956.

Finfish and shellfish and some molluscs are the main capture fisheries. Inshore fishermen operate mainly on the island's coastal shelf areas, within 64 km of the mainland. Operations are also carried out in and from the offshore fishing areas of the Morant and Pedro Banks. Fish landed in Jamaican waters are snapper, grouper, parrotfish, jack, kingfish, grunt, doctor fish and goatfish, yellow fin tuna, blue marlin, dolphin fish, shark, herring, anchovy and mullet. Data on fish catch is very reliable and among the various sources there are many discrepancies. Fish catch data shown in Figure 10.4 are from several sources and in some instances are estimations.

Figure 10.4
Estimated Total Fish Landings 1945–2006, tonnes



Source: Fisheries Division and FAO

The increase seen in fish landings could be due to improved fishing technology and increase in the number of fishing boats.

Box 10.1
MDG Indicator 7.4
Proportion of fish stocks within safe biological limits

Fishing methods used vary from fish traps, gill, trawl and seine nets, hand lines, throw nets to spear guns. The use of nets to catch fish involves at times, the scraping of the sea floor. This can lead to the destruction of coral reefs, seagrass beds and eggs laid by fish. Other practices involve the destruction of the fish habitat when dynamite and chemicals are used to kill fish.

Other problems associated with the fishing industry include poaching by foreign fishing vessels; fishers not respecting the closed fishing seasons and other regulations; and the loss of fish habitat due to pollution.

Humans are a real threat to marine habitats, whether through over-fishing, the use of destructive fishing methods or pollution of marine waters. Globally, it is estimated that 76 per cent of the world's fish stock is fully exploited or overexploited. That is no different for Jamaica where there have been reports of declines in the volume and size of fish taken from Jamaican waters.

Marine Pollution

Marine pollution does not have to derive from the countries themselves as garbage can travel many thousands of kilometres to litter coral reefs and shorelines. Debris can smother the reefs and sea grass beds, trap animals, and cause death if it is mistaken

for food. Fishing gear and nets that are abandoned may cause death to marine life. Plastics and other synthetic material are durable; they last for hundreds of years and threaten not only marine life but land-based wildlife.

Coral Reefs

The marine area of the island is 251,000 km^2 with reef area of 1,240 km^2. The island is surrounded by coral reefs with the north coast reefs being the most diverse and extensive. Reefs and corals also grow on the cays to the south of Jamaica. Possibly the most important role of the reefs is as shoreline protection against erosion by the sea as well as from storm surges and hurricanes. They are also noted for the high biodiversity and role in fishing, tourism and production of services and products. Coral reefs are vulnerable to the effects of climate change and natural disasters. Their ecological importance cannot be overstated as they are home to many varieties of fish and sharks, crabs, lobsters, eels, turtles, shrimps, squid, octopi, snails, sea urchins, anemones, sponges, worms, plankton and algae. Corals also provide medical compounds for the treatment of some diseases and their limestone skeleton has been used for human bone grafts.

Damaged reefs are in danger from storms and hurricanes as the waves from these events can smash shallow reefs. These weather events may produce high rainfall and subsequent sedimentation from the land which block out the sunlight necessary for coral to form.

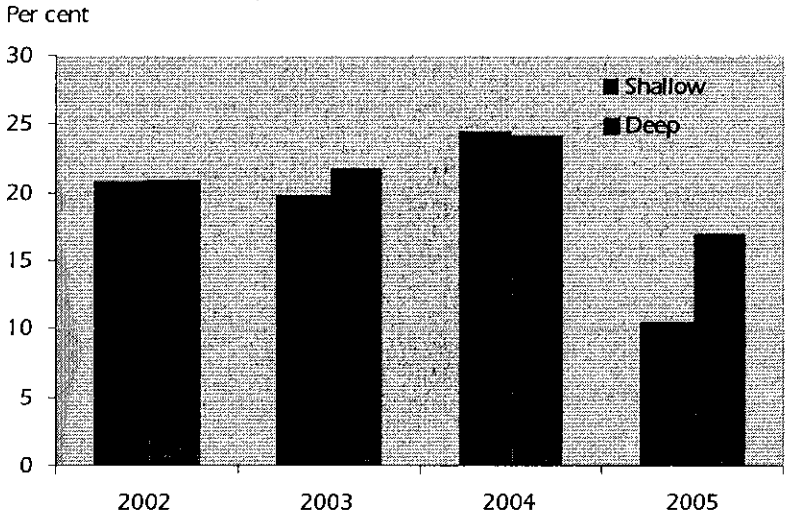
Coral reefs are built up over centuries by skeletons of tiny animals called coral polyps. Within the polyps are smaller plants (*zooxanthellae*) which rely on the sun for life. Corals, then, must have sunlight to grow and reproduce. The loss of *zooxanthellae* leads to corals appearing white as their limestone skeleton becomes visible through the tissues of the coral polyps. This phenomenon is called coral bleaching which has been associated with global climate change. Scientists say that higher than average water temperatures force corals to expel the algae living in its polyps. These polyps are what provide the vivid colours of coral. In mild events, corals regain their colour (algae) but may die in more severe cases. Coral bleaching has been observed mainly on the north coast with some patches on the south coast of Jamaica. Reefs can, however, recover from bleaching events when the sea water cools.

Stresses to coral reefs occur through changes in the salinity of the water, toxins, excessive light and the loss of reef fish. With the loss of algal-grazing fish due to over-fishing in Jamaican waters, the ecosystem became dependent on the long-spined sea urchin (*Diadema*) to keep algal levels down. Unfortunately, in the early 1980s the sea urchins were killed by a disease and algal levels began to rise. Recent monitoring, however, has seen the return of sea urchins and a slight increase in coral cover although algal cover has remained high.

Box 10.2
Eutrophication

Nutrient over-enrichment in marine waters, known as eutrophication, threatens to degrade Jamaica's coastal ecosystem. Two symptoms of this are oxygen depletion (hypoxia) and harmful algal blooms. Activities such as intensive agriculture, industrial emissions along with human settlements near coastlines have raised the levels of nitrogen and phosphorus flows into coastal ecosystems. Excessive nutrients flows cause growth of phytoplankton, micro- and macro-algae leading to reduced light for sub-aquatic vegetation and inhibited coral growth as algae and algal blooms flourish. Eutrophic conditions may lead to changes in species diversity as bottom-dwelling aquatic life is depleted; oxygen-depleted waters may lead to ecosystem collapse. There is insufficient information on the level of eutrophication and the sources of the nutrients.

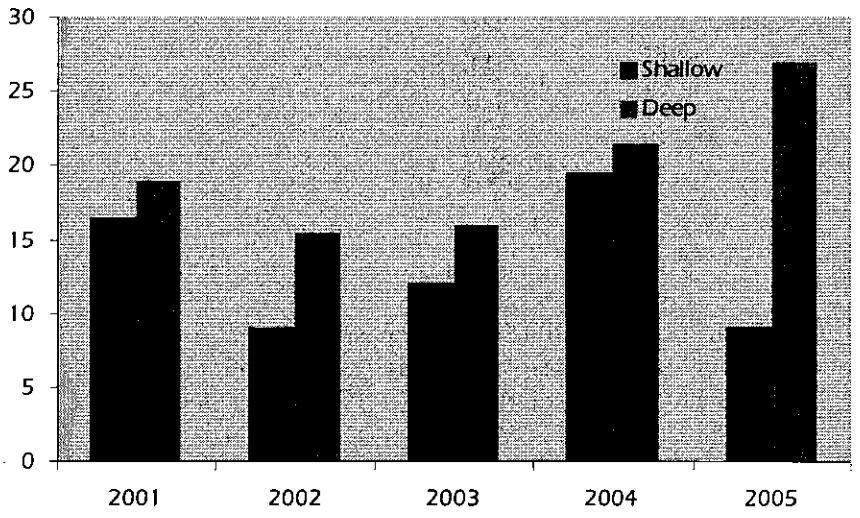
Figure 10.5
North Coast % Cover Hard Corals 2002–2005



Source: NEPA

Figures 10.5, 10.6 and 10.7 show the percentage of the coral reefs that are living on certain sites off the coast of Jamaica. Sites on the north coast have shown a decline in coral cover, from about 21 per cent in 2002 to 10.5–17 per cent in shallow and deep corals respectively in 2005. On the west coast, coral cover in shallow waters has declined but an increase has been recorded for deep corals (19 to 27 per cent between 2001 and 2005). The 17.5 per cent coral cover in shallow waters off the south coast in 2003 increased to 21 per cent in 2006; in deeper waters, coral cover fell from 27 per cent to 20 per cent between 2003 and 2006.

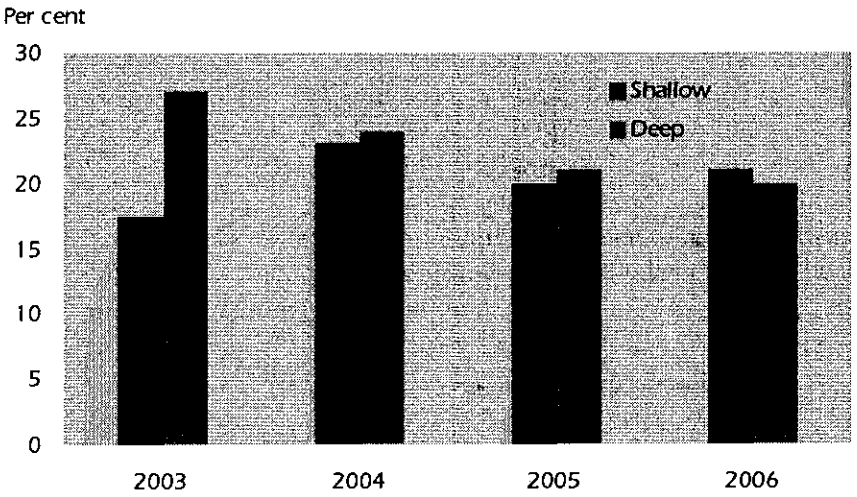
Figure 10.6
West Coast % Cover Hard Corals 2001–2005



Source: NEPA

Direct human activities such as diving and snorkelling and damage from ships' anchors and ship groundings are also a danger to reefs.

Figure 10.7
South Coast % Cover Hard Corals 2003–2006



Source: NEPA

Threats for pollution of coastal and marine ecosystems come from the dumping of garbage and human waste from ships and the discharge of wastewater from tankers, yachts and cruise ships as well as oil spills. Ships' bilge and ballast water are a mix of oil, nutrients, alien species and other pollutants. Although this is spread over large areas, in the Caribbean which is more enclosed, the pollution may linger. It is estimated that the average cruise ship generates 8 mt of oily bilge water and one mt of garbage daily. Waste generated from ships has therefore increased as the volume of cruise ships in the Caribbean has increased. Although, under Marpol, large ships are prohibited from discharging untreated sewage within 7 km of land, other vessels are less likely to comply.

Most modern ships are built with the capacity and facilities to treat, to some extent, solid waste and sewage generated on the vessel.

The health of coastal systems is important for the health and well being of coastal populations and for inland populations, as one of the benefits of a healthy marine ecosystem is as a secure source of food.

11 Tourism

Tourism is one of the most important economic activities in the Caribbean and more specifically Jamaica, earning foreign exchange and providing significant labour opportunities. The Jamaican economy receives particularly large incomes from tourist expenditures. Whether tourism is land-based, or via cruise ships, Jamaica relies on its natural environment as the main appeal to visitors. At the same time, tourism exerts pressures on the resources (natural environment) in the country. The tourism industry generates a high level of waste and due to the seasonal nature of tourism; there are additional burdens on the water supply. The industry also makes strong demands on the environment, such as the use of resources for craft items, use of wetlands for facilities and waste disposal and the removal of seagrass beds at swimming beaches.

The coastal zones are attractive for travellers, space is needed for hotels and other establishments and infrastructure, while at the same time conservation of pristine ecosystems is important.

Number of Visitors

The number of bed nights sold is a base for estimating the use of various resources. Since 2002, the number of bed nights sold in hotels has increased by 32 per cent. Overall there have been increases in the number of bed nights sold among the different regions of the island (see Table 11.1).

Damage to reefs, pollution of the sea by faecal coliform and beach erosion from the construction of hotels are some of the negative effects which the tourism industry can have on the environment.

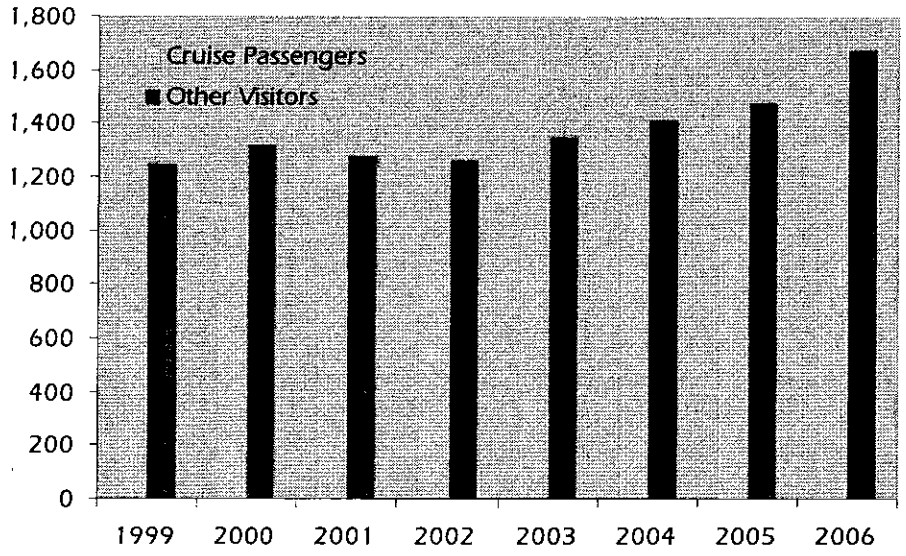
Table 11.1
Number of Bed Nights Sold 2002–2006, '000

Location	2002	2003	2004	2005	2006
Montego Bay	2,047	2,152	2,240	2,304	2,259
Ocho Rios	1,599	1,675	1,651	1,629	2,260
Negril	1,499	1,602	1,854	2,042	2,159
Kingston	325	372	362	364	388
Port Antonio	13	16	18	12	20
Mandeville/South Coast	92	92	76	262	277
Jamaica	**5,575**	**5,909**	**6,201**	**6,613**	**7,363**

Source: Jamaica Tourist Board

Over the past seven years there has been a 75 per cent increase in the number of cruise passengers and a 34 per cent increase in all other visitors to the island (see Figure 11.2). Cruise ship calls at the major ports, with the exception of Kingston, has increased over the years 2002 to 2006 (see Table 11.3). Montego Bay and Ocho Rios had increases of 97 and 15 per cent respectively in cruise ship calls in five years; Portland saw the number of cruise ships coming to call increase from one in 2002 to 16 in 2006. There were even large percentage increases in the number of visitors from cruise ships in the same period. Montego Bay had 156 per cent and Ocho Rios 24 per cent growths in visitors arriving by cruise ship. In Portland, the increase was over 14,000 per cent (from 72 in 2002 to 10,300 cruise ship passengers in 2006).

Figure 11.2
Number of Cruise Passengers and Other Visitors 1999–2006, '000



Source: Jamaica Tourist Board

Table 11.3
Cruise Ship Arrivals by Port of Call, 2002–2006

Port	Calls					Passengers				
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
Montego Bay	111	172	163	181	219	189,761	319,405	328,006	326,964	485,325
Ocho Rios	285	330	310	318	327	675,586	810,019	768,263	804,863	840,923
Port Antonio	1	6	9	9	16	72	2,408	3,504	4,016	10,334
Kingston	–	2	—	1	–	764	–	–	412	
Total	**397**	**510**	**482**	**508**	**563**	**865,419**	**1,132,596**	**1,099,773**	**1,135,843**	**1,336,994**

Source: Jamaica Tourist Board

Accommodation Facilities

In 2006, there was a capacity of 55,183 hotel beds in the island compared to 48,892 in the year 2000 (see Table 11.4). The largest growth in accommodation facilities was in Mandeville (49%) and Negril (17%). Negril, however, has the highest capacity with 17,185 beds, followed by Ocho Rios with 16,361 beds in 2006.

Eco-tourism

Eco-tourism has been defined as travel to an area that is relatively undisturbed and uncontaminated in order to enjoy the culture and natural history of the environment. Despite the goals of the eco-tourism industry, there has been reported difficulties of erosion

Table 11.4
Accommodation Capacity by Location 2002–2006, No. of Beds

Location	2002	2003	2004	2005	2006
Montego Bay	4,171	4,303	4,142	4,155	4,219
Ocho Rios	16,427	16,538	16,396	16,434	16,361
Negril	14,725	14,725	14,539	16,014	17,185
Kingston	11,474	11,863	12,981	13,009	13,018
Port Antonio	1,898	1,984	1,946	1,938	1,960
Mandeville/South Coast	1,636	1,690	1,610	2,390	2,440
Jamaica	**50,331**	**51,103**	**51,614**	**53,940**	**55,183**

Source: Jamaica Tourist Board

Coasts, beaches, islands, mountains and natural attractions are particularly sensitive to tourism development. Degradation, sometimes irreversible, may be occurring in some popular destinations.

along trails, accumulation of wastes and possible deleterious effects on community life through the increased numbers of tourists.

Tourism has added threats to the coastal and marine resources. Coastal zone development, conversion of wetlands and mangrove removal for construction of tourist resorts creates an added pressure on species diversity. Added to this is the loss of beaches for use by the general public, sand mining and pollution of the seashores. Tourism activities such as reef diving, sightseeing, cruise shipping and marina construction add to the deterioration of our natural resources. There is also the competition for land, water and other resources among the tourism, agriculture and other land use sectors.

Environmental Certification

For some stakeholders in the tourism sector, protecting the environment has become both an obligation and a business imperative. Currently there are 25 hotels and tourist attraction sites which have attained Green Globe certification. Green Globe is an international benchmarking and certification programme which facilitates sustainable travel and tourism for companies and communities. Also, there are four beaches in the island which have achieved Blue Flag certification which promotes sustainable development at beaches and marinas through strict criteria dealing with water quality, environmental education and information, and environmental management.

Environmental Impact Assessments (EIAs)

Major developments are required to apply to the National Environment and Planning Agency (NEPA) for permits and licences to discharge effluent. Often, these developments are requested to conduct EIAs by NEPA so that any positive and/or negative environmental impacts can be assessed.

Table 11.5 presents a list of the potential environmental impacts of tourism-related activities in major developments of hotels, resorts and tourist attractions.

Tourism is one of the more important industries in the Caribbean and Jamaica but has become a cause of coastal degradation. Beach erosion, the volume of effluent and litter, deterioration of coastal water quality, destruction of coral reefs and mangroves, disturbance of the coastline due to large developments are symptoms of the growth in the tourism sector.

Table 11.5
Tourism-related Activities and Potential Environmental Impacts

Activity	Environmental Impact
Removal of vegetation	Loss of habitat for birds, reptiles and amphibians on site
Sewage waste disposal	Deterioration of marine water quality due to increased nutrients arising from malfunctioning sewage treatment systems
Solid waste generation and disposal	Increased pressure on municipal dump sites
Beach enhancement/modification	Changes to natural drainage patterns
Dredging to facilitate marina	Increased sedimentation on near shore marine waters and coral reefs
Disruption to sea turtle nesting site	Reduction in population of endangered species
Storm water run-off	Introduction of nutrients, sediments, toxins into marine environment
Removal of mangroves, sea grass beds and reefs	Habitat loss and nursery for many species Resulting changes in bathmetry and current patterns that may alter the conditions for phytoplankton (where present)
Snorkelling and diving	Physical damage to reef structure
Excavation of near-shore bedrock to re-establish beach profile	Disruption in beach processes resulting in increased beach erosion
Fertilisation of golf courses	Contaminated surface run-off into coastal environments
Restricted use by fishermen	Displacement of livelihoods
Increased vehicular traffic	Traffic congestion
Restricted public access to beaches	Impediment to public right to use of beaches
Deepening of sea floor	Change to oceanography
Importation of dolphins	Improper handling and care of animals during transport could have negative effect on welfare of animals
Dredging activities to facilitate cruise ships	Increased sediment loading into coastal waters
Deepening of sea channel	Loss of reef habitat and degradation of coastal ecosystems – removal of living coral, benthic habitats, feeding and spawning areas; increased turbidity and siltation: deposition of fine sediments on coral reefs
Offshore disposal of dredged material	Spillage of material over coral reefs during transit Increased potential for oil spills
Ballast water discharge into coastal and territorial waters	Deterioration of marine water quality
Increased number of visitors in a localised area	Potential of tourism activities exceeding the carrying capacity of the environment
Removal of vegetation for resorts/hotels/housing	Loss of habitats for birds; loss of diversity; soil erosion

Source: North Coast Highway Corridor Study Project – EIA reports for various developments

12 Energy and Transport

Energy

The energy sector is a large user of resources and the basic driving force behind air pollution problems and climate change.

Although the basic source of energy is the sun, other secondary sources are most often used to provide the energy to grow, store and cook food; to light and cool homes, offices, run factories; to manufacture; and to power transport. Most often, these secondary sources are petroleum products, hydropower and electricity from petroleum products and firewood. Other sources of energy are wind, solar power from the sun and the burning of waste products. Households, industries, etc. rely on natural resources to provide electricity which comes from coal or other fossil fuel power plants. These power plants contribute to health and environmental problems that they generate through air, water and noise pollution as well as through their consumption of water. These problems can affect global warming, threaten biodiversity and cause human health risks such as cancer and respiratory disease. It is generally accepted by scientists that the rising levels of CO_2 and other greenhouse gases in the atmosphere, due to fossil-energy combustion are contributing to climate change. As heat is prevented from escaping the atmosphere, there is a rise in global temperatures and consequently, a rise in sea levels as the polar ice melts. This is especially dangerous for low-lying areas and islands.

Energy Supply

Jamaica depends on secondary sources of energy for fuel.

Jamaica's dependence on oil has grown significantly in the past 25 years as the island has no proven fossil fuel reserves, and the vast majority of its fuel needs are imported. In Table 12.1 a summary of Jamaica's primary energy supply sources are shown. For the period 1997–2006, there has been an average annual growth of 2.3 per cent in Jamaica's energy consumption. The use of petroleum, the major source of primary energy supply, hydropower and wind, which contributes small amounts, has increased. However, the other sources of energy, coal, charcoal, bagasse and fuelwood, have provided less energy over the period. The share of petroleum in energy supply

Table 12.1
Primary Energy Supply by Source 1997, 2001 and 2006, per cent

Fuel	Average Annual Growth 1997–2006	Share		
		1997	2001	2006
Petroleum	3.3	88.7	91.9	96.8
Hydropower	2.8	0.8	0.1	0.4
Wind	33.1	–	–	0.1
Coal	-1.3	1.2	1.4	0.6
Charcoal	-11.7	1.0	0.9	n.a.
Bagasse	-4.9	5.4	2.9	2.1
Fuelwood	-11.1	2.8	2.8	n.a.
Total	**2.3**	**100.0**	**100.0**	**100.0**

Source: Ministry of Industry, Technology, Energy & Commerce

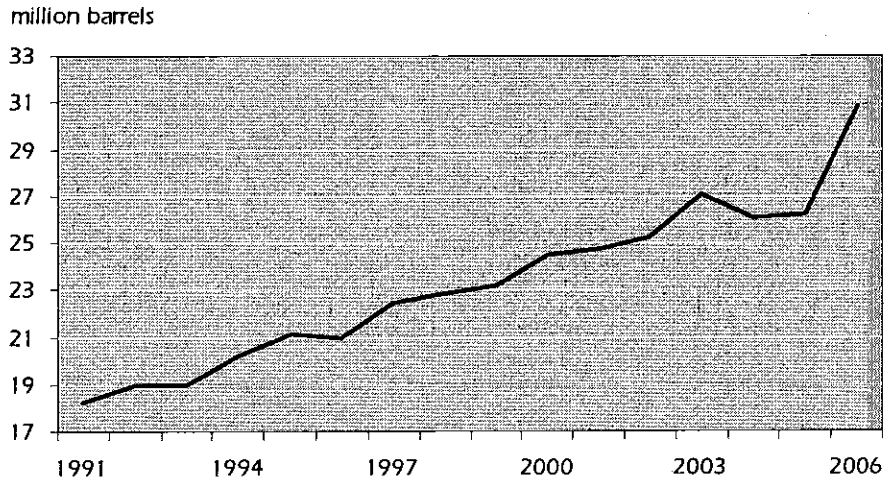
The use of alternative energy in the form of wind energy, bagasse, charcoal and firewood is small.

has grown over the period, to 96.8 per cent by 2006, while the share from hydropower has fluctuated. Note that the increased share for petroleum is due mainly to the unavailability of data for charcoal and fuelwood. The share of wind power is the least, at 0.1 per cent of the total for the years since its addition in 2004.

Energy production involves the use of natural resources; use of energy produces waste products, some of which have harmful emissions.

Total petroleum imports (see Figure 12.2 and Table 12.3) have grown steadily and increased by 69 per cent between 1991 and 2006. Between 2005 and 2006, when 30,860.2 thousand barrels were imported, total imports of petroleum grew by 18 per cent.

Figure 12.2
Total Petroleum Imports 1991–2006, million barrels



Source: Ministry of Industry, Technology, Energy & Commerce

Exploration for fossil fuel minerals has been conducted in Jamaica's offshore waters at various times.

Energy demand in Jamaica continues to rise; over 90 per cent of Jamaica's energy is produced from imported petroleum products.

A breakdown of the types of petroleum products that were imported between 2002 and 2006 is shown in Table 12.3. While there was a 127 per cent increase in crude and spike between 2005 and 2006, the data show that there have been fluctuations between

Table 12.3
Petroleum Imports by Product 2001–2006, million barrels

Product	2001	2002	2003	2004	2005	2006	Percentage Change	
							2005–06	2001–06
Crude and Spike	7.5	8.5	6.3	5.5	3.3	7.5	127.2	-0.9
Refined Products	8.9	8.1	11.6	11.5	15.2	13.7	-9.9	53.9
Bunker C	6.4	6.6	7.1	7.0	7.0	7.3	5.5	14.4
Low Vanadium	1.8	1.9	2.0	2.1	2.4	2.3	-4.9	30.1
Lubricants	0.2	0.2	0.1	0.1	0.1	0.1	59.5	-49.8
Total	**24.8**	**25.2**	**27.1**	**26.3**	**27.9**	**30.9**	**10.8**	**24.5**

Source: Ministry of Industry, Technology, Energy & Commerce

Box 12.1
Renewable Energy Potential in Jamaica

Source	Capacity MW	%age
Wind	65.0	30.0
Hydro	30.0	14.0
Solid waste	15.0	8.0
Bagasse/Coal	85.0	40.0
Fuelwood	15.0	8.0
Total	**210.0**	**100.0**

Source: Extracted from Jamaica's Energy Policy and developed from various Renewable Energy Feasibly Studies

the years 2001 and 2006. Imports of refined products grew by 54 per cent between 2001 and 2006 despite a decline of 10 per cent in 2006 compared to 2005. Bunker C imports grew by 14 per cent in the six-year period. Total imports of petroleum products increased by 24.5 per cent between 2001 and 2006.

With the future depletion of and negative environmental effects of fossil fuels attention has been focused on alternative energy sources. Among these are photovoltaic, wind power and geothermal energy, hydropower and nuclear power.

Photovoltaic (PV) solar cells, which capture solar energy, are used to generate electricity. Thin films of a solid material such as silicon are treated with certain metals and electricity is generated when the sun's rays are absorbed. PV solar cells range in size from small modules, to panels and to large power plants. They are low maintenance and cause no pollution. With the abundance of sunny days in the island, Jamaica is favourably placed for the use of solar energy. An indication of the volume of solar cells imported into Jamaica can be seen in Table 12.4.

Table 12.4
Imports of Solar Cells, etc. 2000–2006, tonnes

Item	2000	2001	2002	2003	2004	2005	2006
Solar lamps & lighting fixtures	1.2	1.7	27.0	25.7	62.9	148.8	138.9
Photosensitive semi-conductor devices	11.7	6.4	12.4	7.7	7.1	8.4	12.6
Parts with solar cells	40.5	32.7	37.0	36.6	43.5	5.0	0.8
Solar water heaters (number)	1,065.0	2,030.0	1,242.0	1,675.0	774.0	n.a.	n.a.

Source: Statistical Institute of Jamaica

Complete data on the number of water heaters imported into Jamaica for 2005 and 2006 are not available but preliminary data indicate that the volume of solar water heaters imported into the island doubled when 2006 quantities are compared to 2005. Imports of

Box 12.2
Renewable Energy – Bio-fuels

Ethanol and bio-diesel are produced from renewable sources and are now being used in some parts of the world to power motor vehicles either as a replacement or as a blend with gasoline and petroleum diesel. It is a clean burning, high-octane fuel that will reduce harmful vehicle emissions. Ethanol is mainly made from sugarcane, corn or straw while bio-diesel is produced from vegetable oils and animal fats and will come into effect in 2008 as an additive to petroleum on the Jamaican market. The introduction of ethanol in fuel will also help to reduce Jamaica's import bill for petroleum. This environmentally safe fuel is used as an octane enhancer much like MTBE (methyl t-butyl ether) is now being used.

Jamaica Broilers Limited opened an ethanol plant at Port Esquivel, St. Catherine in August 2007. This plant, with an annual capacity of 150 million litres, is able to process sugar cane into fuel grade ethanol.

solar lamps & lighting fixtures and other solar cells also show an increase. There is no indication of the amount of energy that is generated from these solar cells or the generation of solar energy in the form of solar water heaters and cookers.

In 2004, a 20.7 MW wind generating facility was launched in Manchester and provides energy to the national grid. Although it is estimated that global wind generation capacity quadrupled between 2000 and 2004, in Jamaica, wind generation capacity has remained static.

Bagasse generated during the manufacture of sugar is used as fuel in the manufacture in the sugar refineries. Biomass is also used in the production of hydrous ethanol, another bio-fuel substitute for fossil energy.

Largely due to the growth in the transport sector, the demand for oil has increased over the past 15 years. The production and usage of bio-fuels, such as ethanol, as an alternative or an addition to petrol, can reduce Jamaica's dependence on foreign oil. The use of ethanol will reduce the emissions of carbon monoxide and carbon dioxide, eliminate sulphur emissions and reduce the emissions of particulates. Petroleum gasoline is considered to be a major contributor to global warming through the level of CO_2 emissions and GHGs. International guidelines recommend that fuel be lead-free and low sulphur in order to reduce the volume of carbon emitted. As Jamaica's gasoline is already lead free, the introduction of ethanol will assist in complying with these recommendations.

Electricity Generation

Electricity is obtained by converting other forms of energy such as solar, hydro, wind and fossil fuel sources (oil, natural gas and coal) and is used for heating, lighting and refrigeration services. The majority of Jamaica's electricity is derived from non-renewable forms of energy — all imported.

Electricity production in Jamaica is a mixture of steam, slow speed diesel, gas turbine and hydroelectric generating units. The Jamaica Public Service Company Ltd. (JPSCo.) provides the majority, 67 per cent, of electricity with the rest supplied by independent electricity producers (IPPs). The JPS has a capacity of about 785 megawatts (MW), including 158 MW from the IPPs. Total production in 2006 was 4.1 million megawatt

Energy garnished from hydropower, wind, solar and biomass has low or no air emissions. As these are renewable sources, they cannot be depleted.

Table 12.5
Net Electricity Generation by Source 2002–2006, '000 mwh

Source	2002	2003	2004	2005	2006
Steam	1,716.9	1,685.0	1,491.7	1,567.9	1,311.9
Diesel	214.1	200.3	239.8	220.4	232.0
Gas Turbines	422.4	641.9	898.3	871.2	988.5
Hydros	104.6	146.3	134.3	151.3	169.6
Purchases	1,066.9	1,022.4	952.8	1,067.1	1,344.4
Total	**3,524.9**	**3,696.0**	**3,717.0**	**3,877.9**	**4,046.4**
Contribution JPSCo (%)	69.7	72.3	74.4	72.5	66.8
Contribution IPPs (%)	30.3	27.7	25.6	27.5	33.2

Source: Jamaica Public Service Co.

Box: 12.3
Bogue Power Station

The JPSCo's Bogue Power Station is regarded as their environmental flagship as, in its electricity generation process, it uses wastewater from stabilisation ponds at the nearby National Water Commission (NWC) sewage treatment plant. As this water may come to the power station as treated or untreated, facilities were constructed at the power plant to treat and purify the grey water from the NWC plant and underground pipes installed to transmit the water between the sites. Other water used at the facility comes from groundwater extracted from a well located on the facility. As well as recycling wastewater the JPS worked on reducing its noise and emissions pollution. An air quality monitoring station was also installed at the station.

hours of electricity. The JPSCo. supplied 67.0 per cent or 2.7 million megawatt hours (Mwhs) and the additional 1.3 million Mwhs was purchased from the IPPs. The majority of electricity (71 per cent in 2006) comes from steam and slow speed diesel generation production from fuel oil (Bunker C). This, however, reflects a reduction of the JPSCo's dependence on fuel oil for its electricity generation as in 2002 electricity generated from the JPSCo's steam and diesel engines was 78.6 per cent of total electricity generated.

The generation of electricity using hydropower plants is an environmentally friendly and inexpensive way of producing electricity. These plants are not expensive to develop but depend on the availability of water and river flow. Hydropower in Jamaica comes from the eight hydroelectric plants operated by the JPSCo. These plants, with a total capacity of 23.8 megawatts, are listed in Table 12.6. In 2006 hydropower's share of electricity supply was four per cent compared to three per cent in 2002.

Table 12.7 summarises the results of a study by the International Energy Agency (IEA 2000a,) and compares the human health impacts of types of energy generation options. Although electricity by itself produces almost no environmental impact, its production and transmission can. Electricity generated from hydropower, petroleum, nuclear plants or natural gas; the location of the plants and the transmission systems used can affect the natural environment as well as human health.

Table 12.6
Hydroelectric Stations Currently Owned By JPSCo. 2006

Plant Location	Year Put in Service	Installed Capacity Mw
Upper White River	1945	3.8
Lower White River	1952	4.9
Roaring River	1949	3.8
Rio Bueno A	1949	2.5
Maggotty Falls	1966	6.3
Constant Spring	1989	0.8
Rams Horn	1989	0.6
Rio Bueno River	1989	1.1
Total		**23.8**

Source: JPSCo. Ltd

Energy Consumption

Fuel oil, used mainly by bauxite companies, remains the major petroleum product consumed in Jamaica (see Table 12.8). The 17 million barrels of Bunker-C and low vanadium used in 2006 represented 58 per cent of all petroleum products. Consumption of unleaded 87 and 90 gasolines was 15.5 per cent of all petroleum products consumed in 2006 while in 2002 its share was 17.1 per cent. Conversely, consumption of auto diesel oil has grown from a 13 per cent share in 2002 to 15

Table 12.7
Human Health Impacts of Electricity Generation Options

Generating system	Source of final significant impact on human health
Hydropower with reservoir	Main issue: breach of dams Risks from water borne diseases, particularly where there is irrigation
Hydropower run-of-river	Main issue: breach of dams
Diesel	Climate change Acid precipitation Photochemical smog Particulate matter
Coal	Climate change Acid precipitation Photochemical smog Particulate matter Toxic metals
Heavy oil	Climate change Acid precipitation Photochemical smog Particulate matter
Nuclear	Radioactive substances
Natural gas turbines	Climate change Acid precipitation Photochemical smog
Wind power	Negligible
Solar photovoltaic	Negligible

Source: IEA 2000b, p 80

Wave power, one indirect form of solar energy, uses wind to make waves, can turn turbines and generate electricity.

per cent in 2006, a 34.7 per cent increase over five years. In 2006, kerosene use fell to 7.8 million barrels, a decrease of 51 per cent when compared to its usage in 2002, and 72 per cent below the volume of usage in 2005.

In 2006 the transport sector (road & rail, shipping and aviation activities combined) was the main user of petroleum, consuming 40 per cent of the petroleum used in the island. The second largest user, the bauxite and alumina sector, consumed 33 per cent of petroleum products in its mining and processing activities. Electricity generation at 22 per cent of total usage was third largest user of the 29 million barrels imported in 2006 (see Table 12.9).

The largest consumer of electricity in Jamaica is the residential sector (see Table 12.10). In 2006 an estimated 1.1 million megawatts hours of electricity were consumed by households, 27 per cent of the 4.1 million Mwhs produced but 35 per cent of the 3.1 million MWhs sold to customers. The percentage usage by sector has not changed

Table 12.8
Petroleum Consumption by Product 2002–2006, '000 barrels

Product	2002[r]	2003[r]	2004[r]	2005[r]	2006	Percentage Change	
						2005–06	2002–06
Aviation Gasoline[a]	5.0	3.2	3.1	5.7	–	–	–
Turbo Fuel	1,611.9	1,616.9	1,789.9	1,571.7	1,983.6	26.2	23.1
Unleaded 87[b]	–	2,609.4	2,828.6	3,149.3	3,330.6	5.8	27.6
Unleaded 90	4,285.7	1,779.0	1,569.4	1,433.5	1,174.2	-18.1	-34.0
Kerosene	43.6	40.9	38.7	39.1	34.3	-12.3	-21.4
Auto Diesel	3,057.9	3,532.7	3,979.0	4,537.9	4,004.2	-11.8	30.9
Auto Diesel Oil Bunker[c]	169.5	147.9	150.9	249.0	342.4	37.5	102.0
Fuel Oil (Bunker-C)	12,722.1	12,856.2	11,969.6	13,134.0	14,805.7	12.7	16.4
Fuel Oil (Low Vanadium)	2,049.9	2,071.0	2,116.3	2,153.7	2,226.1	3.4	8.6
Liquid Petroleum Gas (LPG)	860.6	864.7	864.3	885.7	929.3	4.9	8.0
Lubricants	135.5	107.5	88.0	88.9	104.5	17.6	-22.8
Asphalt	183.6	203.0	254.8	129.4	192.8	49.0	5.0
Other	3.7	2.4	2.9	2.2	2.1	-4.3	-43.4
Total	**25,128.9**	**25,834.9**	**25,655.4**	**27,380.1**	**29,129.7**	**6.4**	**15.9**

Source: Ministry of Industry, Technology, Energy & Commerce

a) The marketing company indicated that no aviation gasoline was sold in 2006.

b) Leaded gasoline was phased out in 2002 and the figure for unleaded 87 was included in unleaded 90 for that year.

c) Prior to 2002 marine diesel oil was imported; the figure for 2002 includes the refinery's consumption. In 2003, there was no production of ADO bunker between April and June as the refinery ceased production to do repairs and retrofitting.

Table 12.9
Petroleum Consumption by Sector 2002–2006, '000 barrels

Activity	2002[r]	2003[r]	2004[r]	2005[r]	2006[p]
Road & Rail Transport	5,822.6	6,037.2	6,075.6	6,247.8	6,373.4
Shipping	381.8	412.4	368.4	1,636.0	3,239.9
Aviation	1,616.9	1,620.1	1,793.0	1,577.4	1,983.6
Cement Manufacture	60.1	51.1	104.8	37.1	14.3
Electricity Generation	6,136.1	6,471.5	6,225.9	6,555.3	6,390.2
Bauxite/Alumina Processing	9,157.8	9,545.7	9,444.1	9,799.1	9,551.8
Sugar Manufacturing	222.7	112.2	76.0	40.3	50.1
Cooking & Lighting	904.2	905.6	902.9	924.7	963.5
Petroleum Refinery	319.7	259.4	223.3	164.2	331.8
Other Manufacturing	73.2	142.3	136.0	163.3	181.7
Other	434.4	226.3	186.0	180.7	83.9
Total	**25,129.5**	**25,783.8**	**25,535.9**	**27,326.0**	**29,164.2**

Source: Ministry of Industry, Technology, Energy & Commerce

Notes: In 2005, Petrojam entered into an agreement to supply bunker fuels for vessels outside the Kingston area to AGEAN Marine Petroleum SA Ltd. of Greece through its subsidiary AGEAN Bunkering Jamaica Ltd.
Totals do not include figures for lubricants and asphalts which are non-energy products.

[r] *revised* [p] *preliminary*

significantly since 1994 with the exception of line losses and unaccounted for electricity which increased from 20 per cent in 1994 to 23 per cent in 2006.

Table 12.10
Electricity Consumption by Major Sectors 1994, 1998, 2002 and 2006, '000 mwh

Sector	1994	1998	2002	2006	%age Share
Residential	618.0	926.3	1,103.1	1,094.2	27.0
Commercial	436.0	589.1	618.1	644.4	15.9
Industrial	433.0	517.1	597.2	760.9	18.8
Large Power	332.0	358.8	510.4	506.0	12.5
Street Lighting	36.0	50.2	57.4	65.7	1.6
Other	14.0	4.7	10.3	22.8	0.6
Sub-total	**1,869.0**	**2,446.2**	**2,896.5**	**3,094.0**	**76.5**
Company Use	11.0	11.0	9.7	12.9	0.3
Line Losses & Other Unaccounted for Net Generation	455.0	503.4	618.6	939.5	23.2
Total	**2,335.0**	**2,960.6**	**3,524.8**	**4,046.4**	**100.0**

Source: Jamaica Public Service Company

The majority of Jamaican households (80 per cent in the 2001 population census) use gas for cooking purposes, up from 26 per cent in the 1982 census and 42 per cent in the 1991 census. Fuelwood and charcoal, mainly used for food preparation, is the principal energy source used for cooking in 11 per cent and five per cent of households respectively. The importance of wood-based fuel as an energy supply is on the decline; as Table 12.11 shows. Its contribution as a fuel for cooking fell between 1982 and 2001, from 45 to 15 per cent.

Box 12.4

One data set collected for the MDGs is the proportion of the population using solid fuels. This is the proportion of the population that relies on biomass (wood, charcoal, crop residues and dung) and coal as the primary source of domestic energy for cooking and heating.

Table 12.11
Type of Fuel Used for Cooking 1982, 1991 and 2001, per cent of households

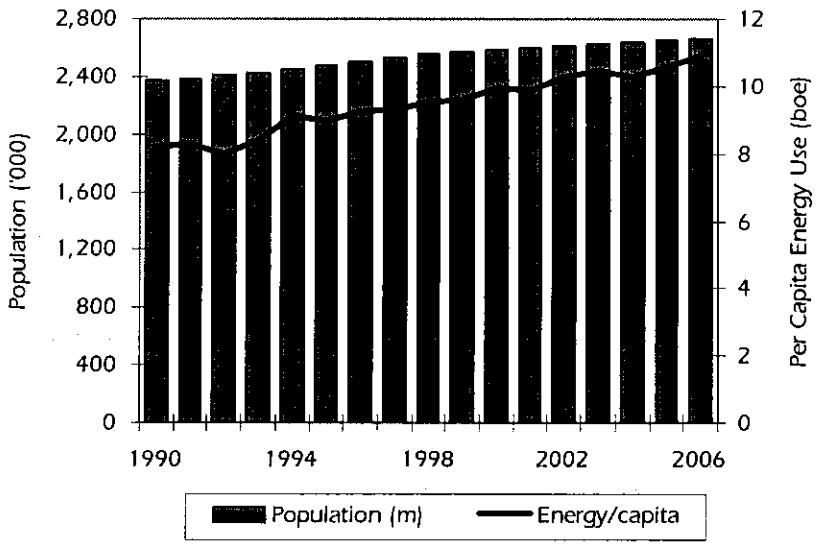
Type of Fuel	1982	1991	2001[r]
Gas	26.3	42.0	79.9
Electric	1.1	1.2	1.6
Wood/Charcoal	44.9	45.3	...
Wood	...	...	10.8
Charcoal	...	...	4.8
Kerosene	16.0	9.9	0.4
Other/None	0.8	0.5	1.1
Not Stated	10.9	1.0	1.4
No. of Households	**517,297**	**588,340**	**748,329**

Source: Population Censuses 1982, 1991 and 2001

Box 12.5
Non-energy uses of fuels
Some fuels used for non-energy purposes are: raw materials for the manufacture of feedstock; lubricants and greases used in engines; bitumen on roofs and roads; and white spirit and other industrial spirits used as diluents in paint manufacture and for industrial cleaning purposes.

Energy consumption per capita is the amount of energy consumed annually per person. An increase in imports of petroleum products, electricity consumption and number of households in Jamaica is reflected in the per capita energy consumption which grew from 8.2 thousand boe in 1990 to 10.9 boe in 2006 (see Figure 12.12). During that period, the average annual population increased by about 300,000 persons. The trend of an increasing population and a rising volume of energy consumed per person will no doubt continue until more energy efficient measures are put in place.

Figure 12.12
Per Capita Energy Consumption 1990–2006



Sources: Ministry of Industry, Technology, Energy & Commerce and Statistical Institute of Jamaica

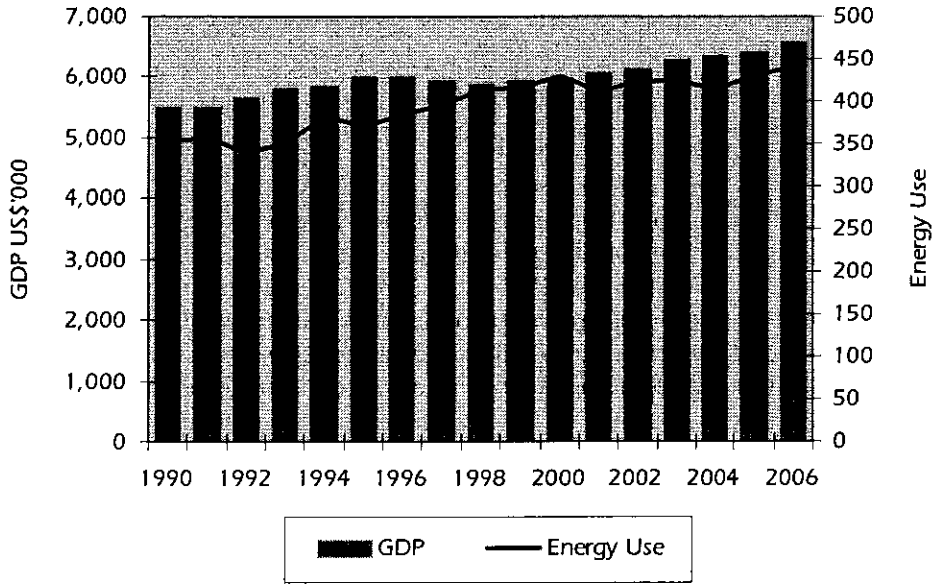
Energy Efficiency

Efficient energy use sometimes referred to as **energy efficiency**, means using less energy to provide the same level of energy service. Efficiency in the use of energy and a reduction in the consumption of petroleum are essential in order to slow the growth in demand and to reduce the level of dangerous emissions. One way of looking at energy efficiency is energy consumption by gross domestic product.

Energy intensity is calculated by dividing total energy consumption by GDP. A low energy intensity implies that the economy is more energy efficient.

Energy use per unit of GDP measures the intensity of energy use (the inverse of energy efficiency) in the production and provision of goods and services. Energy intensity gives a measure of improvements or not in energy efficiency – it combines the use of energy with the monetary/physical output gained. In principle, the lower the ratio, the better the energy efficiency. A reduction in energy intensity is preferred

Figure 12.13
Energy Use per Unit of GDP, 1990–2006



Sources: Ministry of Industry, Technology, Energy & Commerce and Statistical Institute of Jamaica

as energy use contributes to the depletion of resources such as wood, an increase in the import bill (petroleum products) and to environmental pollution. A shift to renewable energy is also important, but if the growth in consumption of carbon fuels is too rapid, the development of renewable energy will not be able to keep up with the level of energy use.

Box 12.6
Another data set of the MDGs is **energy use (kilogram oil equivalent) per US$1 GDP** (PPP) (purchasing power parity). This is commercial energy use measured in units of oil equivalent per US$1 of GDP using purchasing power parity conversion factors.

A crude measurement of energy intensity is shown in Figure 12.13. To compute – energy consumption is divided by GDP to derive the ratio; the lower the ratio the greater the energy efficiency. Jamaica's energy intensity, using this method, rose from 353 in 1990 to 420 in 2006. This increase in energy intensity can be attributed to the growing use of energy for consumption on motor vehicles and electrical appliances and not to increased production.

Energy Balance

The importation, production (or transformation) and consumption of energy can be displayed in an energy balance. The International Energy Agency (IEA) constructs an energy balance which shows the relative importance of different fuel supplies and use and their sectoral contribution (Table 12.14). Using a common energy unit of account, tonnes of oil equivalent or toe, it is possible to have worldwide comparison of energy statistics. A toe is defined as 10^7 kilocalories, approximately equal to the net heat content of 1 tonne or 1,000 kg of crude oil or 41.868 gigajoules. A joule, abbreviated J or the unit TJ (terajoule, or 10^{12} joule) is usually employed for national purposes. A conversion factor frequently used is 1,000 toe = 41.868 TJ.

The energy balance presents energy statistics in a common unit.

Table 12.14
Energy Balance (IEA Format) 2005, '000 tonnes of oil equivalent

Supply and Consumption	Coal	Crude Oil	Petroleum Products	Hydro	Combustible Renewables & Waste	Elec-tricity	Total
SUPPLY							
Indigenous Production	–	–	–	13	469	–	482
Imports	37	473	2,901	–	–	–	3,412
Exports	–	–	0	–	–	–	0
Intl. Marine Bunkers	–	–	-30	–	–	–	-30
Stock Changes	–	–	-28	–	–	–	-28
Total Primary Energy Supply	37	473	2,843	13	469	0	3,835
TRANSFORMATION	–	–	–	–	–	–	–
Statistical Differences	–	–	-51	–	–	–	-51
Electricity and CHP Plants	–	–	-1,662	-13	-148	638	-1,185
Petroleum Refineries	–	-473	468	–	–	–	-5
Other Transformation*	–	–	–	–	-153	–	-153
Own Use	–	–	-2	–	–	-1	-3
Distribution Losses	–	–	–	–	–	-73	-73
CONSUMPTION							
Total Final Consumption	**37**	–	**1,596**	–	**168**	**564**	**2,365**
Industry Sector	37	–	100	–	–	415	551
Transport Sector	–	–	900	–	–	–	900
Other Sectors	–	–	**581**	–	**0**	**149**	**898**
Residential	–	–	113	–	168	95	376
Commercial and Public Services	–	–	22	–	–	54	76
Agriculture/Forestry	–	–	445	–	–	–	445
Non-energy use	–	–	**15**	–	–	–	**15**

Source: International Energy Agency (IEA): www.iea.org
Note: Discrepancies in totals are due to rounding.

To estimate the energy balance the main fuels are expressed in a common unit. The IEA uses tonnes of oil equivalent (toe) to make easy comparisons of the contribution of each fuel to the economy and to each other.

Total primary energy domestic supply (sometimes referred to as energy use) is calculated by the IEA as production of fuels + inputs from other sources + imports – exports – international marine bunkers + stock changes. In the energy balance, the total *supply* of energy, 3,835 ktoe, consists of some coal and hydro and significant more amounts of imported petroleum, crude oil and combustible waste. In the *transformation* section, the imported crude oil is refined into petroleum products; refined oil and combustible waste are used in the generation of electricity. Total energy loss reported in the transformation processes is 1,467 ktoe. In the final stage, the *consumption* of 2,365 ktoe is available to the different sectors with the transport sector the major consumer of energy with 900 ktoe. Domestic supply differs from final consumption in that it does not take account of distribution losses.

Table 12.15
Energy Use by Sector 2003–2005, terajoules (TJ)

Sector	2003 TJ	2004 TJ	2005P TJ	2003 %	2004 %	2005P %
Industry and Construction	26,000	23,279	23,069	25.1	22.6	23.3
Transport	38,142	37,221	37,681	36.9	36.1	38.1
Households	15,784	15,910	15,784	15.3	15.4	15.9
Agriculture	16,957	21,981	18,631	16.4	21.3	18.8
Other Consumers	6,573	4,605	3,810	6.4	4.5	3.8
Total	**103,456**	**102,995**	**98,976**	**100.0**	**100.0**	**100.0**

Source: IEA, www.iea.org

A significant proportion of energy needs goes to transport.

Details of energy imports and use from Jamaican sources (Tables 12.1–12.10) should be considered as more reliable than those in Table 12.14 which are estimates.

The third part of the IEA energy balance (Table 12.14) is the basis for the data in Table 12.15 with the units presented in terajoules (TJ). These estimates are from the IEA only as Jamaica does not disaggregate its energy consumption into sectors for agriculture, industry and construction. The United Nations Energy Statistics, which also compiles its own energy balance, reported a total consumption of energy in 2003 and 2004 at 99,480 and 101,594 TJ respectively.

Transport and the Environment

The different modes of transport available – air, land or sea – provide links between people's living and working places and between manufacturing and industrial entities. Environmental stresses can be created by motorised transport as exhaust contributes to air pollution particularly in urban areas. Oil spills and leaks as well as other materials contaminate the soil and water. Infrastructure, such as roads and parking lots, necessary for transport fragment lands and removes it from other uses such as agriculture and wildlife habitats. Airports, which are usually built by the sea, produce nitrogen oxide (NO). Waste oil from motor vehicles can seep into ground water and affect marine resources. Human well being is also affected through increased noise and congestion, vehicle-related injuries and death. Respiratory tract infections are one result of increased congestion.

The construction of roadways is intended to improve social and economic welfare of people

Table 12.16
Road Network by Parish, lengths of roads (km)

Parish	Main Roads	Parochial Roads	Farm Roads
Kingston	145.8	1,800	124.8
St Andrew	395.9	–	126.4
St Thomas	501.8	829	...
Portland	287.1	1,141	309.0
St Mary	274.6	863	194.6
St Ann	397.4	1,265	...
Trelawny	278.1	604	123.6
St James	362.6	729	65.5
Hanover	231.6	406	131.2
Westmoreland	340.4	713	58.0
St Elizabeth	291.9	960	67.7
Manchester	398.2	1,225	10.4
Clarendon	494.6	1,360	...
St Catherine	457.1	3,000	...
Total	**4,857.1**	**14,895**	...

Source: Annual Transport Statistics: Jamaica in Figures 2004–2005

Transport contributes to environmental problems such as climate change, air emissions and noise pollution.

as travel time and transport costs are reduced, there is more access to jobs, education and health services, among others. However, there are some negative aspects as people and property in the region of the road works can be affected through increased respiratory problems due to air pollution, soil erosion, changes to water systems, disruption of plant and animal life. New roads in previously undeveloped areas can affect the environment to a much larger extent.

Jamaica has a land area of 10,991 km^2, therefore its over 21,000 kilometres of roads is considered to be a dense road network. Main roads and parochial roads that traverse the island are 4,900 and 15,000 kms long respectively (see Table 12.16). A few roads, which carry a high volume of traffic, are tolled to generate additional revenues but tolled roads account for a small per cent of the overall road network in Jamaica.

Technological advances related to motor vehicles and fuels have led to a decrease in emissions.

The increased use of motorised vehicles is considered to be the largest source of urban air pollution as there are greater demands on the road network and increased levels of traffic in residential areas. Air pollutants in urban areas from mobile sources are the most significant sources of nitrogen oxides (NO_x) and carbon monoxide (CO) and will increase as the number of vehicles increases. With the rising demand for cars, there has been an increase in the demand for motor gasoline. It is estimated that for every litre of gasoline burnt in an automobile, 2.4 kg of CO_2 is released into the atmosphere. Nitrous oxides (NO_x) are also produced from the burning of oil, mainly through combustion in motor vehicles. In recent decades, there have been improvements to the composition of gasoline; the use of lead to boost the octane level of gasoline has been eliminated and other additives and oxygenates used to improve fuel combustion are now added. More recently, in order to further reduce pollution and dependency on foreign petroleum products, biofuels (ethanol produced from agricultural crops) have being developed to blend with motor gasoline.

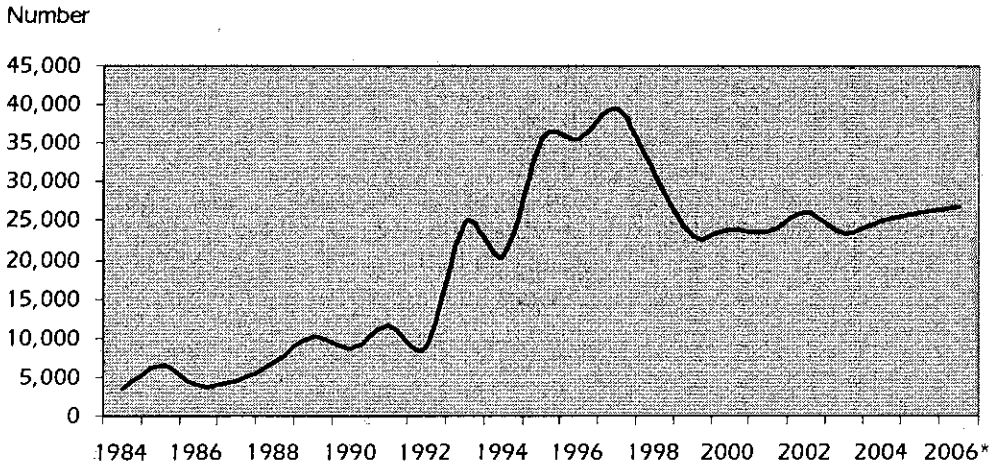
A breakdown of the number of motor vehicles imported in the years 1999–2004 is shown in Table 12.17 and of concern is the growth in importation of large engine vehicles. Since the removal in 1990 of restrictions on importation of large engine vehicles there has been a slight shift from importation of small and medium-sized cars (1000–2000 ccs) to larger 2000–3500 cc vehicles. This has contributed to the

Figure 12.17
Imports of Motor Vehicles 1999–2004, number

Type of Vehicle	1999[r]	2000[r]	2001[r]	2002[r]	2003[r]	2004[r]
Small cars incl. golf cars	9,767	9,505	9,612	9,711	7,811	8,633
Medium cars	5,127	4,953	4,916	5,990	6,184	6,833
Large cars	1,484	1,780	1,787	2,445	2,550	3,332
Pick-ups/trucks & special vehicles	5,317	4,973	4,736	5,676	4,816	4,041
Coaches & buses	367	451	737	623	363	449
Tractors	245	433	355	408	416	354
Motor cycles	933	1,690	1,449	1,171	1,202	1,433
Total	**23,240**	**23,785**	**23,592**	**26,024**	**23,342**	**25,075**

Source: Statistical Institute of Jamaica
r revised

Figure 12.18
Imports of Motor Vehicles 1984–2006, number



Source: Statistical Institute of Jamaica
** 2005 and 2006 estimated*

increased consumption of petroleum products, as these vehicles are less fuel-efficient. It is estimated that in 2005 there were over 450,000 vehicles in Jamaica compared to 184,000 in 1984. The growing number of vehicles poses problems for energy consumption, urban congestion, noise and greenhouse gas emissions. Added to this, vehicle accessories such as car parts, tyres, batteries, used oil, etc. are often disposed of improperly and can become environmental and safety hazards. Figure 12.18 gives an indication of the increased importation of motor vehicles since 1984. The imports of motor vehicles peaked in 1997 and steadily declined until 2002. Since then there have been fluctuations in the number of motorised vehicles brought into the island.

The growth in automobile and air travel has affected travel by bus and rail.

The shipping industry also produces air pollution from sulphur oxide (So_x) and nitrogen oxide (No_x) emissions from ship exhausts. Pollution can also come from oil spillage from ships at sea and in harbour and through the transport of oil, harmful substances and garbage through waterways. Danger to marine resources can also come from the transport of noxious liquid substances and garbage. With the large increase in world trade by sea-borne vessels, there is more danger of pollution in waterways.

There are ten functional ports around the island and 2006 saw 4,063 vessels entering the ports of Jamaica. These ports function to export alumina, foodstuff and manufactured items; they import fuel oil, manufactured items and food, and some serve as ports for the tourism industry; they also serve as transhipment points. The port of Kingston is the main port and in 2006 accounted for 70 per cent of all vessel visits (Table 12.19).

Table 12.19
Vessel Visits to Jamaican Ports 2000–2006

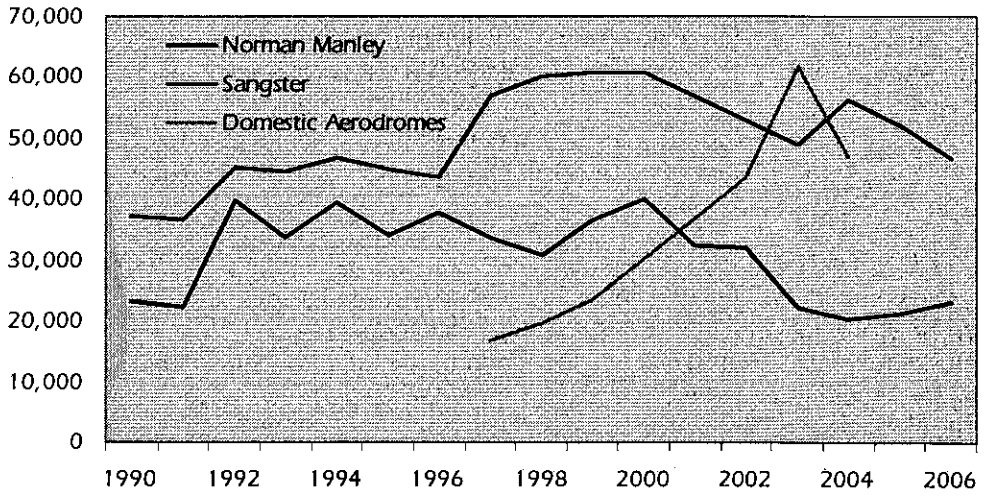
Year	All Vessels		
	All Ports	Kingston	Outports
2000	3,552	2,307	1,245
2001	3,574	2,397	1,177
2002	3,752	2,520	1,232
2003	3,865	2,531	1,334
2004	3,528	2,337	1,191
2005	3,767	2,591	1,176
2006[p]	4,063	2,858	1,205

Source: Port Authority of Jamaica
p preliminary

Scientists now consider aviation to be the mode of transport with the highest specific climate impact although airline manufacturers refute the charge. Modern jets burn kerosene which produces carbon particles, water vapour and nitrogen oxides. Emissions at higher altitudes are a powerful contribution to climate change; around airports and the communities nearby they also affect air quality.

Figure 12.20
Aircraft Traffic at Airports 1990–2006

No. of Flights



Source: Airports Authority of Jamaica

Jamaica has two international airports, four domestic aerodromes for intra-island travel and about other private airstrips, about half of which are closed and/or abandoned. In Figure 12.20 the aircraft movements at both international airports and the four domestic aerodromes are shown. Aircraft traffic at the Sangster International Airport (SIA) is usually higher than at the Norman Manley International Airport (NMIA) because of tourist arrivals. Both the SIA and the NMIA have recorded lower levels of aircraft arrivals since 2002.

Fossil fuels are the dominant form of energy in Jamaica and most parts of the world. It is generally accepted that fossil fuel combustion emits greenhouse gases which accumulate in the atmosphere and contribute to climate change. Jamaica is dependent on a source of fuel – petroleum – that will only get more expensive. There are developed and developing technologies that can harness renewable energy using the sun, air, water, the earth and fire which can be transformed into clean, reliable sources of electricity and fuel for automobiles.

There is little information on the disposal of oils that are used for non-petroleum purposes. Used oils such as lubricants, transmission fluids and metal working oils are hazardous to the environment; there are few safe facilities for their storage and disposal and no legislation in force for their use. There is little recycling and disposal is often in landfills, gullies and pit latrines and therefore absorbed into the environment.

13 Air

As countries become more urbanised their economic activities rely more and more on combustion of fossil fuels leading to increase in outdoor air pollution. Populations gravitate towards urban areas with increased risks of death from cardiopulmonary causes; respiratory symptoms; lung cancer. In Jamaica, the main sources of poor air quality are emissions from industrial sources, motor vehicles and open burning of sugarcane fields and solid waste at dumpsites and in yards. With increasing urban growth and industrialisation, the demand for air quality regulations and standards has increased.

The economic and social costs of air pollution in many countries are increasing along with serious adverse affects on human health. Vehicle emissions create the greatest damage as they occur near ground level and in denser population centres, while industrial sources disperse pollutants more widely at higher elevations. Urban residents have greater exposure to some air pollutants, such as suspended particulates.

The burning of fossil fuels, such as oil, diesel, gasoline, wood and charcoal, and the use of CFCs in air-conditioners and refrigerators have all contributed to the amount of carbon dioxide and ozone in the atmosphere.

Six main air pollutants are:

- total suspended particulate matter (TSP) is fine particles suspended in air and are classified by their size, for example, particulate matter less than ten microns (PM_{10}) or particulate matter less than 2.5 microns ($PM_{2.5}$). PM is released from fossil fuel burning for electricity generation and industrial activity, from mining and quarrying activities, cement and lime manufacturing, road dust and open burning.
- sulphur dioxide (SO_2) from fuel combustion; produced when fossil fuels such as coal and oil are burned during smelting or from other industrial processes
- nitrogen oxides (NO_x) from mobile sources and fuel combustion; produced from cars and power plants.
- volatile organic compounds (VOCs) from refining, storage and use of petroleum products. They include hydrocarbons, alcohols, aldehydes and ethers. They play a role in ozone formation and are emitted by industrial processes and vehicles.
- lead is emitted from lead smelting and from vehicles burning leaded gasoline.
- photochemical oxidants (ozone (O_3)) are created under certain weather conditions by VOCs and nitrogen. Ozone in the troposphere creates a photochemical smog and is toxic.
- carbon monoxide (CO) is an odourless gas emitted from vehicles without a catalytic converter, and from industrial fossil fuel burning.

Three main types of air pollutants which cause the most damage to the environment and human health are sulphur dioxide, nitrogen oxides and particulate matter.

Air Quality Standards

Maximum air contaminant concentrations allowed in the atmosphere are referred to as ambient air quality standards. Jamaica's Ambient Air Quality Standards are summarised in Table 13.1 below.

Air quality regulations have been developed by the National Environment and Planning Agency. These regulations seek to:

Table 13.1
Ambient Air Quality Standards – Jamaica

Pollutant	Averaging time	Standard (Maximum concentration in ¼g/m³)[1]
Total suspended particulate matter (TSP)[2]	Annual	60
	24 h	150
PM_{10}[3]	Annual	50
	24 h	150
Lead	calendar quarter	2
Sulphur dioxide	Annual	80 primary; 60 secondary[4]
	24 h	365 primary; 280 secondary
	1 h	700
Photochemical oxidants (ozone)	1 h	235
Carbon monoxide	8 h	10,000
	1 h	40,000
Nitrogen dioxide	Annual	100

Source: NRCA (Air Quality) Regulations (2006)

1 The regulation should have specified that all air quality measurements expressed in mass per unit volume are to be corrected to 25 °C and 101.3 kilopascals.
2 All particles and aerosols with aerodynamic diameters of 100 micrometers or less can be measured by the high volume sampling method.
3 Refers to particles with an aerodynamic diameter of 10 micrometres or less as measured by the PM_{10} sampler.
4 The secondary standards for sulphur dioxide are designed to protect public health and welfare. They represent the long-term goal for air quality and provide the basis for an anti-degradation policy for unpolluted areas of the country and for continuing development of pollution control technology.

- establish emission standards for new sources
- establish emission standards for existing facilities
- provide an air pollution discharging licensing system, renewable every five years
- allow for the licensing of facilities
- make provision of licensed facilities to be charged an annual discharge fee based on actual emissions
- require annual reports of emissions and pollution-related incidents and pollution prevention activities
- make provisions for punitive sanctions such as warnings, control orders, administrative penalties and prosecution.

Other standards and regulations developed by the NEPA to control the deterioration of air quality are Vehicle Emissions Standards (1996), Stack Emission Standards (1996) and Draft Ambient Air Quality and Stack Emission Regulations (1999).

Electricity production and manufacturing and construction sources are the main source of sulphur oxides (SO_x) which is an acidifying pollutant and can aggravate respiratory diseases. In Jamaica the largest source of SO_2 emissions are from the bauxite and alumina sector.

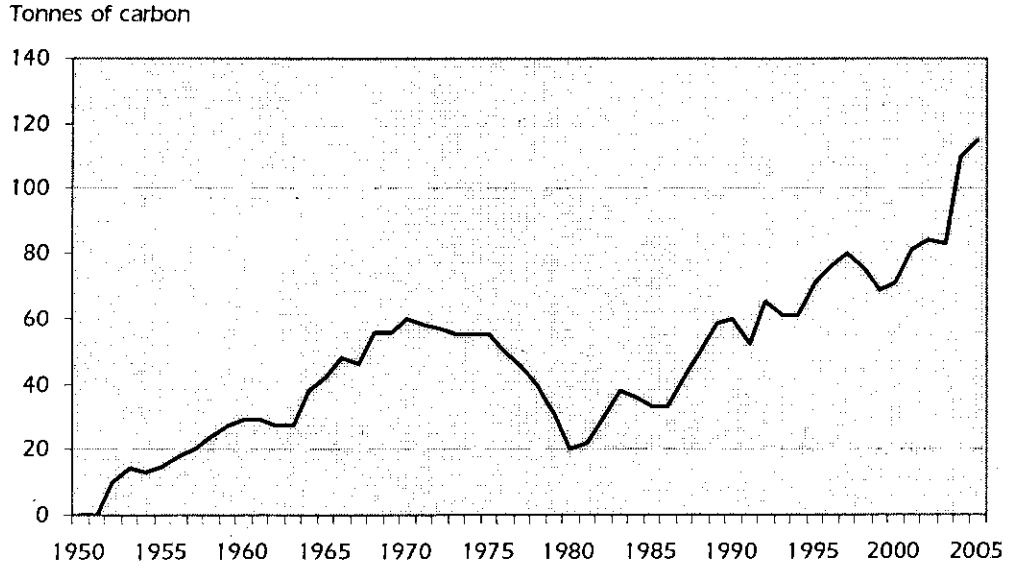
Many technologies and behaviours to curb urban air pollution have been introduced; one example is the elimination of leaded gasoline. The growth in motor vehicle ownership in Jamaica could very well overwhelm any improvements in fuel or vehicle efficiency due to the sheer number of vehicles on our roadways. The largest source of nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs) and the second most important source of PM_{10} emissions are thought to be from motor vehicles. NO_x can trigger respiratory illnesses and contributes to acidification and eutrophication.

The agriculture sector's livestock manure and emissions associated with fertilisers are responsible for the majority of ammonia (NH_3) emissions and can cause acidification and eutrophication.

Cement manufacturing is a source of greenhouse gas emissions. Concrete, and its principal ingredient cement, is the most common construction material used. The production of one tonne of cement results in the emission of about one tonne of CO_2 from both fuel combustion and the calcination of raw materials. Figure 13.5 presents estimates of carbon dioxide emissions in Jamaica during the manufacturing of cement.

Cement production is also an energy intensive industrial manufacturing process.

Figure 13.5
Estimated CO_2 Emissions from Cement Production, 1950–2005, '000 tonnes of carbon



Source: Earth Trends from Carbon Dioxide Information Analysis Center at http://cdiac/esd/ornl.gov/ftp/ndp030/

Besides CO_2, cement and concrete production generate considerable quantities of other air-pollutant emissions, dust being the most visible. Other air pollutants emitted from cement manufacturing plants include SO_2 and NO_x.

One way to reduce CO_2 emissions is by improving the energy efficiency of the cement kiln operation. The Caribbean Cement Company Limited, in its 2006 annual report, stated that it will be installing new state-of-the-art equipment in an attempt to control dust, nitrous oxide and sulphur dioxide emissions.

Ozone Depleting Substances

There is a layer of gases around the Earth called the ozone layer which protects humans, animals and plants from the effects of ultraviolet rays in sunlight. A hole in the ozone layer has been caused by the use of chlorofluorocarbons (CFCs) and halogenated hydrocarbons (halons). CFCs and halons are man-made substances used in air-conditioners, refrigerators, electronics and fire fighting. CFCs were used as propellants (compressed gases used to help push powders and liquids out of a container) in insecticides, furniture polish and other sprays. The international community agreed to ban five CFCs and three halons under the Vienna Convention for the Protection of the Ozone Layer (1985) and the Montreal Protocol on Substances that Deplete the Ozone Layer. In 1996 the Parties to the Protocol banned ten more CFCs; methyl chloroform and carbon tetrachloride were added to the list of controlled substances.

CFCs have a long lifetime in the atmosphere. Extended exposure to ultraviolet radiation could increase the risk of skin cancer.

Box 13.2
MDG Indicator 7.3
Consumption of ozone-depleting substances

Table 13.6
Jamaica's Consumption of Ozone Depleting Substances 2000–2005, tonnes

Group Name	2000	2001	2002	2003	2004	2005	Baseline
CFCs	59.8	48.6	31.7	16.2	16.0	5.04	93.2
Halons	–	–	–	–	–	–	1.0
Methyl Chloroform	2.2	–	–	–	–	–	1.4
HCFCs	6.6	11.3	6.3	5.4	5.6	–	–
Methyl Bromide	0.9	1.5	1.2	1.5	2.9	1.2	4.9

Source: United Nations Environment Programme – Ozone Secretariat

Even tiny concentrations of CFCs could, theoretically, erode the stratospheric ozone layer that shields life from ultraviolet radiation.

In Table 13.6, imports and imputed consumption of ODS in Jamaica seem to be declining. Jamaica has been under the baseline for consumption of all types of ODS for the six years shown in the table.

Air pollution can do serious damage to human health and the natural environment. Sulphur dioxide can contribute to damage to waterways and forests through acid rain. PM_{10} emissions are associated with cardiovascular and respiratory diseases. In most developing countries, like Jamaica, the increasing numbers of motor vehicles, power plants and factories have not been accompanied by cleaner technologies, stricter regulations or compliance with air standards.

14 Climate and Natural Disasters

Jamaica is located at about latitude 18° N and longitude 77° W and is 145 km south of Cuba its nearest neighbour. The climate is a warm tropical maritime climate with average temperatures of 26.7 °C on the coastal lowlands. At the island's highest point, Blue Mountain Peak, average temperature is 13 °C, an estimated fall in temperatures of 16 °C per 300 metre increase in altitude. Temperature differences between the warmest and the coldest periods of the year average about 5°C. The highest rainfall areas are the Blue Mountain range and the northeast coast; most areas of the island experience two wet seasons – May to June and September to November.

Climate is the long-term average of weather conditions.

Climatic influences are the northeast trade winds and the mountain ranges which run through the centre of the island; the warm waters of the Caribbean Sea; weather systems such as upper- and low-level pressure centres, troughs and cold fronts. The cold fronts migrate from North America usually from October to April. Tropical weather systems such as tropical waves, depressions, storms and hurricanes occur from April to December.

Rainfall

Rainfall varies over the island as some mountainous areas in the northeast receive more than 5,080 mms annually while some southern coastal areas receive less than 889 mms. During May and June, most rainfall results from solar radiation intensity which peaks at that time. During September to November, rainfall results from tropical weather systems originating in the Atlantic Ocean. The driest period is usually from December to March as the rainfall is associated with cold fronts from North America. The short duration showers experienced during mid-afternoon are a result of the sea breezes meeting the mountain ranges (convectional rainfall).

Jamaica's seasonal rainfall is often interspersed with long dry spells when the ground gets compacted.

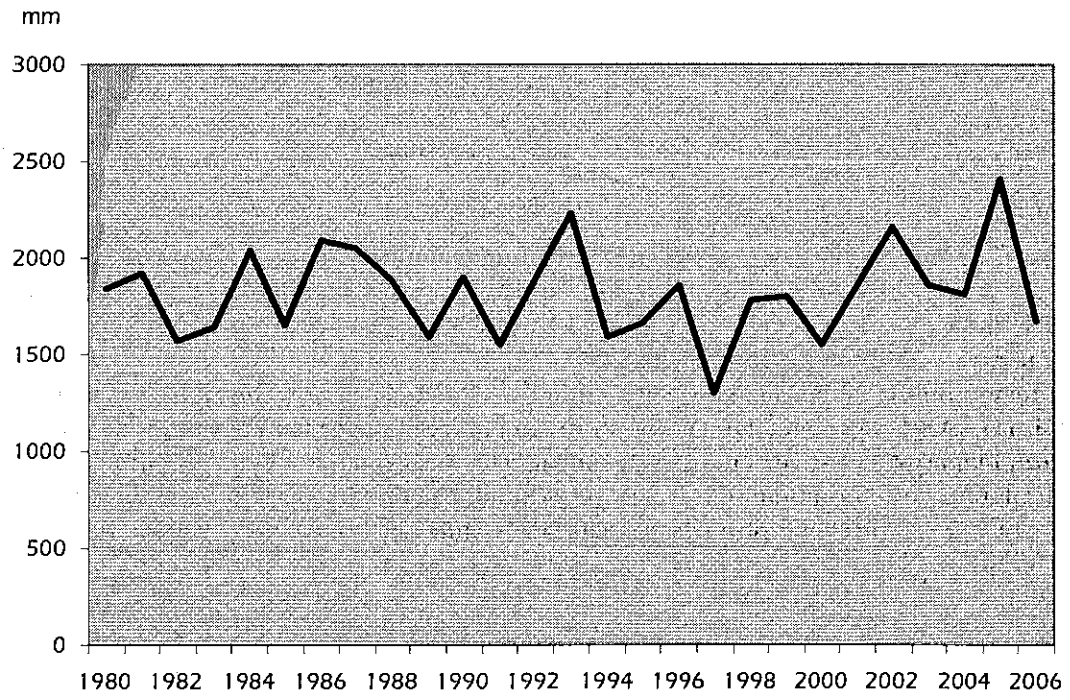
Table 14.1
Mean Rainfall by Month 2002–2006, mm

Month	2002	2003	2004	2005	2006
Annual	**2,159**	**1,861**	**1,807**	**2,412**	**1,665**
January	89	189	67	101	73
February	39	45	35	7	97
March	43	69	122	12	34
April	125	153	129	176	131
May	512	235	256	224	127
June	198	117	50	234	170
July	83	116	141	488	142
August	117	233	158	147	180
September	595	154	454	168	156
October	132	215	159	578	196
November	109	147	76	200	240
December	116	188	160	77	119

Source: National Meteorological Service

The volume of rainfall fluctuates from year to year and is often affected by droughts, storms and hurricanes. Table 14.1 shows the mean rainfall by month with the largest volume of rainfall usually in May but the months of April, July, September and October, depending on the year, have experienced high volumes of rainfall. In the month of December average rainfall levels have been declining, from 116 mm in 2002 to 69 mm in 2006.

Figure 14.2
Mean Annual Rainfall 1980–2006, mm



Source: National Meteorological Service

Jamaica has a tropical marine climate; its climate is affected by rainfall, temperature and winds.

Mean annual rainfall over the 27-year period shown in Figure 14.2, has been between 1500 and 2000 mm for most of the period with the exception of six years when rainfall levels were over 2000 mm. The year 1997 was the only in which rainfall levels fell below 1500 mm.

Mean monthly rainfall by parish for 2005 and 2006 are shown in Tables 14.3 and 14.4. In 2005 rainfall levels were fairly high as total rainfall for the island was 2,413 mm. The 578 mm of rainfall in October 2005 was as a result of hurricane activity during that month. During 2006, rainfall was measured at 1,666 mm. The parish with the highest rainfall was Portland with over 4,700 mm in 2005 and over 3,400 mm in 2006. The parish with the lowest rainfall in 2005 was Trelawny (1,989 mm). In 2006 the parishes of Clarendon and St Catherine experienced less than 1,000 mm of rainfall for the entire year.

Table 14.3
Mean Monthly Parish Rainfall 2005, mm

Parish	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Kingston & St. Andrew	99	1	8	81	215	192	526	166	181	574	130	21	2,194
St. Thomas	56	4	2	53	175	650	485	153	147	825	59	135	2,744
Portland	570	30	16	493	432	325	747	140	176	668	732	363	4,692
St. Mary	207	7	5	268	213	78	449	118	65	465	452	93	2,420
St. Ann	127	1	26	179	251	105	504	138	155	525	301	51	2,363
Trelawny	62	1	13	179	228	108	460	115	125	426	237	35	1,989
St. James	65	24	12	256	209	112	410	184	156	400	239	58	2,125
Hanover	14	7	19	158	150	192	386	252	230	463	109	47	2,027
Westmoreland	10	7	19	118	197	225	440	189	260	496	108	64	2,133
St. Elizabeth	18	2	10	149	342	189	478	173	218	437	72	53	2,141
Manchester	16	4	17	205	271	300	453	141	214	751	68	40	2,480
Clarendon	18	1	2	69	82	351	572	47	127	741	18	16	2,044
St. Catherine	49	0	5	84	149	215	436	97	135	749	76	26	2,021
Jamaica	**101**	**7**	**12**	**176**	**224**	**234**	**488**	**147**	**168**	**578**	**200**	**77**	**2,413**

Source: National Meteorological Service

Rain days

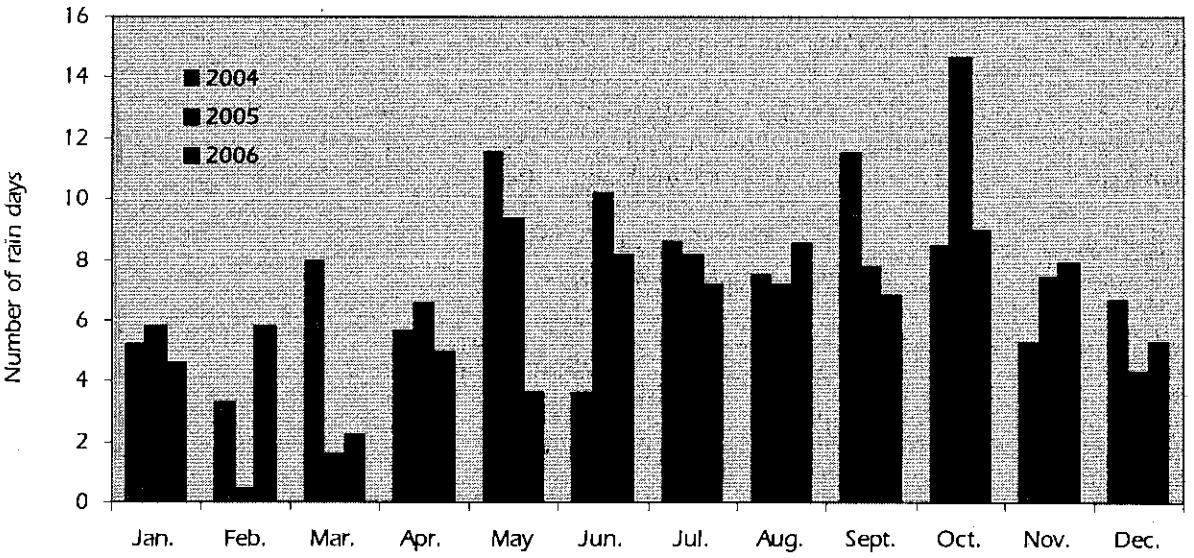
The average number or rain days per year for the years 2004 to 2006 are shown in Figure 14.5. The number of rain days per month was fairly regular for the months of January, April, July, August, November and December 2004 to 2006 with only one- to three-day variations. The other months of the year had variations of between six to eight days. The high number of rain days in September 2004 and October 2005 is due in part to hurricane activity.

Table 14.4
Mean Monthly Parish Rainfall 2006, mm

Parish	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Kingston & St. Andrew	58	17	22	120	134	125	82	174	307	177	228	83	1,527
St. Thomas	33	36	6	47	46	237	211	241	36	171	186	112	1,362
Portland	248	306	92	166	96	256	291	205	96	493	723	417	3,389
St. Mary	168	246	48	47	114	131	73	102	48	239	511	263	1,990
St. Ann	99	136	26	111	170	147	99	108	166	155	276	95	1,588
Trelawny	95	170	10	127	106	116	118	140	158	141	231	54	1,466
St. James	74	83	6	100	100	176	187	203	190	193	154	40	1,506
Hanover	39	72	7	63	129	217	231	240	213	158	132	116	1,617
Westmoreland	44	53	65	118	140	135	227	314	322	226	133	197	1,974
St. Elizabeth	33	41	95	263	141	139	107	238	219	231	163	63	1,733
Manchester	35	71	34	275	205	218	98	164	124	216	164	51	1,655
Clarendon	6	18	15	149	115	149	56	103	54	81	106	19	871
St. Catherine	21	16	20	117	152	162	70	109	94	64	115	39	979
Jamaica	**73**	**97**	**34**	**131**	**127**	**170**	**142**	**180**	**156**	**196**	**240**	**119**	**1,666**

Source: National Meteorological Service

Figure 14.5
Average Raindays per Month 2004–2006



Source: National Meteorological Service

Temperature

With its tropical location, ranges of temperature throughout the year are small in Jamaica, although summer is the hottest time of the year. In coastal areas average maximum temperatures can be 30.3 °C and minimum 22.0 °C with lower values in the interior. Diurnal temperature ranges are greater than seasonal because of the high daytime temperatures which fall by night, especially inland.

Temperature is affected by altitude and distance from the sea.

Table 14.6
Mean Daily Temperatures at International Airports 2004–2006

Month	Norman Manley			Donald Sangster		
	2004	2005	2006	2004	2005	2006
January	26.6	26.6	27.0	25.7	25.1	25.7
February	27.4	26.1	26.7	26.1	24.8	25.1
March	27.2	28.1	27.1	26.3	27.0	26.1
April	28.0	28.6	27.8	26.8	27.2	27.2
May	28.8	28.9	28.8	27.9	28.5	28.2
June	30.1	28.9	29.2	28.7	28.9	28.7
July	29.3	29.3	29.9	28.7	28.7	29.1
August	29.9	29.9	29.3	28.8	29.2	28.8
September	28.9	30.1	29.6	27.8	29.3	29.0
October	29.2	27.9	29.8	28.4	27.7	28.8
November	28.4	28.4	28.5	27.6	27.4	27.4
December	27.5	27.4	28.6	26.3	26.4	27.2

Source: National Meteorological Service

Mean daily temperatures at both international airports are shown in Table 14.6 and reflect the minimal changes in temperature throughout the year.

Sunshine

Monthly variations of hours of sunshine per day are small, usually about one hour but with marked differences between the coast and inland regions. The figures in Table 14.7 are both related to readings along the coast. While sunshine hours along the coast average eight hours per day, inland, in the mountainous areas, mean sunshine is less than six hours per day mainly because of cloud cover.

Table 14.7
Mean Sunshine Hours at International Airports, 2004–2006

Month	Norman Manley			Donald Sangster		
	2004	2005	2006	2004	2005	2006
January	9.0	8.4	8.5	8.0	7.4	8.5
February	9.3	10.3	7.9	8.9	9.5	6.9
March	7.7	9.3	9.7	8.9	8.2	9.4
April	9.3	9.1	8.9	9.9	8.1	9.9
May	8.0	7.7	10.0	7.5	8.2	10.4
June	8.3	6.7	6.4	9.3	7.5	7.7
July	8.2	7.3	6.9	8.8	7.9	8.3
August	8.3	7.2	7.6	9.0	7.3	8.4
September	7.6	7.5	7.6	6.7	7.7	7.3
October	8.8	5.1	6.8	9.2	4.7	7.2
November	9.6	7.7	7.7	9.1	8.2	7.0
December	7.8	7.6	8.8	7.6	7.2	8.3
Average	8.5	7.8	8.1	8.6	7.7	8.3

Source: National Meteorological Service

Natural Disasters

Natural hazards are, as their name implies, occurrences over which we have no control. When they cause destruction to lives and property they are called disasters. A natural disaster is an event for which nations require national or international assistance. Types of natural disasters are floods, earthquakes, torrential rains, droughts, landslides, fires, tsunamis, cyclones, volcanic eruptions, typhoons, mudslides, blizzards and avalanches. Some disasters cannot be avoided (earthquakes, volcanic eruptions) and are sudden onset events. Others such as droughts may be gradual. These are, however, part of natural climate variations which can be exacerbated by human actions.

The hazards which Jamaica has to contend with are floods, droughts, hurricanes, earthquakes and fires. Hazards may be localised or widespread causing damage over many communities or parishes. The disasters can cause deaths or economic loss to roads, agriculture, homes, schools and churches.

Flooding

Flooding is the hazard which occurs most frequently as it may result from hurricanes, storms and cold fronts. Factors relating to flooding include the removal of vegetation causing rainwater to run off; cultivation on sloping lands without the use of conservation measures so that heavy downpours carry away the soil and crops; and in urban areas, where the ground is paved, the force of water moving over the surface causes damage. When drainage channels are filled and cannot accommodate this excessive volume of water, flooding occurs. There have been major floods in different parts of the island in the years 1887, 1899, 1933, 1936, 1937, 1940, 1962, 1979, 1980, 1985, 1986, 1988, 2001 and 2002. Reports of flooding and landslides during hurricanes in 2004 are shown in Table 14.8.

Table 14.8
Occurrences of Flooding or Landslides during Hurricanes Dennis and Emily 2004

Parish	Flooding		Landslides	
	Dennis	Emily	Dennis	Emily
Kingston	2	–	–	–
St. Andrew	9	14	1	–
St. Thomas	16	4	–	–
Portland	6	3	–	–
St. Mary	3	2	2	–
St. Ann	1	–	3	–
Trelawny	2	–	7	–
St. James	2	2	1	1
Hanover	1	–	–	–
Westmoreland	2	–	–	–
St. Elizabeth	4	–	25	–
Manchester	–	–	11	–
Clarendon	10	–	7	–
St. Catherine	27	2	6	–
Total	**85**	**27**	**63**	**1**

Source: ODPEM

Landslides can occur without warning and have the potential to cover houses and people.

Landslides

Landslides are events that often occur after another disaster. Earthquakes can cause vibrations in the earth; heavy rainfall from hurricanes or flooding can cause the top layers of soil to slide. Landslides may also be cause through human action in the case where forests and hillsides are stripped of vegetation and tree cover causing land slippage.

Severe weather conditions such as thunderstorms, cold fronts, tropical waves, tropical depressions and hurricanes which lead to intense rainfall can cause flooding and landslides. Danger to lives and housing are exacerbated by people living in flood-prone areas on the coast and along gully banks.

Hurricanes

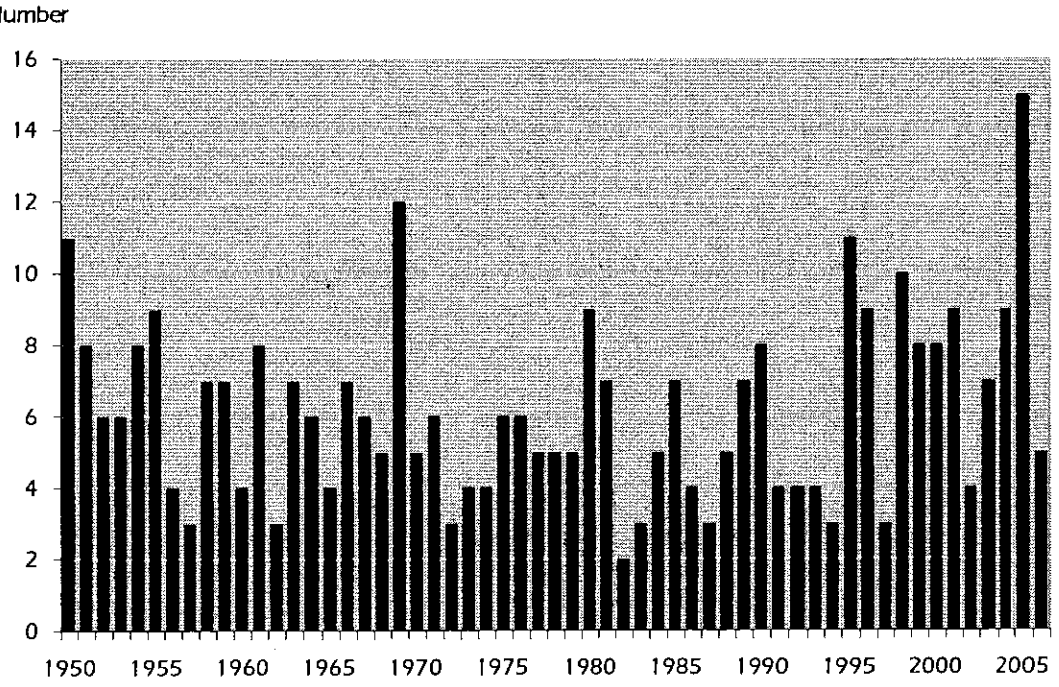
Hurricanes are created when still warm air over ocean waters absorbs heat and begins to rise taking up water vapour. Air from around rushes in to replace the air which is rising and the unsettled weather gets larger becoming a tropical depression. Tropical depressions usually form off the coast of Africa and get their energy from the warm waters of the Atlantic Ocean. As the depression moves, wind speeds increase, clouds get thicker and rainfall heavier. The winds rotate in a counter-clockwise direction towards the 'eye' or centre of the system. Because of the rotation of the earth, the system moves to the west or north-west. Wind speeds below 118 km per hour classify the system as a tropical storm. Over 118 km per hour, the system is called a hurricane. Box 14.1 lists the classification of hurricanes under the Saffir-Simpson scale.

Box 14.1
Classification of Hurricanes
Hurricanes are classified on the Saffir-Simpson hurricane scale based on the intensity of the storm.

Category 1:	wind speeds of 119–153 kph
Category 2:	154–177 kph
Category 3:	178–209 kph
Category 4:	210–249 kph
Category 5:	above 250 kph

Hurricanes are often accompanied by storm surges, high winds and flooding. During a hurricane the surface of the ocean can rise and form a huge wave which can rise as high as six metres or more above sea level causing damage to the shoreline. The number of hurricanes that developed in the North Atlantic over the past 57 years is shown in Figure 14.9 below. The peak years for hurricanes during that time were 1950, 1969, 1995, 1998 and 2005 which had ten or more hurricanes annually.

Figure 14.9
North Atlantic Hurricanes 1950–2006



Source: Vulnerability and Adaptation Assessments & Draft Regional Strategic Plan for Building Resilience to Climate Change, Second National Communication of Jamaica to the UNFCCC

Table 14.10
Damage to Dwellings and Household Effects during Hurricanes Dennis and Emily 2004

Parish	Totally destroyed	Major damage	Moderate damage	Minor damage	Household effects
Kingston & St. Andrew	35	140	34	54	28
Portland	13	18	–	2	57
St. Mary	1	5	1	3	–
St. Ann	–	11	2	3	1
Trelawny	–	–	114	4	52
Clarendon	–	1	5	26	302
Total	**49**	**175**	**156**	**92**	**440**

Source: ODPEM

Reports to the authorities of damage to dwellings and household effects during two hurricanes in 2004 – Dennis and Emily – and Wilma in 2005 is shown in Tables 14.9 and 14.10. In 2004, 49 households were totally destroyed, the majority being in Kingston and St Andrew. Other households in other parishes were affected but were not reflected in the data.

Heavy winds from hurricanes damage and destroy buildings, trees, utility poles, crops. The rains which accompany the winds will damage roads, bridges, buildings, crops and storm waves and winds flood coastal areas.

Table 14.11
Communities Affected by Hurricane Wilma by Parish 2005

Parish	No. of affected communities
Kingston & St. Andrew	19
St. Thomas	1
Portland	2
St. Mary	0
St. Ann	7
Trelawny	0
St. James	1
Hanover	0
Westmoreland	1
St. Elizabeth	5
Manchester	3
Clarendon	27
St. Catherine	40
Total	**106**

Source: ODPEM

Earthquakes

The Earth's crust is divided into slabs called plates which move slowly so that the islands and continents which rest on them also move. Cracks which develop along any weaknesses in the plates can cause earthquakes when there are movements in these fault lines. Earthquakes that are experienced in Jamaica result from fault lines which pass through or close to the island.

An earthquake measuring 5.1 on the Richter scale shook Jamaica on 12 June 2005. The epicentre of the quake was about 4 km northwest of Aenon Town, Clarendon. This earthquake occurred in central Jamaica although most earthquakes occur in and around Kingston and St Andrew. Fifteen aftershocks were recorded, 13 in the first 15 hours after the main shock. Earthquakes are sudden and unpredictable.

Table 14.12
Reports Received after 12 June 2005 Earthquake

Parish	No. of reports	No. of communities affected
St Ann	19	4
Trelawny	13	3
Manchester	17	5
Clarendon	23	3

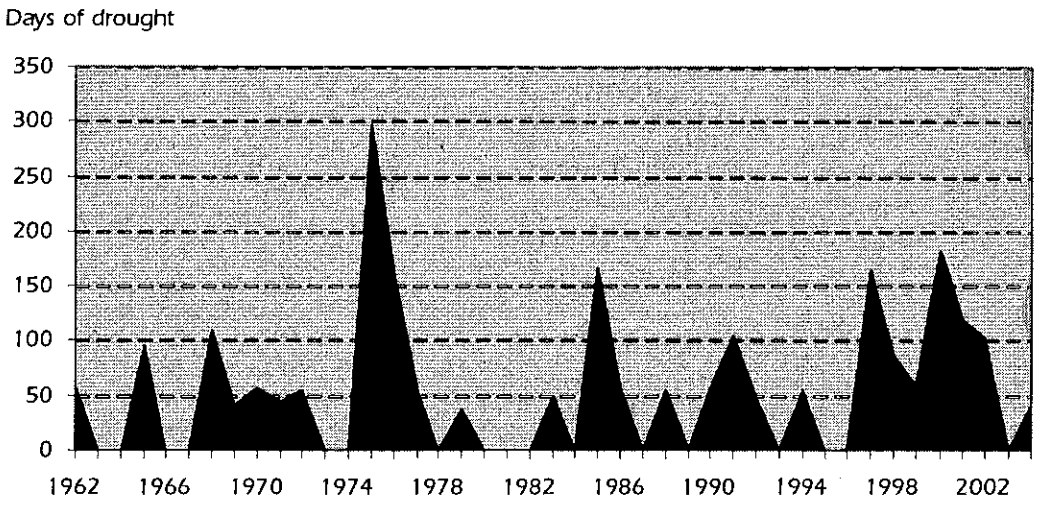
Source: ODPEM

Drought

A drought can be defined as a lack of precipitation over an extended period of time resulting in water shortages for a sector. Other factors such as high winds and temperature and low humidity can be associated with a drought. As the amount of rainfall over the island varies some areas are more prone to drought conditions than others.

The longest continuous period of drought conditions experienced in Jamaica during 1962 to 2004 was in the period of January to June 1975, a total of 297 days. Other continuous periods of drought conditions were in 1997 and 2000.

Table 14.13
Droughts in Jamaica 1962–2004



Source: ODPEM

Drought conditions have had negative effects on wetlands where the lowered ground water levels have caused spontaneous fires on very hot days where the peat in the wetlands are exposed. Bush fires are another result of drought conditions and domestic water supply is also adversely affected.

There are, on average, 8,800 fires per year in Jamaica.

Table 14.14
Forest Reserves Affected by Fire, by Parish 2005

Parish	Reserves/ Crown lands	Area (ha)	
		Natural forest	Forest plantation
St Andrew	4	–	37
St Thomas	5	40	17
St Ann	3	2	5.5
Trelawny	6	193	103
Hanover	1	8	–
St Elizabeth	3	112	–
Manchester	1	–	80
Clarendon	5	0.5	80
Total	**28**	**355.5**	**322.5**

Source: OPDEM

Forest and bush fires are a major feature of droughts and natural forest reserves and forest plantations are often affected. In Table 14.14 the number of forest reserves and Crown lands affected by bush fires during 2005 are presented. A total of 678 ha in eight parishes were affected by fires mainly caused by drought conditions.

Climate Change

Climatic conditions have been changing worldwide.

Changes in the balance of atmospheric gases have been observed over the past one or two centuries. The disproportionate increase in gases, particularly CO_2, has contributed to an increase in the surface temperature of Earth. This phenomenon is called global warming. The burning of fossil fuels contributes to both pollution and an increase in global temperatures. In addition, scientists have found that there have been increases in the amount of ultraviolet rays reaching Earth. The ozone layer is also been destroyed by gases released by modern society.

The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is the principal policy instrument governing international action on climate change. The objectives of the UNFCCC are to

- encourage industrialized nations to stabilise 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system.' This suggests that some change is inevitable and nations and the world should adapt to some changes and seek preventative measures for others.
- obtain commitments from some countries to limit greenhouse gas emissions and enhance natural sinks, such as forests.

- assist governments to slow climate change by the implementation of national programmes to reduce emissions. Each country party to the convention must develop greenhouse gas 'inventory' that lists sources (industry, transport) and 'sinks' (forests).

The Kyoto Protocol is linked to the UNFCCC and sets binding targets for 37 industrialised countries and the European community for reducing GHG emissions by an average of five per cent over the period 2008–2012. The Protocol has realised that developed countries are principally responsible for the high levels of GHG emissions. This Protocol was adopted in Kyoto, Japan on 11 December 1997 and entered into force on 16 February 2005. The convention has been ratified by 183 parties.

The average temperatures of Earth have risen by 0.6 °C since 1860 with 1998 being the warmest and 2001 the second warmest day since then. The Meteorological Office of Jamaica has reported that between 1992 and 1997, average temperatures at the Norman Manley International Airport were 29.7 °C in July, one degree higher than the average temperature between 1951 and 1980.

Rising sea levels cause an increase in seawater volume and is a threat to coastal areas.

With rising temperatures, glaciers and ice caps in temperate and polar latitudes will melt and have been melting. The excess water in our oceans has contributed to rising sea levels of 0–25 cm over the past 100 years. Another area of concern is the increase in sea temperatures. Some islands may have begun to feel the effects of sea level rise, estimated to be about 0.5 cm per year in the Caribbean. Rising temperatures will also affect marine life. Another effect of rising sea levels is the loss of sand and coastal erosion; buildings and roads close to the coast are affected by sea rise.

15 Environmental Policies and Actions

The government of a country is responsible for initiating and passing policies and laws for the protection and conservation of the natural environment and their resources within the state. It is also its responsibility to see that the country is compliant with that any regional and international treaties and laws to which it is a signatory. The main agency under which this responsibility falls is the National Environment and Planning Agency (NEPA). Other agencies with direct responsibility for various areas which affect the environment are the Forestry Department and its parent Ministry of Agriculture, and the National Solid Waste Management Authority (NSWMA) through its ministry.

Government Expenditure on Environment Protection

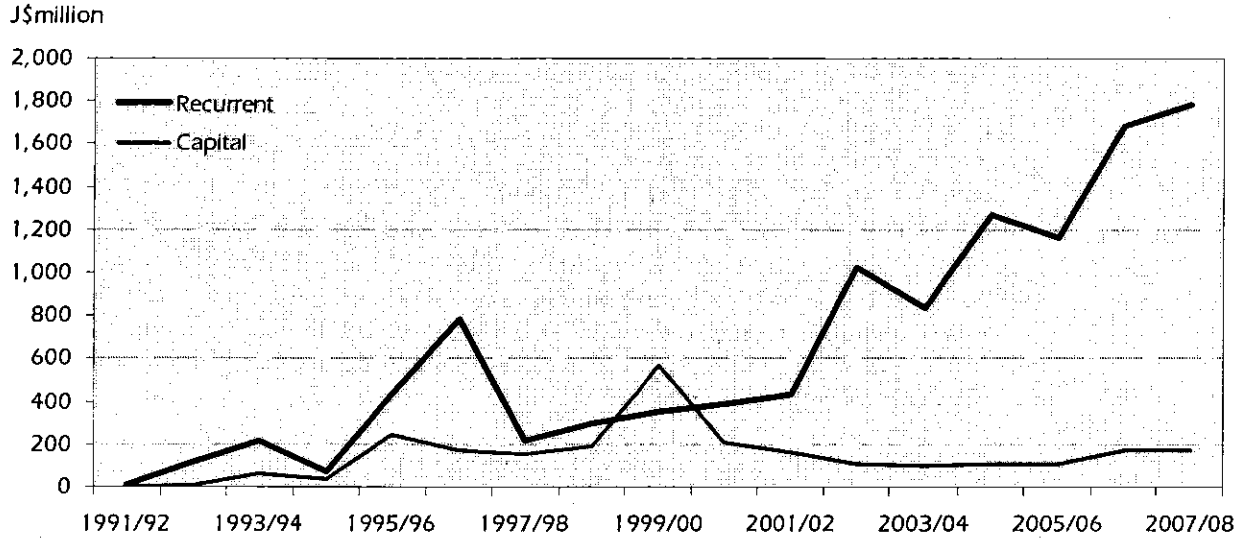
Selected items of environment protection financed by the Jamaican government are shown in broad categories in Table 15.1. The items chosen were the most easily identified and it must be noted that there are other smaller items included in other heads of expenditure. Recurrent estimates of expenditure for environmental protection and conservation totalled $464 million in the 2007/08 financial year. This item includes expenditure for NEPA as well as in the Ministries of Health and Local Government and Environment. The review and implementation of regional and international treaties and agreements are funded through recurrent expenditure under the heading of environmental protection and conservation. Also covered is the development of laws and policies for environmental protection and conservation.

Table 15.1
Estimates of Expenditure for Selected Areas 1999/00–2007/08, J$million

Year	Environmental Protection and Conservation		Forestry & Wildlife Management		Solid Waste Management		Total	
	Re-current	Capital	Re-current	Capital	Re-current	Capital	Re-current	Capital
1999/00	94.2	102.2	72.2	409.8	187.0	60.0	353.4	572.0
2000/01	134.1	112.0	87.9	31.3	161.1	60.4	383.2	203.7
2001/02	264.2	56.7	86.0	16.0	86.6	85.5	436.8	158.2
2002/03	340.4	34.3	139.0	15.0	549.3	59.5	1,028.7	108.8
2003/04	371.2	25.5	96.1	10.2	375.0	63.6	842.3	99.3
2004/05	346.8	34.1	170.2	8.2	751.6	66.1	1,268.5	108.4
2005/06	351.3	61.5	157.5	11.1	657.0	38.0	1,165.8	110.5
2006/07	410.5	126.3	202.0	1.0	1,070.0	47.5	1,682.5	174.8
2007/08	464.1	62.8	232.8	11.0	1,084.9	98.2	1,781.8	172.0
2008/09	546.6	56.2	460.1	16.8	678.6	1,102.0	1,685.2	1,175.0

Source: Ministry of Finance & Planning, Estimates of Expenditure

Figure 15.2
Estimates of Expenditure for Selected Areas 1991/92–2007/08, J$million



Source: Ministry of Finance & Planning, Estimates of Expenditure

In 2007/08, the $236 million under the heading forestry and wildlife management was spent by the Forestry Dept and the Ministry of Agriculture for the care and management of nature preserves; the rehabilitation, protection and management of national forests and the management of public gardens and the Hope Zoo.

The collection, management and disposal of solid waste is the responsibility of the NSWMA. In the 2006/07 financial year the $1,070 million also covered expenditure on beautification of verges and median strips in preparation for World Cup Cricket 2007.

In 2007/08, total recurrent expenditure on the selected areas ($1,953.8 million) was 0.7 per cent of the total recurrent budget of $252,916 million; capital expenditure was 0.1 per cent of the $150,440 million capital budget.

Figure 15.2 presents expenditure on the environment for selected areas for the 1991/92 to 2007/08 fiscal year. While expenditure for recurrent costs have grown to almost $2 million, capital costs have remained fairly constant.

Policies

NEPA became operational on 1 April 2001 and its vision is to ensure sustainable use of the natural resources of Jamaica, an understanding of the environment, planning and development issues and citizen's participation and compliance with environmental legislation. The agency operates under the:

- Beach Control Act
- Endangered Species Act
- Land Development and Utilization Act
- Natural Resources Conservation Act
- Town and Country Planning Act
- Watershed Protection Act; and
- Wildlife Protection Act.

Box 15.1
Target 7.A of the MDGs: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.

The plans and policies which guide its work are the:

- Beach Policy for Jamaica
- Biodiversity Strategy and Action Plan
- Environmental Management Systems Policy and Strategy
- Jamaica National Environmental Action Plan (JaNEAP)
- National Environment Education Action Plan for Sustainable Development (NEEAPSD)
- Policy for Jamaica's System of Protected Areas; and
- Watershed Management Policy.

Policy Papers developed by NEPA

- Jamaica Coral Reef Action Plan
- Protected Animals in Captivity Policy (Exemption to the Wildlife Protection Act)
- Draft Crocodile Action Plan
- Draft Jamaican Swallowtail Recovery Plan
- Draft National Environmental Education Action Plan for Sustainable Development
- Draft Mangrove and Coastal Wetlands Policy and Regulation
- Draft National Policy for the Conservation of Sea Grasses
- Draft National Environmental Policy
- Draft Coral Reef Protection and Preservation Policy and Regulations
- Jamaica National Environment Action Plan
- Towards a National System of National Parks and Protected Areas
- Draft Watershed Policy
- Draft National Mariculture Policy
- Green Paper #2 – Towards a Beach Policy for Jamaica (A Policy for the Use of the Foreshore and the Floor of the Sea)

Table 15.3
Applications Received and Processed 2004–2007

Type of Application	2004–05		2005–06		2006-07	
	No. Received	No. Processed	No. Received	No. Processed	No. Received	No. Processed
Planning	557	424	405	333	514	323
Subdivision	849	792	557	537	616	752
Enquiry	114	–	151	–	123	195
Environmental permit	270	141	301	164	293	104
Environmental licence	44	29	60	12	49	27
Beach licence	55	46	70	67	47	33
Restrictive covenant	237	267	976	959	840	848
CITES	85	83	56	57	75	74
Exemptions under Wildlife Protection Act	11	7	26	22	9	6
Research	32	27	33	30	22	17
Transboundary movement of hazardous waste permit	3	3	2	1	3	2
Total	**2,257**	**1,819**	**2,637**	**2,182**	**2,591**	**2,381**

Source: NEPA

Applications to NEPA

As part of its operations, NEPA has responsibility for the processing and granting of applications for environmental permits and licences and granting permits and licences for beach use, construction and operation of some industrial facilities, sewage and industrial waste discharge adn the export of wildlife species. In 2006-07 the agency received just fewer than 2,900 and processed 2,400 applications (see Table 15.3).

The agency also conducts monitoring activities after granting permits and licences in order to encourage compliance. In the 2006/07 year, there were about 2,400 routine visits and 2,100 post-permit visits to recipients.

Table 15.4
Enforcement Actions Taken by NEPA 2000/01–2006/07

Year	Enforcement Notices	Warning Letters	Stop and Cessation Orders	Court Actions	Other	**Total**
2000/01	1	41	6	3	45	**96**
2001/02	5	68	8	3	48	**132**
2002/03	12	101	8	3	54	**178**
2003/04	18	177	23	4	128	**350**
2004/05	24	187	30	5	125	**371**
2005/06	58	147	31	3	118	**357**
2006/07	4	117	11	5	172	**309**

Source: NEPA

There are various measures taken by NEPA to enforce the environmental regulations, standards and guidelines. These include verbal warnings, warning letters, stop and cessation orders and court actions. Table 15.4 presents the types and number of enforcement actions taken over a seven-year period.

International Obligations

Concern over environmental pollution and depletion of natural resources has generated the regional and international multilateral environmental agreements that we know today. Agreements entered into force since the *Declaration of the United Nations Conference on Human Environment* and the *Plan of Action for Human Environment*, both in 1972 are conventions on biological diversity, climate change, desertification, world heritage, hazardous waste and the ozone, wetlands, migratory species endangered species and the law of the sea, among others. The conventions, treaties, protocols and obligations to which Jamaica is a party are listed in Table 15.5 along with their dates of accession and entry into force.

Table 15.5
International and Regional Agreements to which Jamaica is a Party 2007

Name of Treaty	Date of Accession for Jamaica	Entry into Force for Jamaica
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (as amended), London, Mexico City, Moscow, Washington, 1972	22 March 1991	21 April 1991
International Convention for the Prevention of Pollution from Ships, (Marpol) London, 1973	13 June 1991	12 Sept. 1991
Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, London, 1973	13 June 1991	12 Sept. 1991
United Nations Convention on the Law of the Sea, Montego Bay, 1982	21 March 1983	16 Nov. 1994
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	31 March 1993	29 June 1993
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal 1987	31 March 1993	29 June 1993
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990.	31 March 1993	29 June 1993
Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	7 November 1997	4 February 1998
Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997	24 September 2003	22 December 2003
Beijing Amendment to the Montreal Protocol on Ozone Depleting Substances, Beijing, 1999	24 September 2003	22 December 2003
United Nations Framework Convention On Climate Change, New York, 1992	6 January 1995	5 April 1995
Kyoto Protocol to the United Nations Framework Convention on Climate Change, Kyoto, 1997.	28 June 1999	16 February 2005
Convention on Biological Diversity, Rio de Janeiro, 1992	6 January 1995	5 April 1995
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal, 2000	4 June 2001	
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	22 July 1997	23 April 1997
Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar)	7 October 1997	7 February 1998
United Nations Convention to Combat Desertification, Paris, 1994 (UNCCD)	12 November 1997	16 March 1998
Convention on Transboundary Movement of Hazardous Waste and their Disposal (Basel Convention) Basel, 1989	23 January 2003	23 April 2003
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam, 1998.	20 August 2002	24 February 2004
Stockholm Convention on Persistent Organic Pollutants, Stockholm, 2001	23 May 2001	1 June 2007
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartagena de Indias, 1983 (Cartagena Convention)	24 March 1983	1 April 1987
Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region, 1983	24 March 1983	1 April 1987

Table 15.5 cont'd

Name of Treaty	Date of Accession for Jamaica	Entry into Force for Jamaica
Protocol to the Cartagena Convention on Specially Protected Areas and Wildlife (SPAW Protocol), 1983	18 January 1990	under consideration
International Plant Protection Convention, Rome, 1951		24 November 1969
Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972	14 June 1983	
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies, London, Moscow, Washington, 1967	10 August 1970	
Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil Thereof, Washington, 1971	30 July 1986	
Treaty on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, London, Moscow, Washington, 1972	30 July 1986	
Convention on the Territorial Sea and the Contiguous Zone, Geneva, 1958	8 October 1965	
Convention of the High Seas, Geneva, 1958	October 1965	30 October 1962
Convention on Fishing and Conservation of the Living Resources of the High Seas, Geneva, 1958	16 April 1968	20 March 1966
Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, Moscow, 1963	13 August 1963	22 November 1991
Convention on Civil Liability for Bunker Oil Pollution Damage, 2001	28 July 2003	21 November 2008
International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990	30 January 2001	
International Convention for the Safety of Life at Sea (SOLAS) 1974	15 October 2001	
Protocol Concerning Pollution from Land-based Sources and Activities (LBS Protocol) to the Cartagena Convention, 1999	under consideration	
Convention on Migratory Species (CMS), Rome, 2008	under consideration	

Sources: *Ministry of Land & Environment*
National Environment and Planning Agency

Environment Protection Expenditure 2004

Contents

1 Introduction

The overall goal of environmental policy in Jamaica has been sustainable development, a path of environmental, economic and social development that will ensure that the quality of life for future generations is no worse compared to that which is enjoyed by the present generation. This requires the need for the quality of the environment to be sustained even as the economy continues to develop, and especially so in Jamaica which has a resource based economy. Hence there is a need for protection of the environment.

Environmental protection includes all actions or activities where the main purpose is to protect the environment or reduce/eliminate environmental pollution caused by activities of enterprises and industries. Environmental protection expenditure or 'EPE' for short is an internationally recognised term used to describe all goods and services that are aimed at protecting the environment and encouraging the sustainable use of the earth's natural resources. Environmental protection expenditure results from actions and activities where the main purpose is prevention, reduction and treatment of pollutants and elimination of pollution or any other degradation of the environment, which result from an enterprise's operating activities.

Essentially, EPE refers to the capital and current expenditure for the undertaking of environmental protection activities (or 'EP activities'). Capital expenditure refers to investments that may be for pollution treatment as well as pollution prevention. Resource saving investments (aiming to minimise the use of water, energy, raw materials) are not considered as EPE but can be accounted for separately. Current expenditure can be divided into (i) in-house expenditure; and (ii) payments for goods bought and purchase of services.

2 Background/Rationale

All activities inevitably affect the environment to some degree, which therefore means that all sectors of the economy have a specific role to play in the overall efforts to minimise negative impacts on the environment. The industries of tourism, manufacturing and mining are three of the main contributors to the Jamaican economy. However, these sectors are heavily dependent on the environment, in particular - beaches, sea, land, mountains, fresh water and scenic beauty. Unfortunately, these environmental and natural resources are deteriorating and if this trend is not halted or preferably reversed, then the industries and the population at large will be jeopardized.

Internationally, environmental protection is now being integrated into all policy fields with the general aim of ensuring sustainable development. It is quite relevant to keep track of the costs for environmental protection, as much of the pressure placed on the environment is a direct result of the production of goods and services. Hence the need for a survey to determine the costs associated with the protection of the environment by business establishments.

With the above factors in mind, the Environment Statistics Unit of the Statistical Institute of Jamaica (STATIN) conducted an Environmental Protection Expenditure (EPE) Survey of specific enterprises in Jamaica for the reference year 2004 (between 2005 and 2006).

EPE 2002 Pilot Survey

A pilot survey of EPE was carried out in 2002 and it covered four selected sectors of the economy, for the reference year 2001. Unfortunately, very few responses were returned and so the approach to the implementation of this survey was somewhat different.

3 Objective of an EPE Survey

The overall aim of the EPE survey was to determine the annual cost of protecting the environment, incurred by enterprises in selected sectors. For the purpose of this survey, the environmental protection activities were classified into four domains. These domains are as follows:

- Protection of surrounding air
- Wastewater management
- Solid waste management
- Protection of soil, ground water or surface water.

4 Significance of the EPE Survey

The information collected from the survey can be used in the following ways to:

- Construct indicators that describe what enterprises do to reduce environmental problems;
- Provide an indication of the economic response to environmental policies and regulations;
- Evaluate the costs of complying with environmental regulations;
- Analyse how to attain high levels of environmental protection at lower costs;
- Produce estimates which can be used to analyse the impacts of economic and social policy on the environment;
- Produce estimates that can enable a calculation to be made of the contribution of the 'environment industry' towards gross domestic product.

5 Design Methodology

5.1 Sample Design

The sample was chosen from four specific sectors. These were as follows:

- Manufacturing of Food Products and Beverages
- Manufacturing of Chemicals and Chemical Products
- Mining and Quarrying
- Hotels.

These sectors were chosen to be sampled as they are known to impact directly, whether negatively or positively, on the Jamaican environment.

The sample for the survey was drawn from a list known as the Central Register of Establishments that is divided into two sections. These two sections are:

- Companies with less than 50 employees
- Companies with 50 or more employees.

All companies with 50 or more employees in the above-mentioned sectors were sampled – a total of 138 companies. A sample was drawn from the section of companies with less than 50 employees in the above-mentioned sectors using random sampling design – a total of 58 companies.

Additionally, there were four specially selected companies that did not fall under the above-mentioned sectors. These particular companies were chosen for the sample and designated the category of 'Other'. It was perceived that these companies have a major impact on the environment.

A total of 200 companies were chosen to be sampled (See Appendix 1).

5.2 Survey Topics

The topics covered under the survey are as follows:

- Total Capital and Current Expenditure
- Capital and Current Expenditure of each Environmental Domain
- Total Freshwater Usage
- Total Energy Usage
- Environmental Certifications
- Barrier to Implementation of Environmental Protection strategies.

See Appendix 2 for a copy of the questionnaire.

6 Survey Findings

6.1 Return Rate

Table (i) shows that of the 200 questionnaires that were sent out, only 37 were returned. This represents a low return rate of only 19 per cent. The Food and Beverage sector had the greatest return rate of 31 per cent. There was no response from either the Mining sector or the 'Other' category. The Chemical sector had a return rate of 12 per cent while the Hotel sector had a return rate of 6 per cent.

Table (i): Percentage of Questionnaires Returned by Sector

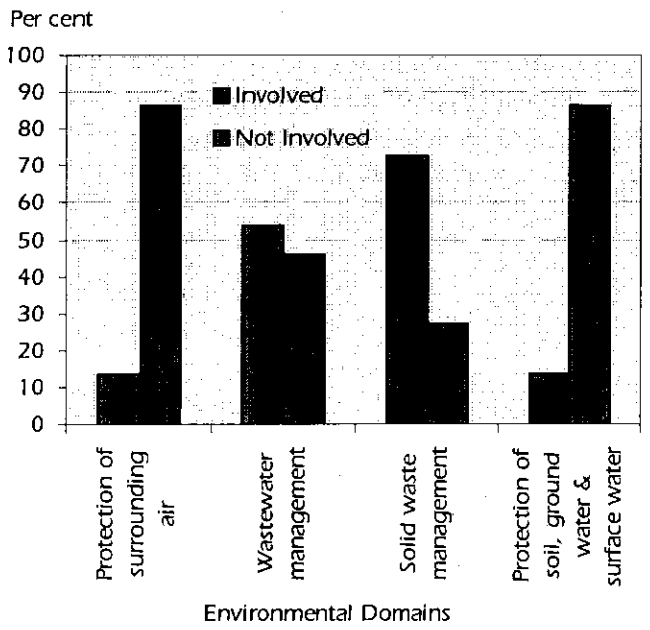
Name of Sector	Total Sent Out	Total Returned	% Returned
Chemical	25	3	12
Food and Beverage	96	30	31
Hotel	64	4	6
Mining	11	0	0
Other	4	0	0
Total	**200**	**37**	**19**

Table (ii): Percentage of Companies Involved or Not Involved in the Different Environment Domains

Environmental Domain	No. of Companies Reporting	Involved	Not Involved
Protection of surrounding air	37	13.5	86.5
Wastewater management	37	54.1	45.9
Solid waste management	37	73	27
Protection of soil, ground water & surface water	37	13.5	86.5

wastewater management (54 per cent). The finding as it relates to solid waste management is quite surprising as it should have been 100 per cent since all companies have some form of solid waste to be disposed of. Perhaps the explanation of solid waste was not clear.

Figure (i): Involvement of Companies in the Various Environmental Domains



6.2 Involvement in EP Activities

Most companies were involved in solid waste management (73 per cent) and least were involved in the protection of surrounding air and protection of soil, ground water and surface water (both were 14 per cent). More than half of the companies were involved in

6.3 Allotment of Expenditure for EP Activities

From Table (iii), of the three sectors that replied, the Food and Beverage sector allotted the greatest amount of capital expenditure to EP activities (2.23 per cent) while the Chemical sector allotted the smallest amount (0.68 per cent).

Table (iii): Percentage of Capital Expenditure allocated to Environmental Protection Activities

Sector	No. of Companies Reporting	Capital Expenditure
Chemicals	2	0.68
Food and Beverage	13	2.23
Hotels	3	2.08

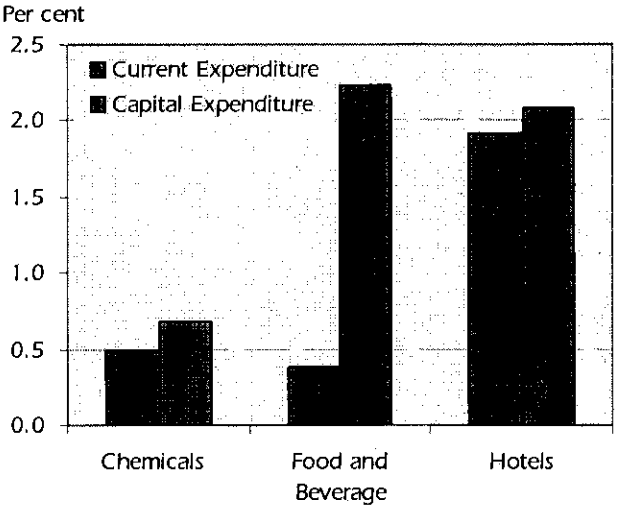
With respect to current expenditure, the Hotel sector allotted the most to EP activities (1.92 per cent) while the Food and Beverage sector allotted the least (0.38 per cent).

Table (iv): Percentage of Current Expenditure allocated to Environmental Protection Activities

Sector	No. of Companies Reporting	Current Expenditure
Chemicals	2	0.49
Food and Beverage	17	0.38
Hotels	3	1.92

Overall, all sectors spent the most of their total expenditure (0.34 per cent) on the environmental domain of wastewater management while the least was spent on protection of soil, ground water and surface water (0.01 per cent). For all sectors, 0.18 per cent of the total expenditure was spent on protection of the surrounding air while 0.25 per cent was allocated for solid waste management. Of all three sectors, the Hotel sector spent the most of its total expenditure on wastewater and solid waste management, 1.55 and 0.38 per cent respectively. The Chemical sector spent the least, of all sectors, of its total expenditure on the four environmental domains. The Hotel sector was not involved in the environmental domains of protection of surrounding air and protection of soil, ground water and surface water.

Figure (ii): Percentage of Expenditure Allocated to Environmental Protection Activities



In total, all sectors spent the most capital expenditure (0.77 per cent) on wastewater management and the least on the protection of soil, ground water and surface

Table (v): Percentage of Total Capital Expenditure Spent on each Environmental Domain by Sector

Environmental Domain	Name of Sector			
	Chemicals	Food & Beverage	Hotels	All Sectors
Protection of surrounding air	0.34	1.56	0.00	0.63
Wastewater management	0.00	0.70	1.62	0.77
Solid waste management	0.00	0.10	0.46	0.19
Protection of soil, ground water & surface water	0.34	0.00	0.00	0.11

Table (vi): Percentage of Total Current Expenditure Spent on each Environmental Domain by Sector

Environmental Domain	Name of Sector			
	Chemicals	Food and Beverage	Hotels	All Sectors
Protection of surrounding air	0.05	0.00	0.00	0.02
Wastewater management	0.18	0.14	1.54	0.62
Solid waste management	0.24	0.26	0.37	0.29
Protection of soil, ground water & surface water	0.00	0.01	0.00	0.00

water (0.11 per cent). For all sectors, 0.63 per cent of the capital expenditure was spent on protection of the surrounding air while 0.19 per cent was allocated for solid waste management. Of all three sectors, the Hotel sector spent the most of its capital expenditure on wastewater and solid waste management, 1.62 and 0.46 per cent respectively. Of all the chemical companies that responded, none reported capital expenditure figures for the domains of wastewater management and solid waste management.

Overall, all sectors spent the most current expenditure (0.62 per cent) on wastewater management and none on the protection of soil, ground water and surface water. For all sectors, 0.02 per cent of the capital expenditure was spent on protection of the surrounding air while 0.29 per cent was allocated for solid waste management. Of all three sectors, the Hotel sector spent the most of its current expenditure on wastewater and solid waste management, 1.54 and 0.37 per cent respectively.

6.4 Research and Development

Respondents were asked to give figures on the how much was spent during 2004 on research and development to reduce the environmental impacts of the companies' activities. Of the 200 questionnaires, only two per cent replied to that particular question. The figures reported ranged from a low of $90,000 to a high of $18,000,000.

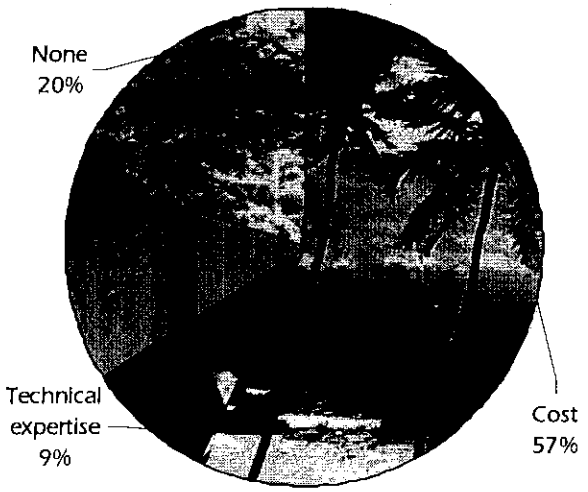
6.5 Environmental Certifications

The survey asked respondents to identify any environmental certifications attained by the particular company, in particular ISO 14001 and Green Globe Certification. ISO 14001 is an international standard primarily concerned with 'Environmental Management' while Green Globe is a global certification and improvement system for sustainable tourism and travel. None of the respondents had achieved either ISO 14001 or Green Globe Certification. Some companies listed other certifications, however they were not considered to be environmental certifications.

6.6 Barriers to Implementation of EP Activities

Companies were asked to determine the greatest barrier faced in the implementation of EP activities/strategies. For the purpose of this survey, the barriers were classified as – cost, technical expertise, lack of awareness, other and none. Figure (1ii) below shows the results of this particular question.

Figure (iii): Percentage of Companies by Greatest Barrier to Implementation of EP Activities



Cost was deemed the greatest barrier faced by the majority of companies (57 per cent). The barrier faced by the least amount of companies was technical expertise with only 9 per cent of companies. 20 per cent of the companies responded that there was no barrier faced in the implementation of environmental protection activities.

7 Limitations and Challenges of the EPE Survey

The validity and authenticity of this survey has been greatly undermined due to the paucity of the data as well as the great number of improperly completed questionnaires. Due to this, no statistics for entire sectors can be adequately reported. As mentioned earlier, of the 200 questionnaires that were sent out, only a 37 questionnaires were returned (19 per cent). The questionnaires were sent out in September 2005 and up to March 2006, when it was decided that collection should be discontinued, only 37 were returned. The deadline for completion of the questionnaire had been set at fourteen days within receipt.

The pilot survey which was carried out in 2002, yielded an even fewer number of questionnaires and it was envisaged that this survey would have generated an improved response. Although the response rate had moderately increased (in comparison to the previous survey), the data was quite inefficient. A number of questionnaires which indicated an involvement in the various environmental domains, failed to indicate the expenditure on these domains. This resulted in difficulties in determining the actual expenditure for environmental protection.

Some respondents refused to report any sort of monetary figures for the purpose of this survey, while others reported on only certain aspects of the expenditure (for example, reporting only on current expenditure figures and not on capital expenditure figures). Some of the figures that were reported were quite erroneous as well. For example, some questionnaires had capital and current expenditure figures for the environmental domains being significantly higher than the companies overall total capital and current expenditure for the year. Due to these factors, there was gross under-representation of the involvement of the sectors in environmental protection strategies.

The results do however indicate that there is an awareness of environmental protection activities and its importance. The companies/businesses spending money to protect and preserve the environment are faced with challenges in the implementation of these activities. The results of the survey indicate that of all three sectors that responded, the Hotel sector is the one with the greatest response to environmental protection.

8 Recommendations for Future EPE Surveys

The environment is extremely important for all sectors of the Jamaican economy and its integrity needs to be preserved. In this light, it is quite necessary to keep track of the costs associated with protecting the environment and hence, there needs to be a continuation of the EPE survey. Unfortunately many companies are not aware of the importance of protecting the environment while others are simply nonchalant of its importance.

However, the approach to the implementation of any future EPE survey needs to be different in order to achieve valid and timely results. The experience of this survey can be used as a guide for forthcoming EPE surveys and to indicate what needs to be done differently.

It is recommended that during the next survey, a statistician should take a more active role in administering the questionnaire to the various business establishments (especially the larger ones). This would facilitate in proper completion of questionnaires. Companies could probably have an 'awareness session' before the administering of questionnaires to be informed prior to the implementation of the survey.

It should be noted that there was an attempt at a workshop prior to the pilot EPE survey but this failed due to lack of response from companies/businesses. Although a meeting was held with the Jamaica Manufactures Association (to inform and educate), it failed to raise the level of awareness required for the pilot EPE survey.

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References

American Coalition for Ethanol at www.ethanol.org

Australian Bureau of Statistics. *Australians and the Environment.* ABS, 1996.

Caribbean Cement Company Limited. Annual Report 2006.

Caribbean Environment Programme at www.cep.unep.org.

Earth Trends at www.earthtrends.wri.org.

Ecosmart Concrete at www.ecosmartconcrete.com/enviro_cement.cfm

European Environment Agency. *The European Environment — State and outlook 2005.* Copenhagen, 2005.

Evelyn, OB, Camirand R. 'Forest Cover and Deforestation in Jamaica: An Analysis of Forest Cover Estimates Over Time.' International Forest Review 5(4), 2003.

Faiz, Asif. 'Air pollution from motor vehicles: standards and technologies for controlling emissions'. World Bank, 1996.

Food and Agriculture Organization. 'Forest Resources Assessment Programme.' June 2005.

Forestry Department. Forest Policy 2001.

_____ National Forest Management and Conservation Plan 2000.

Gleaner, The. Thu. 19 April 2007.

_____ Thu. 20 Sept. 2007.

Griffith, S, Emmanuel, K. 'Protecting Heritage and Culture: Its Role in the Protected Areas System Plan and Impact on National Development.' National Environment Societies Trust, 2005.

International Energy Agency at www.iea.org.

International Union for Conservation of Nature and Natural Resources at iucn.org

Jamaica Hotspots at www.camacdonald.com/birding/carjamaica.htm

Jamaica Tourist Board. *Annual Travel Statistics,* various years.

Ministry of Agriculture and Lands. *National Quarry Survey.* 2006.

Ministry of Agriculture at www.moa.gov.jm

Ministry of Finance. *Estimates of Expenditure,* various years.

Ministry of Land and Environment. Draft National Minerals Policy August 2006.

Ministry of Mining and Energy, 'Mining and its Effect on Land Degradation', April 2000.

Ministry of Transport and Works. Annual Transport Statistics: Jamaica in Figures 2004-2005.

_____ Final Draft National Transport Policy.

Ministry of Water and Housing. Jamaica Water Sector Policy.

_____ Water Resources Authority Annual Report 2002–2003. (Also 2003–2004, 2004–2005).

National Environment and Planning Agency. 'Ambient Air Quality Guideline Document'. Claude Davis & Associates. November 2006.

_____ Annual Report 2005-06.

_____ Beach Policy 2000.

_____ Mangrove and Coastal Wetlands Protection Draft Policy and Regulation.

_____ National Strategy and Action Plan for Biological Diversity in Jamaica 1999.

_____ Handbook on Environment and Sustainable Development, Environment Action Programme (ENACT).

_____ Regulatory Impact Analysis Statement (RIAS) for the NRCA (Air Quality Regulations, 2003).

_____ Terrestrial Fauna and Avifauna. NRCA, 1997.

Office of Disaster Preparedness and Emergency Management. *An Assessment of the Impact of the 2005 Drought.* Nov. 2005.

_____ *Assessment of Damage Caused by Hurricanes Dean and Emily in Selected Parishes.* Feb. 2006.

_____ *Earthquake Damage Assessment Report of the 12 June 2005 Aenon Town Earthquake.* Aug. 2005.

Office of the Prime Minister. North Coast Highway Corridor Study Project. 30 Apr. 2008.

Petroleum Corporation of Jamaica. Group Annual Report 2005/2006.

Planning Institute of Jamaica. 'Assessment of the Socio-Economic and Environmental Impact of Hurricane Wilma on Jamaica.' Oct. 2005.

_____ *Economic and Social Survey* Annual Reports, various years.

Planning Institute of Jamaica and Statistical Institute of Jamaica. *Jamaica Survey of Living Conditions* Vols. 2006 and 2007.

Port Authority of Jamaica. *Port Statistics,* various years.

Reefbase at www.reefbase.org.

Renewable Fuels Association at www.ethanolrfa.org.

Ritter, Michael E. *The Physical Environment: an Introduction to Physical Geography.* 2006. Visited 17 September 2008 at www.uwsp.edu/geo/faculty/ritter/geog101/textbook/hydrosphere/water_balance_1.html

Smith, Ianthe. 'National Sanitation Policy for Jamaica.' Environment and Engineering Managers Ltd. Sept. 2005.

Soil Erosion Site at www.soilerosion.net

Statistical Institute of Jamaica. *Census of Agriculture* Vols. 1996 and 2006.

_____ Demographic Statistics, various years.

_____ Enumeration Manual 2007 Census of Agriculture Jamaica.

_____ National Income and Product 2007.

_____ Population Census 2001. Vol. I.

United Nations Energy Statistics at www.unstats.un.org/unsd/energy/

United Nations Environment Programme at www.unep.org.

United Nations Food and Agriculture Organisation at www.fao.org

Vogel, P, Levy, C. Demo Palisadoes and Port Royal Protected Area Project Output 6.

Water Resources Authority. Annual Report 2002–2003. (Also 2003–2004, 2004–2005).

_____ Water Resources Development Master Plan.

Wilkinson, C. (ed) *Status of Coral Reefs of the World: 2000,* Australian Institute of Marine Science.

_____ *Status of coral reefs of the world:2002.* GCRMN Report, Australian Institute of Marine Science, Townsville.

Wilkinson, C, Souter, D. *Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005.* Global Coral Reef Monitoring Network, and Reef and Rainforest Research Centre, Townsville. 2008

World Wildlife Fund at www.worldwildlife.org

World Resources Institute at www.wri.org

Appendix I

Names Companies Sampled for the EPE Survey by Sector

Chemicals
Agricultural Chemical Plant
Associated Manufacturers Ltd.
BRK Ltd.
Barco Caribbean Ltd
Berger Paints Jamaica Ltd
Blue Power Ltd
Brandram-Henderson (WI)
Caribspray Ltd
Chemco Ltd
Colgate Palmolive Co. Ja. Ltd
Content Agricultural Products Ltd
Drac Chemical & Equipment Co. Ltd
Edgechem Jamaica Ltd
Hi-Grade Industries Ltd
Industrial Chemical Co.
Industrial Gases Ltd (IGL)
Johnson's Diversey Ltd
Kem Swift Chemicals Ltd
Matrix Chemicals Ltd
Sherwin Williams West Indies Ltd
Shirlhome Chemical Corp. Ltd
Stacote Finishes Ltd
Starfish Oils Ja. Ltd
Windsor Laboratories Ltd
Zep Products Ltd
Total - 25

Food and Beverages
AML Bakery Ltd
Appleton Estate
Ashman Food Products Ltd
Audreens Bakery
Best Dressed Chicken Feed Mills
Betapac Ltd
CMK Bakery

Food and Beverages cont'd
Canco Ltd
Captain's Bakery
Caribbean Broilers Ja. Ltd
Caribbean Food Ltd
Caribbean Products Ltd
Carreras Group Ltd
Central Food Packers Ltd
Consolidated Bakeries
Continental Baking Co. Ltd (NCC Ltd)
Copperwood Ltd
Coronation Bakery
Dairy Industries Ltd
Dairy Queen Ltd
Food Ingredients Ltd
Gauron Food Products
Golden Delight Bakery
Grace Food Processors (Canning) Ltd
Grace Food Processors Ltd
Hammonds Pastry Place
Hampden Estate Ltd
Hawthorn's Bakery
Heminics Co. Ltd
Highgate Food Products Ltd
Hilton's Bakery Ltd
Honey Bun Ltd
International Ingredients
Island Spice Ltd
Jamaica Beverages Ltd
Jamaica Biscuit Co. Ltd
Jamaica Broilers Group Ltd
Jamaica Citrus Growers Ltd
Jamaica Dairy Farmers Federation
Jamaica Drink Co. Ltd
Jamaica Flour Mills Ltd

Food and Beverages cont'd
Jamaica Grains & Cereals
Jamaica Macaroni Factory
Jamaica Standard Product
Juici Patties Ltd
Kingston Ice Making Co. Ltd
Kraft Food Jamaica Ltd
Long Pond Sugar Co. Ltd
Midel Distributors Ltd
Musson (Ja.) Ltd
National Processors Ltd
Native Food Packers Ltd
Nestle Jamaica Ltd
New Yarmouth Ltd
Newport Mills Ltd
North Clarendon Processing Co.
Nutrition Products Ltd.
PA Benjamin Manufacturing Co. Ltd
Peak Bottling Co. Ltd
Pepsi Cola Ja. Bottling Co. Ltd (D&G)
Plantation Pride
Polly Foods Ltd
RST Industries Ltd
Red Stripe
Roberts Products Co. Ltd
Salada Foods Jamaica
Sam Fo Bakery
Santa Cruz Bakery & Restaurant Ltd
Santa Cruz Processors Ltd
Scoops Unlimited Ltd
Scope Industries Group Ltd
Seprod Ltd
Serge Island Dairies Ltd
Shim's (Successors) Ltd
Smith & Stewart Dist. Ltd

Food and Beverages cont'd
Southern Fruits & Food
Spike Industries Ltd
St James Bakery
St Thomas Sugar
Susies Fine Baked Goods
Tastee Ltd
The Patty Place Ltd
The Sugar Company of Ja. Ltd
Time & Patience Pastry Shop
Trade Winds Citrus Ltd
Tweedside Processors
Unique Bakery
United Estates Ltd
Uriel Dunkley
Vap Ltd
Walkers Wood Caribbean Food Ltd
Whitfield Town Bakery
Wisynco Group
Worthy Park Estate Ltd
Wray & Nephew Group
Young Sang Bakery Ltd
Total - 96

Hotels
Altamont Court Hotel
Ambiance Hotel
BRL Ltd (Grand Lido Braco)
Bar B Barn Hotel & Restaurant
Beach Comber Club Hotel
Beaches Negril
Breezes Runaway Bay
Caribbean Village Beach Resorts
Charela Inn Ltd
Chatwick Gardens Hotel
Club Ambiance Hotel
Club Caribbean
Club Jamaica Beach Resort

Hotels cont'd
Coco Lapalm Resort
Coral Cliff Hotel Entertainment Resort
Couples Hotel
Courtleigh Hotel
Daniel Beach Village
Devine Destiny Co. Ltd
Doctors's Cave Beach Hotel
Dragon Bay Beach Resort
Fern Hill Club Hotel
Firefly Beach Cottage
Gloucestershire Hotel
Goblin Hill Hotel Ltd.
Golf View Hotel
Grand Lido Great Resorts Ltd
Grand Lido Sans Souci
Half Moon Hotel
Harbour Way Hotel
Hedonism Ii
Hilton Kingston Hotel
Holiday Inn Sunspree Resort
Hotel Four Seasons
IZIT Properties Ltd.
Invercauld Hotel
Island Dairies Ltd
Jamaica Grande
Jamaica Inn Hotel
Jamaica Pegasus Hotel
Mandeville Hotel (1986) Ltd
Milk River Hotel & Spa
Moon Dance Villas
Negril Beach Club
Negril Garden Beach Resort
Negril Idle Awhile Hotel
Negril Inn Ltd
Negril Tree House Resort
Orchard Great House

Hotels cont'd
Plantation Inn
Point Village Resort
Powersun Ja. Ltd (Golden Seas)
Ritz Carlton Golf & Spa Resort
Rockhouse Hotel
Rondel Village
Round Hill Hotel
Sandals Resorts Int'l Ltd
Shaw Park Beach Hotel
Swept Away Resorts Ltd
Tamarind Tree Resort
Terra Nova Hotel & Restaurant
Trident Villas & Hotel
Wexford Court Hotel
Wyndham Rose Hall
Total - 64

Mining
Alcoa Mineral (Jamalco)
Alumina Partners of Jamaica
Bell's Engineer Works
Explosives Sales & Service Ltd
Glencore Alumina Ja. Ltd
HWE Mining & Contracting Ltd
Jamaica Gypsum & Quarries
Kaiser Jamaica Bauxite Co.
Lydford Mining Company Ltd
Rugby Ja. Lime & Minerals
Somerset Enterprises Ltd & Quarry
Total - 11

Other
Petrojam Ltd
Caribbean Cement Co. Ltd
Jamaica Premix Co. Ltd
Jamaica Public Service Co. Ltd
Total - 4

Appendix II

STATISTICAL INSTITUTE OF JAMAICA
7 Cecelio Ave., Kingston 10
Tel. 926-5311. Fax 926-1138
E-mail:sesu@statinja.com

Form No. EPE-01

QUESTIONNAIRE No.

SURVEY OF ENVIRONMENTAL PROTECTION EXPENDITURE IN SELECTED SECTORS

QUESTIONNAIRE

Please correct any errors on this label.

PLEASE READ CAREFULLY THE INSTRUCTIONS BELOW BEFORE COMPLETING THIS FORM

Purpose:
The purpose of this survey is to determine annual expenditure of companies on protecting the environment.

Confidentiality of information supplied:
The Statistics Act protects the confidentiality of the information provided in this form. Sections 17 and 18 of the Act prohibit the publication or communication of information in any manner so that an individual or a business may be identified.

Help and Information:
For enquires contact: Miss Philone Mantock or Mrs Janet Geoghagen-Martin
Telephone: 926-5311 ext. 1073 or 1120
Fax: 926-1138
Mail: Statistical Institute of Jamaica
7 Cecelio Avenue, Kingston 10
E-mail: sesu@statinja.com

Definition:
Environmental protection expenditure is defined as the spending incurred by companies where the primary aim is to reduce environmental pollution caused during normal operations.

Environmental Protection Activities:
Environmental protection includes all the actions or activities where the main purpose is to protect the environment or reduce/eliminate environmental pollution or degradation caused by activities of the enterprises.

For the purpose of this questionnaire, environmental protection activities have been classified into four domains: protection of surrounding air, wastewater management, solid waste management and protection of soil, ground water or surface water. The expenditure on these four domains should be seperated into capital and current expenditure where possible.

Reference year:
All expenditure should relate to the calendar year **2004** or your accounting year closest to that period. Please insert that accounting period in the spaces provided below.

Accounting period: From _____ **To** _____
Year Month Year Month

Deadline:
Please complete within **14 days** of receipt of this questionnaire.

1. What was your company's total capital expenditure, including environmental protection activities, during 2004?

JS

2. What was your company's total operating/current expenditure, including environmental protection activities, during 2004?

JS

3. Is your company involved in the **protection of surrounding air**? ☐ 1. Yes ☐ 2. No (Go to Q. 5)

4. What was the total expenditure for this activity during 2004?

(a) Protection of surrounding air	Capital Expenditure (JS) 1	Current Expenditure (JS) 2
(i) Prevention of pollution through in-process modifications		
(ii) Treatment of exhaust gases and ventilation air		
(iii) Measurement, control, laboratories and the like.		
(iv) Other activities		
Total		

5. Is your company involved in **wastewater management**? ☐ 1. Yes ☐ 2. No (Go to Q. 7)

6. What was the total expenditure for this activity during 2004?

(b) Wastewater management	Capital Expenditure(JS) 1	Current Expenditure (JS) 2
(i) Prevention of pollution through in-process modifications		
(ii) Sewerage networks		
(iii) Wastewater treatment		
(iv) Treatment of cooling water		
(v) Measurement, control, laboratories and the like.		
(vi) Other activities		
Total		

7. Is your company involved in **solid waste management?** ☐ 1. Yes ☐ 2. No (Go to Q. 9)

8. What was the total expenditure for this activity during 2004?

(c) Solid waste management	Capital Expenditure (J$) 1	Current Expenditure (J$) 2
(i) Prevention of pollution through in-process modifications		
(ii) Collection and transport		
(iii) Treatment and disposal of hazardous waste		
(iv) Treatment and disposal of non-hazardous waste		
(v) Measurement, control, laboratories and the like.		
(vi) Other activities		
Total		

9. Is your company involved in the **protection of soil, groundwater or surface water?**

☐ 1. Yes ☐ 2. No (Go to Q.11)

10. What was the total expenditure for this activity during 2004?

(d) Protection of soil, groundwater or surface water	Capital Expenditure (J$) 1	Current Expenditure (J$) 2
(i) Prevention of pollution infiltration		
(ii) Cleaning up of soil and water bodies		
(iii) Protection of soil from erosion and other physical degradation		
(iv) Prevention and remediation of soil salinity		
(v) Measurement, control, laboratories and the like.		
(vi) Other activities		
Total		

11. How much was spent during 2004 on Research and Development to reduce the environmental impacts of your company's activities? J$

12. Which of the following environmental certifications does your company have?

☐ 1. ISO14001 ☐ 3. Other (Specify.....)

☐ 2. Green Globe ☐ 4. None

13. What was the total quantity of freshwater used (bought, not self-produced), in m^3 during 2004?

m^3

14. What was the total energy use (bought, not self-produced), in kWh during 2004?

kWh

15. Which is the greatest barrier to the implementation of environmental protection strategies in your company?

- ☐ 1. Cost
- ☐ 2. Technical expertise
- ☐ 3. Lack of awareness
- ☐ 5. Other (Specify.....)
- ☐ 4. None

16. How many persons does your company employ?

- ☐ 1. Less than 50
- ☐ 2. 50 - 100
- ☐ 3. More than 100

End of questionnaire - Thank you