Statistical Institute of Jamaica

ENVIRONMENT STATISTICS REPORT 2019

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Feedback on the topics and material in this publication is welcome.

This report is available in electronic format as well as a reference in the library at the Statistical Institute of Jamaica.

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PREFACE

The ***Environment Statistics Report 2019*** presents data from various sources designed to provide a sound basis for decision-making, monitoring progress towards development goals, and supporting public awareness on environmental issues. The state of the environment is important for the survival of the planet and those who live on it. However, human activities, as well as natural events affect the environment and can alter it. Statistics on the environment provide empirical data on the state of and subsequent changes in the environment and informs policy and decision-making.

The publication follows the guidelines laid out in the United Nation's Framework for the Development of Environment Statistics (FDES)[1] and is organised under the themes/components of the FDES. In 2013, the FDES provided guidance on the Core Set of Environment Statistics, which was endorsed by the 44th session of the United Nations Statistical Commission. While the data presented here follow the guidelines of the FDES, they also contain statistics that are relevant to small island developing states (SIDS) which may not be included in the FDES.

STATIN is pleased to have been a part of formulating the FDES and continues its involvement in the process by participating in the Expert Group of Environment Statistics (EGES). The EGES has responsibility for preparing manuals related to the themes and topics in the FDES.

This publication will be useful to, among others, government ministries and agencies, non-governmental organisations, students and the wider public, both locally and abroad. This and previous publications may help identify changes in Jamaica's environmental landscape.

Carol Coy
Director General
January 2020

[1] https://unstats.un.org/unsd/environment/FDES/FDES-2015-supporting-tools/FDES.pdf

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Many thanks to the various divisions within STATIN that provided information and members of the Statistical and Editorial Review Committees for providing technical oversight and guidance and for reviewing the publication. This publication was produced by the Environment Statistics Unit in the Censuses, Demographic & Social Statistics Division of STATIN. We are grateful to the staff members who contributed to this report in various ways.

NOTATIONS

–	data nil
…	data negligible
p	preliminary
r	revised

INTRODUCTION

Environment statistics are integrative in nature. They measure how human activities and natural events affect the environment, the impacts of these activities and events, our response to said environmental changes and the quality. The availability of natural assets is also examined (UNSD, 1997).

Environment statistics are important in providing a robust data-driven foundation for decision making, monitoring progress and supporting public awareness relating to environmental matters. "The role of environment statistics is to process environmental and other data into meaningful statistics that describe the state of and trends in the environment and the main processes affecting them." (UNSD, 2017).

This compendium presents information on Jamaica's environment under the six components of the Framework for the Development of Environment Statistics (FDES). The publication's structure follows the FDES from Component 1, which features the Environmental Conditions and Quality, through Component 6, which features the Environmental Protection, Management and Engagement. Data and statistics available at the time of publication are presented up to the year 2019.

The United Nations Framework for the Development of Environment Statistics (FDES, 2013) is a flexible, multi-purpose conceptual and statistical framework that is comprehensive and integrative. It provides countries with a structure that can be used to guide the collection and compilation of environment statistics. The FDES is cross-cutting and brings data together from relevant subject areas and sources. It also examines the issues and aspects of the environment that are necessary for policy analysis and decision making. Environment statistics are organised in a simple and flexible manner into components, sub-components, statistical topics and individual statistics, using a multilevel approach.

It should be noted that data for Jamaica is not currently available for all sub-components and topics. Where the data is not available, the sub-component or topic is not addressed in this report.

COMPONENTS AND SUBCOMPONENTS OF THE FDES

Component 1: Environmental Conditions and Quality	• Subcomponent 1.1: Physical Conditions • Subcomponent 1.2: Land Cover, Ecosystems and Biodiversity • Subcomponent 1.3: Environmental Quality
Component 2: Environmental Resources and their Use	• Subcomponent 2.1: Mineral Resources • Subcomponent 2.2: Energy Resources • Subcomponent 2.3: Land • Subcomponent 2.4: Soil Resources • Subcomponent 2.5: Biological Resources • Subcomponent 2.6: Water Resources
Component 3: Residuals	• Subcomponent 3.1: Emissions to Air • Subcomponent 3.2: Generation and Management of Wastewater • Subcomponent 3.3: Generation and Management of Waste • Subcomponent 3.4: Release of Chemical Substances
Component 4: Extreme Events and Disasters	• Subcomponent 4.1: Natural Extreme Events and Disasters • Subcomponent 4.2: Technological Disasters
Component 5: Human Settlements and Environmental Health	• Subcomponent 5.1: Human Settlements • Subcomponent 5.2: Environmental Health
Component 6: Environmental Protection, Management and Engagement	• Subcomponent 6.1: Environmental Protection and Resource Management Expenditure • Subcomponent 6.2: Environmental Governance and Regulation • Subcomponent 6.3: Extreme Event Preparedness and Disaster Management • Subcomponent 6.4: Environmental Information and Awareness

COMPONENT 1: ENVIRONMENTAL CONDITIONS AND QUALITY

Component 1 of the Framework for the Development of Environment Statistics (FDES) examines the characteristics and natural conditions of the environment and how they change over time. It includes "Meteorological, hydrographical, geological, geographical, biological, physical and chemical conditions and characteristics of the environment that determine ecosystems and environmental quality" (UNSD, 2017). There are three sub-components, covering Physical Conditions; Land Cover, Ecosystems and Biodiversity; and Environmental Quality.

SUB-COMPONENT 1.1 PHYSICAL CONDITIONS

Physical conditions refer to the physical aspects of the environment that change slowly due to human and natural influence. This sub-section contains statistics on meteorological, hydrographical, geological, and geographical conditions and soil characteristics.

ATMOSPHERE, CLIMATE AND WEATHER

This topic will provide data on Jamaica's atmospheric, climatic, and weather conditions over time. Data obtained from the Meteorological Service of Jamaica's monitoring stations provides information on the country's weather (atmospheric behaviour over the short term); and climate (average long term weather conditions).

Jamaica has a warm tropical climate with minimal variation in temperature throughout the year. Across the island, the prevailing temperature is influenced by altitude and distance from the sea. Jamaica's climate is influenced by the north-east trade winds, and there is little fluctuation in the amount of sunlight each day. The country is located approximately 18° North and 77° West and has a tropical marine climate, with greater variation in precipitation than temperature.

Temperature

Jamaica's temperature plays a significant role in the country's economy and the life of its people. An increase in air temperature can affect humans and the environment. Significant changes can affect agriculture, energy and water supply, the health of plants and animals, ecosystems, and recreational activities.

Table 1.1 Mean Monthly Temperatures at International Airports 2015 – 2019, °C

Month	Norman Manley International					Sangster International				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
January	27.4	27.0	26.7	26.7	26.6	26.6	26.7	26.2	26.0	26.8
February	27.0	26.8	26.5	26.5	26.7	26.0	26.0	26.5	26.5	26.6
March	27.4	27.4	26.9	27.1	26.7	27.1	27.3	26.4	26.7	27.1
April	27.9	28.1	27.8	27.9	27.6	28.0	28.3	27.7	27.8	27.8
May	28.5	28.7	28.1	28.2	28.1	28.8	28.7	27.9	28.2	28.5
June	29.8	29.3	28.9	29.2	29.5	29.4	29.2	28.7	29.3	29.7
July	29.3	29.9	29.6	29.7	29.6	29.6	29.8	29.5	30.1	29.7
August	29.8	29.9	29.7	29.8	29.6	30.1	29.4	29.6	30.1	29.8
September	29.6	29.7	29.3	29.3	29.3	29.3	29.1	29.3	29.4	30.0
October	29.4	28.9	28.4	28.1	28.4	28.7	28.6	28.6	28.8	28.9
November	28.5	28.0	27.5	28.2	28.1	28.3	27.8	27.4	28.3	28.6
December	28.4	28.1	27.1	27.3	27.8	27.4	27.3	26.8	27.2	27.7

Source: Meteorological Service of Jamaica

Table 1.1 shows the mean monthly temperature measured at the two major international airports: the Norman Manley International Airport (NMIA), located in the city of Kingston (southeast section of the island), and the Sangster International Airport (SIA) in the city of Montego Bay (northwest section of the island).

The mean monthly temperatures at the NMIA for the period 2015 to 2019 ranged from 26.5°C to 29.9°C (Table 1.1). The average temperature for 2019 (28.2°C) was marginally lower in the southeast of the island than the average temperature at the northwest (28.4°C). During the year, the temperature as measured at NMIA ranged from 26.6°C to 29.6°C. The mean monthly temperature in 2019 was lower than or equal to the five-year average for all months except for June and December. In 2019, the lowest mean monthly temperature was recorded for January at 26.6°C. For all other years in the five-year review period, the lowest monthly mean temperature was recorded in February (Table 1.1).

In the northwest of the island, mean temperature at the SIA ranged between 26.0°C and 30.1°C during the period 2015 to 2019 (Table 1.1). The average annual mean monthly temperature for 2019 was 28.4°C; this was 0.2°C higher than the 28.2°C five-year average. In 2019, mean monthly temperature at the SIA ranged between 26.6°C and 30.0°C. When assessed monthly, the mean monthly temperature exceeded the five-year average for all months except April.

Table 1.2: Minimum and Maximum Monthly Temperature at Norman Manley International Airport 2015 – 2019, °C

Month	Minimum Temperatures					Maximum Temperatures				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
January	23.3	23.5	22.6	22.8	22.7	31.4	30.6	30.7	30.6	30.5
February	23.2	22.9	22.6	22.1	22.9	30.9	30.7	30.4	30.9	30.4
March	23.6	23.8	23.2	23.4	22.9	31.2	31.1	30.5	30.8	30.5
April	24.6	24.6	24.4	24.5	24.0	31.3	31.6	31.2	31.4	31.1
May	25.1	25.1	24.9	25.2	24.8	31.9	32.3	31.4	31.2	31.5
June	26.7	25.9	25.6	26.0	26.0	32.9	32.7	32.2	32.4	32.9
July	25.9	26.7	25.9	26.4	26.0	32.7	33.2	33.3	33.0	33.1
August	26.4	26.7	26.1	26.3	26.0	33.1	33.1	33.2	33.2	33.2
September	26.1	26.2	25.5	25.5	25.5	33.1	33.3	33.0	33.0	33.1
October	25.8	25.7	24.7	24.5	24.6	32.9	32.2	32.1	31.7	32.2
November	24.9	24.7	23.9	24.6	24.1	32.1	31.2	31.1	31.9	32.1
December	24.9	24.3	22.9	23.4	23.8	31.9	31.8	31.2	31.2	31.8

Source: Meteorological Service of Jamaica

The minimum monthly temperature recorded in Jamaica for the years 2015 to 2019, at NMIA was 22.1°C in February 2018. During this period, the lowest temperature recorded each year was in the month of February, except for 2019, when the lowest minimum monthly temperature (22.7°C) was recorded in January. This was 2.0°C below the average minimum monthly temperature for 2015 – 2019 of 24.7°C. Below average minimum temperatures were recorded for seven of the twelve months of 2019 primarily in the first and last quarters of the year (Table 1.2).

On the other hand, the maximum recorded monthly temperature at the NMIA for 2015 to 2019 was 33.3°C. This was observed in the summer months of September 2016 and July 2017. On average, the maximum monthly temperature recorded was 31.9°C for the same, which was also the average maximum temperature recorded for 2019. The highest temperature for 2019 in the southeast of the island (33.2°C)

was recorded in August, which is traditionally one of the warmer months (Table 1.2).

In 2019, the temperature at NMIA ranged from a low of 22.7°C to a high of 33.2°C, a difference of 10.5°C. Of the ten lowest minimum temperatures recorded during the five-year period, three were recorded during the first three months of 2019. Additionally, among the three lowest maximum temperatures recorded from 2015 to 2019, two were recorded between January and March 2019. This implies that the first three months of 2019 were cooler than in previous years. Conversely, the maximum temperature recorded during the months of July, August and September 2019 were among the top ten maximum monthly temperatures recorded for the period 2015-2019 (Table 1.2).

Table 1.3 Minimum and Maximum Monthly Temperatures at Sangster International Airport: 2015 – 2019, °C

	Minimum Temperatures					Maximum Temperatures				
Month	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
January	22.9	22.6	22.2	22.9	22.7	30.4	30.8	30.1	29.2	30.9
February	22.1	22.3	22.2	22.8	22.3	29.9	29.5	30.9	30.2	30.9
March	23.1	23.2	22.6	22.8	23.1	31.1	31.4	30.1	30.2	31.2
April	24.0	24.6	23.7	23.4	23.7	32.0	32.0	31.6	32.1	31.9
May	24.6	24.7	23.7	24.0	24.4	33.0	32.8	31.8	32.4	32.5
June	25.4	25.0	24.5	24.9	25.3	33.4	33.4	32.8	33.7	34.0
July	25.4	25.3	25.2	25.6	26.3	33.9	34.2	33.8	34.5	33.1
August	26.1	25.3	25.2	25.6	25.4	34.2	33.5	33.9	34.6	34.1
September	25.2	24.9	25.1	25.0	25.8	33.5	33.4	33.5	33.7	34.3
October	24.8	25.0	24.5	24.8	24.8	32.6	32.2	32.7	32.8	33.0
November	24.3	24.6	23.6	24.2	24.7	32.3	31.1	31.2	32.4	32.4
December	23.3	23.9	23.5	23.1	23.8	31.6	30.6	30.2	31.4	31.5

Source: Meteorological Service of Jamaica

At the SIA, the minimum temperature recorded over the five-year period 2015 to 2019, was 22.1 °C in February 2015. For 2019, the average minimum monthly temperature recorded was 24.4°C; 0.2°C higher than the five-year average. The minimum monthly temperature for January (22.7°C) and February (22.3°C) 2019, were among the ten lowest recorded during 2015 to 2019. Conversely, two of the three highest minimum monthly temperatures for the five-year period were recorded in July (26.3°C) and September (25.8°C) 2019, indicating that these months were among the warmest (Table 1.3).

The maximum temperature (34.6°C) at the SIA for the period 2015-2019, was recorded in August 2018. For the calendar year 2019, the highest maximum temperature recorded was 34.3°C, which is also the third-highest monthly temperature recorded between January 2015 and December 2019.

In 2019, the temperature, as measured at the SIA ranged from a low of 22.3°C to a high of 34.3°C, a range of 12.0°C (Table 1.3).

At both NMIA and SIA the highest temperatures occurred during the summer months, from June to September and lowest temperatures occurred from December through March.

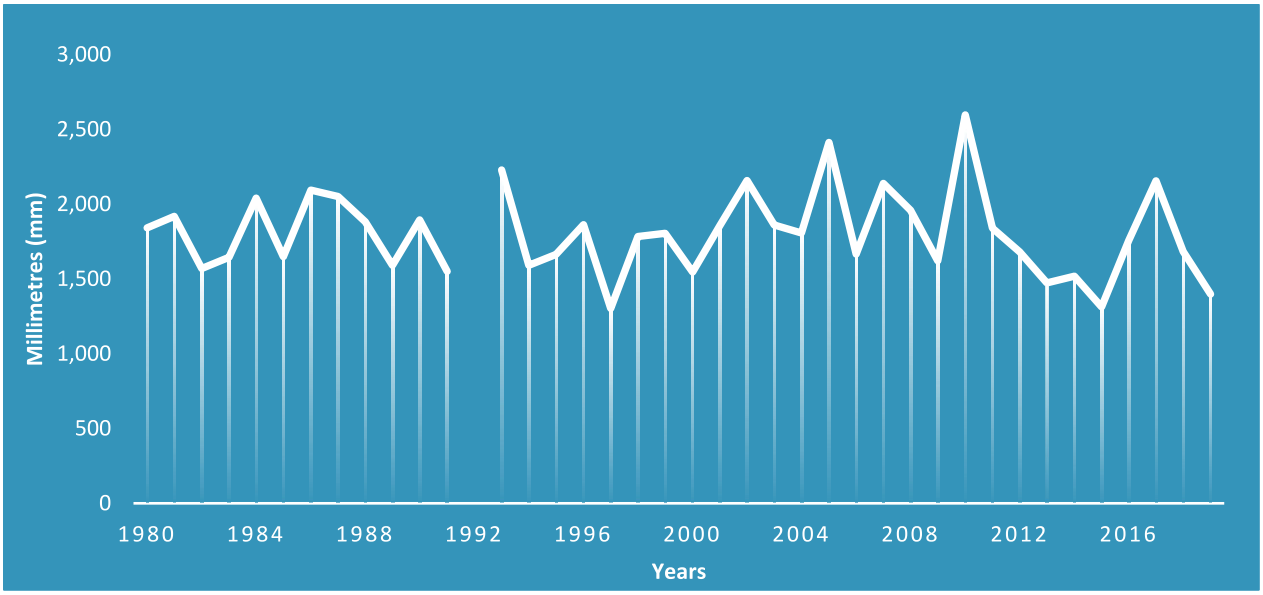
Precipitation

Any form of water descending from the clouds to the ground, which can range from rain to hail, is regarded as precipitation. In Jamaica, the primary form of precipitation experienced is rain. Jamaica has two peak periods of rainfall, referred to as a bimodal rainfall pattern. One from April to June (early rainfall

season), and the other from September to November (late rainfall season). A bimodal rainfall pattern is described as a wet season with two rainfall peaks, separated by at least one dry month. Jamaica's primary peak rainfall typically occurs in October, during the late rainfall season. The secondary peak rainfall period that produces a lower volume of rain typically occurs in May.

From April and June, most rainfall results from the intensity of solar radiation which peaks at that time. During September to November, rainfall is largely a result of tropical weather systems such as the North Atlantic High (NAH) pressure system originating in the Atlantic Ocean. The driest period is usually from December to March, as rainfall is influenced by factors such as cold fronts from North America.

Jamaica's agricultural sector depends heavily on rainfall. Many farmers practice open-field agriculture and depend on rainfall as their primary source of irrigation. Rainfall, therefore, determines which crops are grown, when these crops are grown and influences the price of produce.



Source: Meteorological Service of Jamaica

Figure 1.1 Mean Annual Rainfall: 1980–2019, mm

Over the 40 years (1980–2019) shown in Figure 1.1, mean annual rainfall varied between 1,500 mm and 2,000 mm, except for nine years when rainfall levels were over 2,000 mm. Average annual rainfall levels peaked at 2,597 mm in 2010. According to the National Oceanic and Atmospheric Administration (NOAA) in 2010 the El Niño-Southern Oscillation (ENSO) which affects ocean temperature and winds, went through its warm phase (El Niño) and then its cool phase (La Niña). This resulted in significant influences on temperature and precipitation patterns across the globe. The Atlantic Basin saw an unusually active hurricane season that year. The years 1997, 2013, 2015 and 2019 were the only periods when rainfall levels fell below 1,500 mm (Figure 1.1).

Table 1.4 shows the total mean rainfall by month for the five year period 2015 to 2019. Fluctuations in mean annual rainfall were observed throughout the five years; with data showing a 33.9 per cent increase in 2016 when compared to 2015 and a 17.0 per cent decrease in 2019 compared to 2018. The mean annual rainfall increased by 6.5 per cent in 2019 when compared to 2015.

During January 2018, all parishes in Jamaica recorded above-average rainfall compared to previous years, resulting in a mean rainfall of 270 mm for the month (Table 1.4). The data show a great increase in the volume of rainfall in January 2018 (270 mm) compared to all the other years. The second highest mean rainfall for January being 73 mm. This increase is an anomaly, as it occurred in a month traditionally characterized in the country's dry period.

Table 1.4 shows fluctuations ranging from a low annual average rainfall of 1,314 mm in 2015 to a high of 2,159 mm in 2017 for the reporting period, 2015 to 2019.

Table 1.4 Mean Rainfall by Month 2015–2019, mm

Month	2015	2016	2017	2018	2019
January	94	67	58	270	73
February	71	151	75	88	44
March	108	43	165	75	111
April	80	176	248	115	89
May	128	253	391	227	160
June	39	91	167	56	56
July	72	105	81	72	91
August	106	169	130	111	123
September	107	147	227	169	233
October	218	295	230	208	192
November	163	178	231	217	117
December	128	85	156	77	110
Annual	**1,314**	**1,760**	**2,159**	**1,685**	**1399**

Source: Meteorological Service of Jamaica

In 2017, rainfall levels were fairly high, as total rainfall for the island was 2,159 mm (Table 1.5). The highest total monthly rainfall was 391 mm in May 2017 and resulted from flood rains. In 2017, the parish with the highest rainfall of 4,843 mm, was Portland. Kingston and St Andrew recorded the lowest volume of rainfall (1,541 mm). St Thomas and Manchester had the highest rainfall for the month of September and the highest increase from the previous month. In September 2017, St Thomas recorded 339 mm of rainfall, an increase of 290.0 per cent over August, while Manchester recorded 303 mm, a 191.0 per cent increase. Despite most parishes experiencing an increase in rainfall from August to September, Westmoreland and Hanover recorded a decrease of 24.8 per cent and 2.7 per cent respectively (Table 1.5).

Table 1.5 Mean Monthly Parish Rainfall 2017, mm

Parish	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Kingston & St Andrew	39	65	108	141	261	101	66	70	261	180	136	113	**1,541**
St Thomas	32	57	123	385	404	165	25	87	339	368	339	174	**2,498**
Portland	193	247	580	615	677	279	83	190	297	403	684	595	**4,843**
St Mary	61	45	150	161	280	82	24	98	117	132	296	163	**1,609**
St Ann	112	64	196	191	398	148	54	126	135	154	235	177	**1,990**
Trelawny	95	50	104	147	293	116	70	121	210	137	123	177	**1,643**
St James	60	34	114	128	395	102	128	146	218	183	207	122	**1,837**

Parish	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Hanover	29	59	104	207	380	159	166	225	219	212	150	95	**2,005**
Westmoreland	54	63	110	162	390	106	189	210	158	224	154	72	**1,892**
St Elizabeth	27	95	167	220	326	159	87	151	206	242	170	122	**1,972**
Manchester	11	75	179	296	445	255	40	104	303	170	137	112	**2,127**
Clarendon	11	32	109	268	420	246	31	62	235	294	249	47	**2,004**
St Catherine	27	83	97	306	410	252	91	99	254	292	133	67	**2,111**
Jamaica	**58**	**75**	**165**	**248**	**391**	**167**	**81**	**130**	**227**	**230**	**232**	**157**	**2,159**

Source: Meteorological Service of Jamaica

Table 1.6 shows that during 2018, total rainfall across the island was 1,684 mm. Portland recorded the highest rainfall with 3,191 mm, while Clarendon recorded 1,069 mm of rainfall, the lowest for the year. Jamaica's mountainous inland generally receives more rainfall than the north and south coasts. The country's exterior tends to be significantly drier, with the plains of the south coast being the driest region. High rainfall levels which occur over eastern Jamaica, specifically Portland, are likely due to the convergence of the mountains and sea breeze. The rainfall recorded for January (270 mm) was due to above-average rainfall for parishes such as Portland which recorded 1,042 mm of rainfall. In June and July 2018, the Meteorological Service of Jamaica reported that all parishes recorded below-normal levels of rainfall and that total rainfall for those months was lower than in the previous year.

Table 1.6 Mean Monthly Parish Rainfall 2018, mm

Parish	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Kingston & St Andrew	147	60	28	68	214	16	26	47	135	121	407	33	**1,302**
St Thomas	247	93	28	44	300	31	81	44	139	407	317	97	**1,828**
Portland	1,042	297	212	69	254	58	125	151	248	317	149	269	**3,191**
St Mary	380	159	113	9	165	4	39	24	85	149	141	90	**1,358**
St Ann	443	116	79	71	205	27	44	62	131	141	153	80	**1,552**
Trelawny	173	68	71	147	152	88	67	115	187	153	133	42	**1,396**
St James	323	63	57	145	193	71	86	80	154	133	165	77	**1,547**
Hanover	211	32	63	241	330	142	151	217	217	165	228	46	**2,043**
Westmoreland	114	48	76	213	339	124	119	297	280	228	235	39	**2,112**
St Elizabeth	108	54	103	184	180	42	64	106	204	214	214	53	**1,526**
Manchester	105	14	89	177	247	40	62	98	100	235	235	71	**1,473**
Clarendon	96	41	29	52	195	11	17	38	114	221	221	34	**1,069**
St Catherine	117	98	28	74	180	69	50	168	207	220	220	65	**1,496**
Jamaica	**270**	**88**	**75**	**115**	**227**	**56**	**72**	**111**	**169**	**208**	**217**	**77**	**1,684**

Source: Meteorological Service of Jamaica

Rain days

A rain day is usually defined as a 24-hour period where at least 0.2 mm of rainfall is recorded. The number of rain days recorded at the island's two international airports is shown in Table 1.7. The SIA recorded more rain days for the period 2015 to 2019 than the NMIA. As shown in the previous tables, St. James consistently received more rainfall annually than Kingston.

For the five years, 2015 to 2019, NMIA recorded the highest number of rain days during October (58 days), November (39 days) and May (38 days). The least number of rain days were recorded in April (13 days) and March and June, each with 15 days. For the period, SIA recorded the most rain days in October (61 days), September (54 days) and May (51 days). The least rain days recorded between 2015 and 2019 were in June (25 days) and July (27 days). Both airports recorded the most rain days in 2017 due to excess rainfall in that year. This was the wettest year on record in the last 20 years.

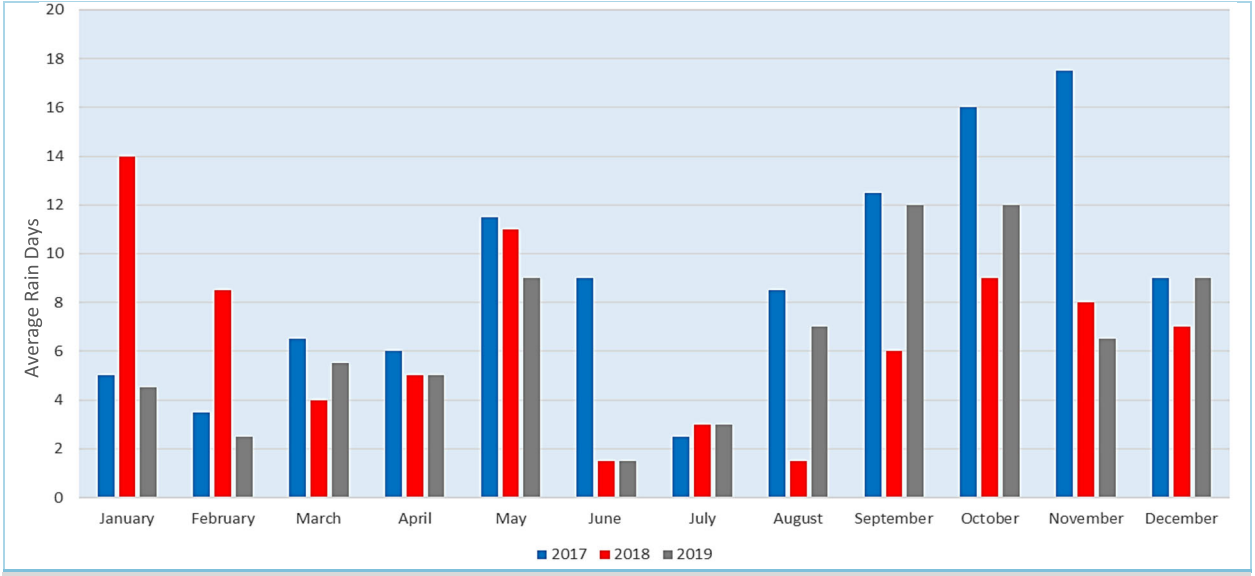
Table 1.7 Number of Rain Days at Selected Airports by Month, 2015 – 2019

	Norman Manley International					Sangster International				
Month	**2015**	**2016**	**2017**	**2018r**	**2019**	**2015**	**2016**	**2017**	**2018r**	**2019**
January	0	3	1	9	3	5	6	9	19	6
February	5	6	3	7	2	6	11	4	10	3
March	3	2	4	3	3	12	4	9	5	8
April	0	4	3	2	4	4	4	9	8	6
May	1	9	8	10	8	8	6	15	12	10
June	0	5	9	1	0	5	6	9	2	3
July	5	6	0	2	3	3	12	5	4	3
August	2	8	5	1	6	7	13	12	2	8
September	1	5	9	6	12	10	10	16	6	12
October	6	11	16	13	12	14	14	16	5	12
November	5	7	14	8	5	4	7	21	8	8
December	7	1	7	5	6	6	7	11	9	12
Total	**35**	**67**	**79**	**67**	**64**	**84**	**100**	**136**	**90**	**91**

Source: Meteorological Service of Jamaica

The average number of rain days for 2017 to 2019 are shown in Figure 1.2. The number of rain days per month was fairly consistent for March, April, May, July, and December 2017 to 2019 with only 0.5 to 2.5 differences between the days. The other months of the year had differences of between 6 - 11 days. The high number of rain days in January 2018 was an anomaly as this was not typical for that time of the year. In October and November 2017, the high rain days were due to heavy rains, particularly on the north coast (Figure 1.2).

Source: Meteorological Service of Jamaica



Source: Meteorological Service of Jamaica

Figure 1.2 Average Rain Days per Month: 2017-2019

Drought

Drought is defined as a long period without rain. There are different definitions for specific types of droughts, namely:

> **Agricultural drought:** a period when soil moisture is inadequate to meet the demands for crops to initiate and sustain plant growth. In areas experiencing agricultural drought, plant life is severely damaged.
>
> **Meteorological drought:** a period of well-below average or normal precipitation (rainfall) that spans from a few months to a few years.
>
> **Hydrological drought:** a period of below-average or normal streamflow and/or depleted reservoir storage. Hydrological drought does not occur at the same time as meteorological and agricultural droughts because it takes longer for the deficiencies to show up in lakes and streams.

As an island, Jamaica is particularly vulnerable to droughts for several reasons. The country's location within the tropics makes it reliant on more than one rainy season. A deficiency in any one of the rainy seasons can result in a shortfall in the renewal of water resources. Low rainfall can affect agriculture production – a source of food and employment. Additionally, approximately 54.0 per cent of Jamaica's population live in urban areas, which contributes to an increased demand for water[2].

[2] https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi

The **standardised precipitation index** (SPI) is a tool that is used to characterise meteorological drought and allows for the determination of the rarity of drought events (or anomalous wet events) on a range of timescales. On short timescales, the SPI is closely related to soil moisture, while at longer timescales, the SPI can be related to groundwater and reservoir storage[3].

Table 1.8 Standardized Precipitation Index Assessment by Month, by Parish - 2018

Parish	Dec 17/ Jan 18	Jan/ Feb	Feb/ Mar	Mar/ Apr	Apr/ May	May/ Jun	Jun/ Jul	Jul/ Aug	Aug/ Sep	Sep/ Oct	Oct/ Nov	Nov/ Dec
Kingston & St Andrew	0.09	0.22	-0.45	-0.66	-0.42	-0.4	-1.06	-1.18	-1.44	-0.87	-0.9	-0.96
St Thomas	1.84	1.84	-0.09	-0.91	0.52	0.1	-1.22	-1.53	-1.32	0.5	0.44	-0.76
Portland	2.54	2.72	0.38	-0.84	-0.79	-0.64	-1.4	-1.22	-0.39	-0.06	-0.71	-1.01
St Mary	0.7	1.91	0.54	-1.06	-0.7	-0.66	-1.55	-1.4	-0.99	-0.28	-0.76	-1.78
St Ann	2.46	3.02	0.73	-0.11	0.21	-0.25	-1.56	-1.25	-0.85	-0.56	-0.83	-1.33
Trelawny	2.17	1.87	0.25	0.14	0.14	-0.09	-0.14	-0.15	0.45	0.23	0.17	-0.32
St James	2.64	2.47	-0.11	0.77	0.43	-1.1	-1.71	-1.68	-1.68	-1.58	-0.73	-0.1
Hanover	1.52	0.74	-0.89	0.54	0.78	-0.53	-1.42	-1.36	-1.32	-1.61	-1.5	-0.73
Westmoreland	1.01	0.69	-0.29	0.78	1.06	0.04	-1.26	-0.26	0.63	0.03	0.11	0.13
St Elizabeth	1.99	0.83	-0.15	0.4	-0.13	-0.87	-1.28	-1.31	-0.26	-0.07	0.59	0.84
Manchester	1.84	0.4	-0.7	0.25	0.27	-0.49	-1.24	-1.05	-1.39	-0.88	-0.01	0.36
Clarendon	1	1.55	-0.04	-0.65	0.32	-0.18	-1.35	-1.35	-0.69	0.16	0.07	-0.96
St Catherine	1.12	1.9	0.31	-0.9	0	-0.16	-0.95	-0.18	0.19	0.27	0.19	-0.05

Standardized Precipitation Index (SPI) Scale

0.00 to -0.50	Near normal	**0.00 to 0.50**	Near normal
-0.51 to -0.79	Abnormally dry	**0.51 to 0.79**	Abnormally wet
-0.80 to -1.29	Moderately dry	**0.80 to 1.29**	Moderately wet
-1.30 to -1.59	Severely dry	**1.30 to 1.59**	Severely wet
-1.60 to -1.99	Extremely dry	**1.60 to 1.99**	Extremely wet
-2.00 or less	Exceptionally dry	**2.00 or more**	Exceptionally wet

Source: Meteorological Service of Jamaica

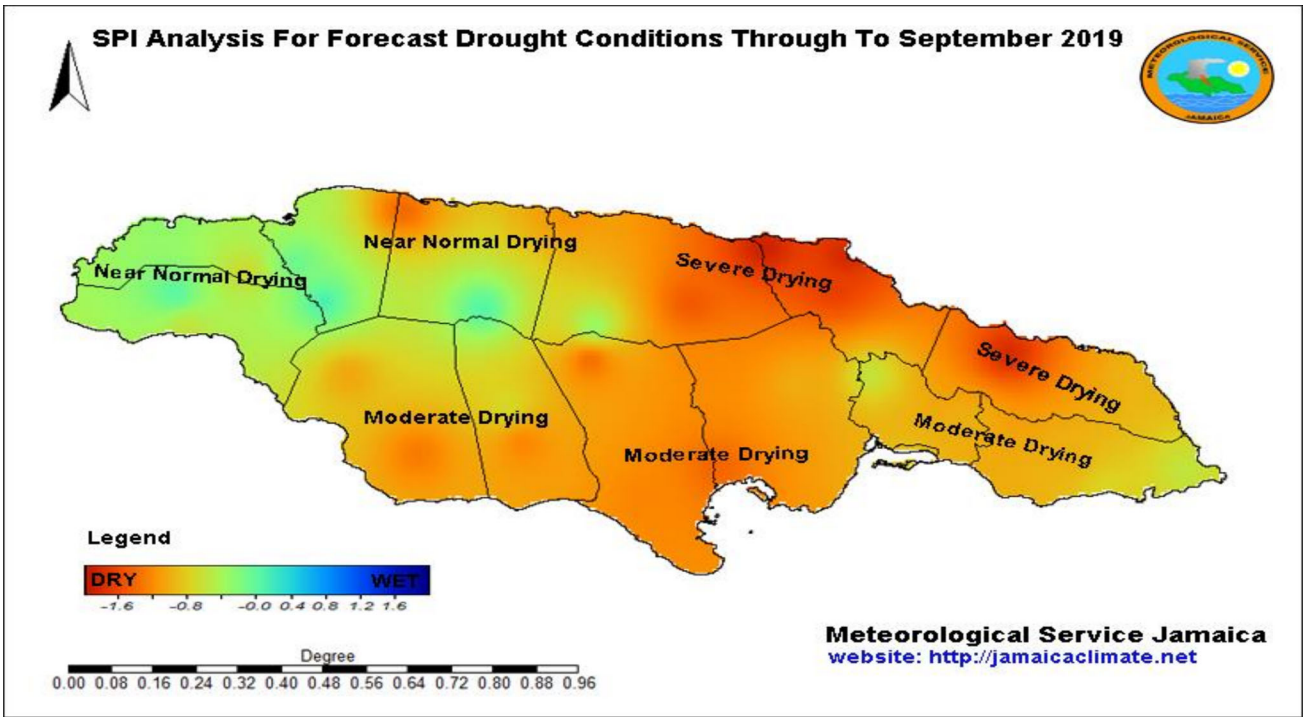
The method used by the Meteorological Service of Jamaica is the Standardised Precipitation Index (SPI), a tool designed to monitor drought conditions based on precipitation. Jamaica uses a two-month time interval to calculate an observed SPI drought index. The SPI scale is shown in Table 1.8; for SPI analysis,

[3] https://climatedataguide.ucar.edu/climate-data/standardized-precipitation-index-spi

positive values above +1 indicate wetter than normal whilst those below -1 indicate drier than normal. Values below -2 are considered to be exceptionally dry, and above +2 to be exceptionally wet. In the Caribbean, a meteorological drought occurs whenever the standardized precipitation index (SPI) is negative for at least two consecutive months and reaches a value of -0.80 or less from November to April or -1.30 or less from May to October.

Table 1.8 shows the SPI results yielded in 2018. The periods December 2017- January 2018 and January - February 2018 were the wettest as they yielded extremely wet to exceptionally wet conditions across several parishes with St Ann recording the highest (3.02). The February-March period recorded mostly near normal conditions with no severely wet or dry period across parishes. The lowest SPI value recorded was in St Catherine for the April-May period. The driest period was the June- July months where all parishes except Trelawny (0.14) and St. Catherine (0.95) experienced moderately dry to severely dry conditions. Manchester and Hanover were the first parishes to experience abnormally dry and moderately dry conditions, respectively (Table 1.8).

Due to the depth of the data provided from SPI results and its ability to cover long periods, it enables the monitoring and forecasting of drought conditions in a given area. This allows the Meteorological Service of Jamaica to provide early warnings for drought.



Source: Meteorological Service of Jamaica

Figure 1.3 Standardized Precipitation Index (SPI) Analysis for Forecast Drought Conditions through to September 2019

Source: Meteorological Service of Jamaica

Figure 1.3 the Meteorological Service of Jamaica used the SPI to issue a three-month drought forecast for the country, with a specific focus on the parishes that would experience severe drying conditions. The Meteorological Service reported that over the three-month period (July to September 2019),

temperatures were likely to be hotter than normal with near normal to below normal rainfall. Additionally, they urged Jamaicans to brace for an increase in heat stress-related impacts such as frequent bush fires, as well as, reduced water inflows in water storage facilities and reservoirs in the July-September season.

GEOLOGICAL AND GEOGRAPHICAL INFORMATION

Geological, Geographical and Geomorphological Conditions

Jamaica is located between latitudes 17°N and 18°N and longitudes 77°W and 79°W and is 145 km south of Cuba, its nearest neighbour. The island is the third largest in the Caribbean after Cuba and Hispaniola. Over 60.0 per cent of Jamaica's altitude is above 230 metres above sea level, making it a primarily mountainous country. A significant feature of the island is the central ridges extending across the length and breadth of the country. In the east, the ridge's apex exceeds 2,100 metres above sea level for at least 16 km, with the highest summit in the Blue Mountains, which peaks at 2,256 metres above sea level. The Blue Mountain Range is made up of igneous and metamorphic rocks and is dissected by a network of steep-sided ravines. The formation of the land contributes to surface drainage through an extensive network of streams and rivers. Limestone rocks largely make up the remainder of the island. Few igneous and metamorphic rocks can be found. Surface drainage, in the form of rivers, is far less dominant in these limestone areas. Jamaica is also home to the Kingston Harbour to the southeast, the seventh-largest natural harbour in the world.

The island has a warm tropical climate. Most areas experience two wet seasons – April to June and September to November. Some regions on the south coast, such as the Liguanea Plain and the Pedro Plains, are relatively dry rain-shadow areas.

The climate is influenced by several factors, including the northeast trade winds, the mountain ranges that run through the centre of the island, the warm waters of the Caribbean Sea and weather systems such as upper- and low-level pressure systems, troughs and cold fronts. The cold fronts migrate from North America, usually between October to April. Tropical weather systems such as tropical waves, depressions, storms and hurricanes occur from April to December. Jamaica is also located in a seismically-active part of the world. The Enriquillo–Plantain Garden fault zone (EPGFZ), a system of strike-slip faults, runs along the southern side of the Dominican Republic and Haiti and through the Plantain Garden River region in Jamaica. Seismic activity, therefore, creates additional risks for the island's population and infrastructure.

HYDROGRAPHICAL CHARACTERISTICS

Coastal waters (including areas of coral reefs and mangroves)

Jamaica has 1,022 km of coastline that mainly consists of:

- 1,240 km^2 of coral reefs consisting of approximately 64 hard coral species, 43 soft coral species and 8 black coral species, sponges and other living organisms.

Sub-Component 1.5 Environmental Quality - provides additional data on coral reefs.

- Seagrass beds found around large parts of the shoreline, mainly up to 10 metres in depth.
- 290 km of mangrove and swamp forests, which currently account for almost 10,000 hectares.
- Approximately 300 beaches (primarily white sand beaches) made from calcareous material. A number of beaches have eroded due to natural and human-induced causes related to sea-level rise; intense

storms and hurricanes; damage or clearing of coral reefs, seagrass beds and mangroves; illegal sand mining and hotel developments that do not fully comply with the setback limits.

- Rocky coastline which accounts for almost half of Jamaica's total coastline.
- Wetlands (more commonly known as morass) make up less than 2.0 per cent of Jamaica's total surface area and are largely found in the coastal zone. They are among the most biologically productive ecosystems and are great contributors to ensuring coastal stability. Coastal wetlands that sustain mangrove growth are important as marine nurseries and as sources for shellfish harvesting.

Wetlands have several functions including:

- Shoreline protection — coastal wetlands protect the shoreline from erosion by acting as a buffer against wave action, as seen in coastal mangroves.
- Flood protection — coastal marshlands reduce the effects of floods on coastal areas by acting as a sponge and slowing flood waters. Without wetlands, the full force of flood waters would lead to erosion of river banks and the extermination of coral reefs.
- Sediment trap — sediment produced by erosion from upland areas settles out when the water flow slows upon entering wetlands. This helps in preventing the silting of rivers and flooding of adjoining areas. As a sediment trap, wetlands also protect marine resources such as coral reefs and seagrass beds from being smothered by silt brought down by rivers and streams.
- Wildlife habitat and nursery area — Jamaica's coastal wetlands support a rich indigenous flora and fauna, including several endemic species. Wetlands support various species of birds, crabs, fish, shrimp and the American crocodile. The Black River Morass, for example, has been described as the best area in Jamaica for all water birds and is known to be the only area where the flamingo nests occasionally. Commercially-important species that use wetland as a breeding and nursery area include snapper, snook, tarpon, jack and several fresh and brackish water shrimp species.
- Land building — mangrove wetlands are considered to be land builders. As a result of their root system being anchored below water, mangroves slow down water movement and trap suspended materials and the remains of organisms associated with the mangroves. The build-up of this organic material helps to raise the soil level. Continued accumulation of soil, particularly by sea-fringing mangrove stands, builds the shoreline seaward.

SUB-COMPONENT 1.2 LAND COVER, ECOSYSTEMS AND BIODIVERSITY

ECOSYSTEMS AND BIODIVERSITY

Ecosystems are found in forests, mountains, fresh and marine waters, deserts and agricultural land. It is the interactions within the ecosystems that make Earth habitable. Biological diversity or biodiversity is the variety of living organisms – the variations within species, between species and of their ecosystems. Forests, mountains, lakes, rivers, deserts and agricultural landscapes are biodiverse ecosystems.

Ecosystem
An **ecosystem** consists of living and non-living organisms that interact as a system, with each having its role to play.

Figure 1.4 illustrates the structure of an ecosystem. An ecosystem is categorized into its abiotic components, non-living things such as climate, soil, water and sunlight and its

biotic components, consisting of all living things. The sun generates the energy used by producers or autotrophs (largely consisting of green vegetation) to help maintain their life processes. Organic matter created by autotrophs helps sustain consumers or heterotrophs that cannot make their own food.

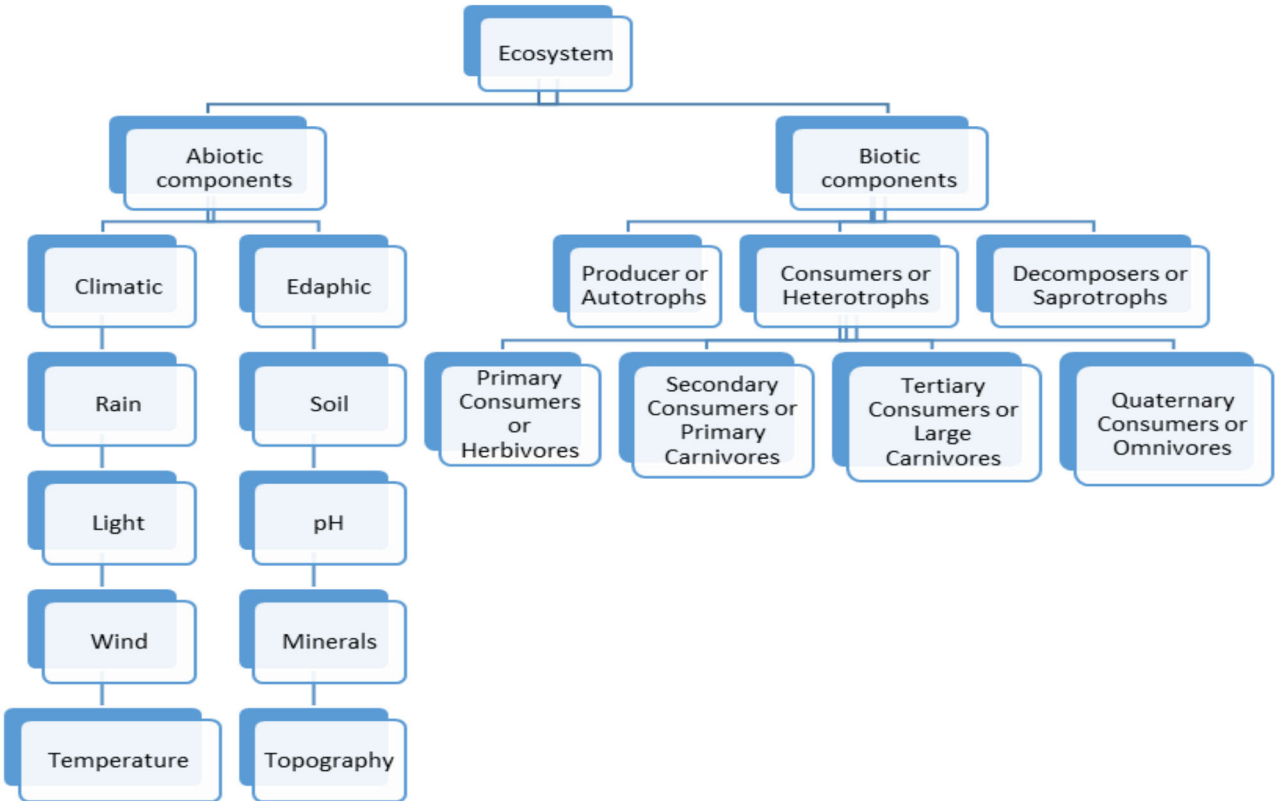


Figure 1.4 Structure of an Ecosystem[4]

The goods and services provided by ecosystems are essential to socio-economic development through the provision of:

i) commodities such as freshwater, oxygen, fish, wood, medicine, oil, resin and leaves;

ii) genetic material to produce new varieties of crops to maintain food security, improve nutrition and support adaptation of agriculture to climate change;

iii) pollinators such as bees and other insects for crops, flowers and trees, which provide by-products such as honey, wax and resins;

iv) protection, by acting as regulators of rainwater (forests), an obstacle for pests and disease, and a barrier to tsunamis, high tides and storm surges (mangroves and coral reefs); and

v) production of oxygen and the fixing of carbon dioxide (CO_2) in the soil, which helps prevent global warming.

[4] http://www.yourarticlelibrary.com/environment/ecosystem/ecosystems-concept-structure-and-functions-of-ecosystems-with-diagram/28211

Source: State of the Environment Report 2013, NEPA

International Union of Conservation and Natural Resources (IUCN)

The IUCN Red List provides an approach to evaluating the conservation status of plant and animal species. The Red List has nine categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, deficient and not evaluated.

Species

Table 1.9 State of Animals and Plants in Jamaica on IUCN Red List: 2015-2019

Category	2015		2016		2017		2018		2019	
	Animals	Plants	Animals	Plants	Animals	Plants	Animals	Plants	Animals	Plants
Extinct	4	2	4	2	3	2	3	2	3	2
Extinct in the wild	–	–	–	–	–	–	–	–	–	–
Critically endangered	19	41	20	41	22	41	21	41	25	41
Endangered	20	55	30	55	32	55	32	56	37	56
Vulnerable	47	118	47	118	48	118	50	118	47	118
Near Threatened	40	75	41	75	41	75	40	76	43	76
Lower Risk	–	–	–	–	–	–	–	–	–	–
Data Deficient	84	7	89	7	87	7	85	7	87	7
Least Concern	1,140	114	1,149	135	1173	146	1183	184	1314	195
Total	**1,354**	**412**	**1,380**	**433**	**1,406**	**444**	**1,414**	**484**	**1556**	**488**

Source: IUCN Red List version 2015.4, 2016.3, 2017.3, 2018.2 and 2019.1

-nil or negligible

Table 1.9 summarises the animals and plants that have been classified by the IUCN over the period 2015 to 2019. Three animals were extinct in 2019 compared to four in 2015. There were 25 critically endangered animals in 2019, an increase of four over the previous year. The number of vulnerable animals decreased from 50 in 2018 to 47 in 2019. Animals that were characterized as being of least concern increased from 1,140 in 2015 to 1,314 in 2019, an increase of 15.3 per cent.

There were minimal changes in the categories of plants throughout the period 2015 to 2019, Table 1.9. The category 'Least Concern' moved from 114 in 2015 to 195 in 2019, an increase of 71.1 per cent.

The practice of identifying different organisms, classifying same and naming the categories is called taxonomy. All organisms, whether living or extinct, are classified into individual groups with other similar organisms and given a scientific name. Threatened species are those that have been placed in any of the three Red List categories of 'Critically Endangered', 'Endangered'and 'Vulnerable' by the IUCN.

Table 1.10 Threatened Species by Taxonomic Group: 2015-2019

Species	2015	2016	2017	2018	2019
Mammals	6	6	6	7	7
Birds	10	10	10	11	10
Reptiles*	10	21	25	25	28
Amphibians	15	15	15	15	15
Fish*	30	30	31	30	34
Molluscs*	–	–	–	–	–
Other Invertebrates*	15	15	15	15	15
Plants*	214	214	214	215	215
Total	**300**	**311**	**316**	**318**	**324**

Source: IUCN Red List version 2015.4, 2016.3, 2017.3 2018.2, and 2019.3

— nil or negligible

Note: Reptiles, fish, molluscs, other invertebrates and plants: please note that for these groups, there are still many species that have not yet been assessed for the IUCN Red List and therefore their status is not known (i.e., these groups have not yet been completely assessed). Therefore the figures presented for these groups should be interpreted as the number of species known to be threatened within those species that have been assessed to date, and not as the overall total number of threatened species for each group.

Table 1.10 shows the changes in the threatened species between 2015 and 2019. The number of reptiles categorized as threatened increased by 18 between 2015 and 2019, moving from 10 to 28 respectively (Table 1.10). There was an increase of 8.0 per cent in the total number of threatened species over the five years 2015 to 2019. No change was recorded for mammals, amphibians and other invertebrates between 2018 and 2019, thus they remained at 7, 15 and 15 respectively. An additional mammal was added to the list in 2018, moving from six to seven mammals. The number of plants that are categorized as threatened remained stable at 214 from 2015-2017, in 2018 it increased to 215.

Table 1.11s provides data on six endemic and threatened groups. Endemic species are found in one particular region of the world and nowhere else. As a result, endemic species are more susceptible to extinction. Except for cycads, all species were threatened between 2016 and 2018. *No data was available in 2019 for mammals, birds, amphibians, conifers and cycads.*

Table 1.11 Total Endemic and Threatened Species by Taxonomic Group: 2016-2018

Species	2016		2017		2018	
	Endemic	Threatened	Endemic	Threatened	Endemic	Threatened
Mammals	7	4	7	4	7	4
Birds	31	5	31	5	31	5
Amphibians	21	15	21	15	21	15
Conifers	2	2	2	2	2	2
Cycads	–	–	–	–	1	–
Cacti	5	2	5	2	5	2

Source: IUCN Red List version 2015.4, 2016.3, 2017.3 and 2018.2

— nil or negligible

Note:- * Reptiles, fish, molluscs, other invertebrates and plants: please note that for these groups there are still many species that have not yet been assessed for the IUCN Red List and therefore their status is not known (i.e. these groups have not yet been completely assessed). Therefore, the figures presented for these groups should be interpreted as the number of species known to be threatened within those species that have been assessed to date, and not as the overall total number of threatened species for each group.

Unregulated international trade in flora and fauna resulted in considerable threat to the world's species of wild fauna and flora several decades ago. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was created to ensure that no species of wild fauna or flora becomes, or remains, subject to unsustainable exploitation because of international trade. On March 3, 1973, Jamaica signed the CITES, which was entered into force on June 22, 1997. Jamaica later enacted the Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000) to regulate the trade in endangered species of wild fauna and flora.

Anyone desirous of trading in endangered species of wild fauna and flora must submit a special application to NEPA and await approval. Table 1.12 shows the number of CITES application permits that NEPA issued during the five-year period 2015 to 2019. The number of permits issued throughout the period ranged from a high of 190 in 2015 to a low of 94 in 2019. The largest number of permits were issued in May (107).

Table 1.12 CITES Application Permits/Certificates Issued by Month: 2015 – 2019

Month	2015	2016	2017	2018	2019	Total
January	26	20	20	2	2	70
February	11	5	19	12	14	61
March	26	18	21	5	1	71
April	15	2	2	4	1	24
May	30	0	22	20	35	107
June	11	10	0	4	7	32
July	9	23	16	4	10	62
August	9	13	21	11	7	61
September	14	9	20	11	6	60
October	19	9	11	17	3	59
November	16	5	8	7	8	44
December	4	13	19	15	0	51
Total	**190**	**127**	**179**	**112**	**94**	**702**

Source: National Environment and Planning Agency

Note:- CITES (Convention on International Trade in Endangered Species) is an international agreement between governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Permits may be issued for, among others, the export of orchids, conch meat, parrots, iguana, birds, snakes, frogs, crocodile & manatee liver tissue; and for the import of dolphins, other animals and watch bands made from alligator skins.

SUB-COMPONENT 1.5 ENVIRONMENTAL QUALITY

AIR QUALITY

As countries become more urbanised, their economic activities rely increasingly on the combustion of fossil fuels leading to an increase in outdoor air pollution. In Jamaica, the main sources of poor air quality are emissions from industrial sources, motor vehicles, 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 FDES describes residuals as "flows of solid, liquid and gaseous materials, and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation"[5]. Component 3 describes residuals that are emitted into the air, water or soil, wastewater and waste. Component 3 also describes the release of residuals from the application of chemical substances.

PM_{10} are particulate matter less than ten microns or ten millionths of a metre that can lodge in airways and cause respiratory problems. $PM_{2.5}$ are more perilous and can be breathed deep into the lungs. They are so minuscule that they can cross over into the bloodstream.

Table 1.13 Mean Concentration (µg/m3) of Particulate Matter <10 microns (PM10) at Monitoring Sites, 2014-2018

Location	2014		2015		2016		2017		2018	
	Annual Average (µg/m³)	No. of times	Annual Average (µg/m³)	No. of times	Annual Average (µg/m³)	No. of times	Annual Average (µg/m³)	No. of times	Annual Average (µg/m³)	No. of times
Cross Roads	42.48	0	46‡	0	---	---	---	0	37	1
Harbour View	0	0	40^	0	^%	^%	46^	0	41^	2
PMA Branch (Old Hope Road)	35.31	0	37‡	0	31‡	0	33^	0	29	0
Portmore	50.65*	0	57‡*	0	41‡	0	---	---	---	---
Spanish Town Road	66.00*	0	71*	0	67‡*	0	63‡*	n.a.	67*	1
Washington Gardens	0	2	---	---	---	---	---	---	---	---

Source: National Environment and Planning Agency

* indicates annual average is greater than annual ambient standard.
--- indicates site was not monitored during the year due to issues with monitoring equipment
^ indicates data obtained from industry-operated monitor
% indicates data not yet available; Agency has not yet received all monitoring reports from the site
‡ indicates data did not meet the 75% recovery rate as stipulated in the NRCA guideline document.
High levels of particulate matter (PM_{10} and smaller) have been linked with upper respiratory illnesses

Testing for PM_{10} was undertaken at six locations in the Greater Kingston Metropolitan Area in 2018. Since 2014, the Spanish Town Road station has consistently recorded annual average ambient levels of PM_{10} that are higher than the standard. This may be attributed to the fact that Spanish Town Road is one of Kingston's most heavily trafficked thoroughfares. The station is also located close to the Riverton City

[5] Framework for the Development of Environment Statistics (FDES 2013)

landfill, the country's major garbage disposal site, which occasionally catches on fire.

Freshwater quality

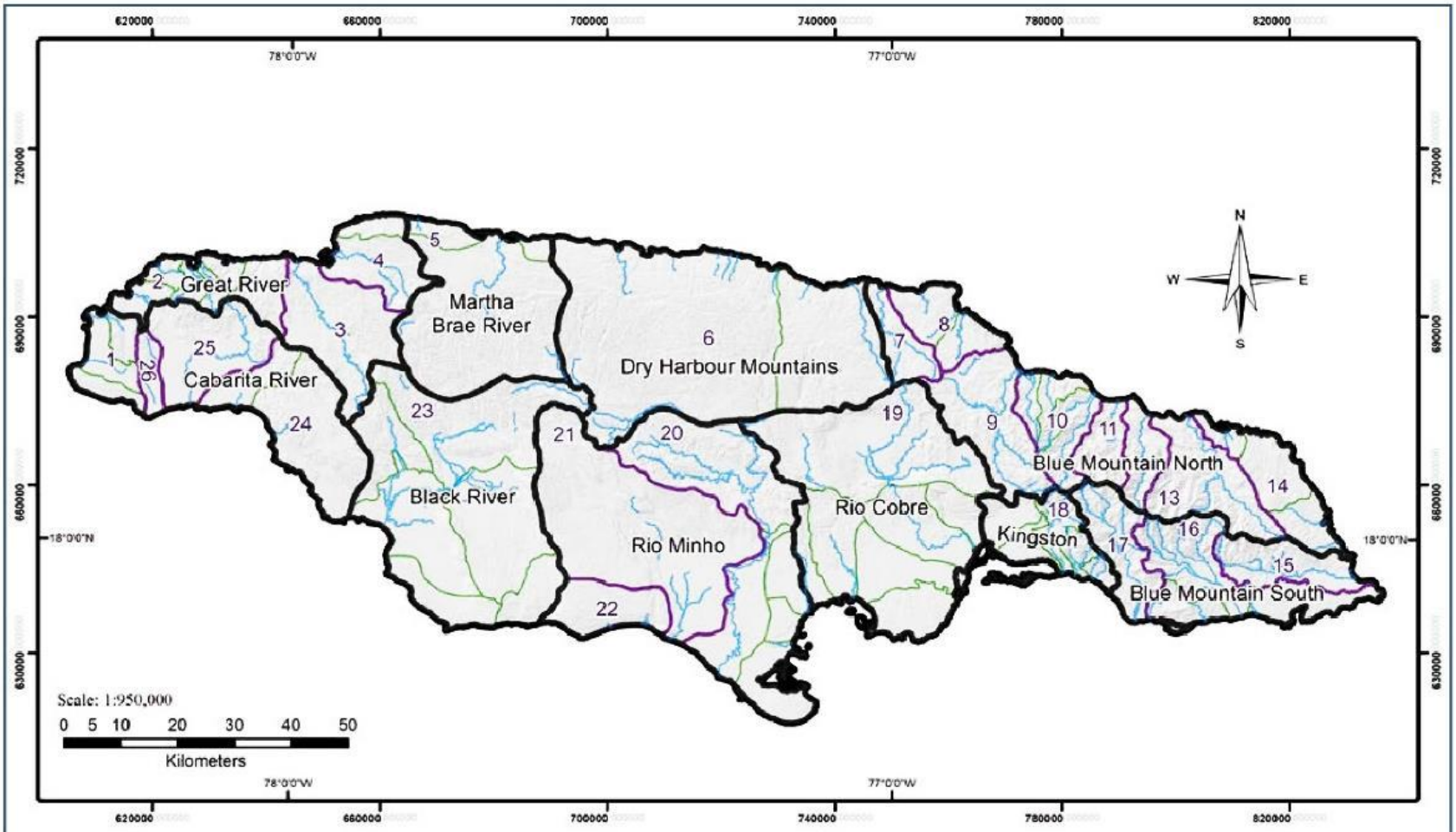
Water quality may be defined as the suitability of water for a particular use based on selected physical, chemical and biological characteristics. The safety and quality of the water that humans consume are of great importance to their overall development and well-being. The provision of access to safe drinking water is a critical factor in promoting health, reducing poverty and protecting ecosystems.

The World Health Organization (WHO) is the international authority on public health and water quality. The WHO states that poor access to sufficient quantities of water may not only contribute significantly to water-related diseases but is also closely linked to the health of an ecosystem[6]. Water ecosystems contribute to the replenishment and purification of water resources essential to human health and well-being.

Freshwater can be contaminated by bacteria and chemicals, turbidity, colour and acidity caused by physical or chemical changes. Sources of contaminants include agricultural runoff, household waste and industrial discharges. Additionally, contaminants can seep from underlying waste disposal systems, soak-away pits, bauxite waste and underground petroleum storage tanks. This can have adverse effects on the quality of freshwater.

Various government bodies, including the Ministry of Health & Wellness (MoHW), the Water Resources Authority (WRA), the National Environment and Planning Agency (NEPA) and the National Water Commission (NWC), monitor water quality across Jamaica. These agencies monitor various parameters such as biochemical oxygen demand (BOD), pH, total coliform, faecal coliform and nitrate nitrogen.

[6] WHO – Water, Health and ecosystems. https://www.who.int/heli/risks/water/water/en/



LEGEND

- Hydrologic Basin
- Watershed Management Unit Divide
- Sub-Watershed Management Unit Divide
- Perennial River

Hydrologic Basin	WMU	Hydrologic Basin	WMU
1-Blue Mountain South	15-Plantain Garden River	7-Great River	2-Lucea River
	16-Morant River		3-Great River
	17-Yallahs River		4-Montego River
2-Kingston	18-Hope River	8-Martha Brae River	5-Martha Brae River
3-Rio Cobre	19-Rio Cobre	9-Dry Harbour Mountains	6-Rio Bueno – White River
4-Rio Minho	20-Rio Minho	10-Blue Mountain North	7-Rio Nuevo
	21-Milk River		8-Oracabessa – Pagee River
	22-Gut-Alligator Hole		9-Wagwater River
5-Black River	23-Black River		10-Pencar - Buff Bay River
6-Cabarita River	24-Deans Valley River		11-Spanish River
	25-Cabarita River		12-Swift River
	26-New Savannah River		13-Rio Grande
	1-South Negril – Orange River		14-Drivers River

Water Resources Authority

Coordinate System: Lambert Conformal Conic JAD 2001 Grid
Datum: WGS1984
False Easting: 750,000
False Northing: 650,000
Central Meridian: -77
Latitude of Origin: 18
Standard Parallel 1: 18
Standard Parallel 2: 18
Units: Meter

Figure 1.5: Hydrologic Basins & Watershed Management Units , 2019

Watersheds are an important ecosystem. Watersheds provide several ecosystem services which include providing habitats for a wide range of species, protection from flooding and refilling stream channels so that water is always available. Healthy watersheds mean better water quality and quantity downstream.

2 billion

People worldwide use water source contaminated by faeces (WHO).

Jamaica has 10 hydrologic basins that are further divided into 26 watershed management units (WMUs) which contain over 100 streams and rivers (Figure 1.5). The total land area of all 10 basins is 10,949 square kilometres. The largest basin is Basin IV-Rio Minho with an area of 1,814 square kilometres. The largest WMU is Rio Cobre (the basin and WMU have the same boundary) with an area of 1,257 square kilometres.

Table 1.14 Watershed Areas with Freshwater Sites within Acceptable Standards/Range: 2015–2019

	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
	Nitrate 0.1-7.5 mg/l					Phosphate 0.01-0.80 mg/l				
All	18	N/D	3	8	8	13	N/D	3	5	**7**
Most	4	N/D	5	0	1	9	N/D	5	3	**1**
Few	3	N/D	0	0	0	2	N/D	0	0	**1**
Total no. of WS areas	**25**	**N/D**	**8**	**8**	**9**	**24**	**N/D**	**8**	**8**	9
	BOD (0.80-1.70 mg/l)					Faecal Coliform 0.0-1000 MPN/100ml (WHO)				
All	7	2	0	0	3	0	3	0	0	**2**
Most	14	6	3	7	5	3	2	1	1	**0**
Few	4	5	5	1	1	22	8	7	7	**7**
Total no. of WS areas	**25**	**13**	**8**	**8**	**9**	**25**	**13**	**8**	**8**	**9**

Source: National Environment and Planning Agency
BOD – biochemical oxygen demand
Note:- MPN – most probable number
All - 100% of the samples met all the standards
Most - 50% - 99% of the samples\ met all the standards
Few - Less than 50% of the samples met all the standards

Table 1.14 shows the number of watersheds assessed for the acceptable levels of biochemical oxygen demand (BOD) and faecal coliform in freshwater sites between 2015 and 2019. Of the nine sites assessed for faecal coliform in 2019, 78.0 per cent met less than 50.0 per cent of the standards. No assessment was performed for nitrate or phosphate in 2016. The data show a 64.0 per cent decline in the number of sites assessed for all standards from 2015 to 2019. Of the nine watersheds tested for nitrate in 2019, eight met all the standards and one met most of the standards (Table 1.14). See *Appendix I* for additional freshwater quality standards.

MARINE WATER QUALITY

It is estimated that more than one-third of the world's population lives within 100 kilometres of a seashore (WHO). The quality of coastal and marine waters is affected by the discharge of sewage, urban runoff and agricultural and industrial effluent. Recreational activities, with the accompanying disposal of waste into the sea, also affect coastal water quality.

Samples were collected from marine sites from 2015 to 2019 and analysed for nitrate, phosphate,

biochemical oxygen demand and faecal coliform to determine the level of contaminants (Table 1.15). High levels of nitrates and phosphates accelerate the growth of algae, which can smother coral reefs. Table 1.15 shows that of the 11 sites assessed for nitrate, phosphate and faecal coliform in 2018 and 2019, none of the samples met all the standards. In 2019, of the 10 sites assessed for BOD, one site met all of the standards (Table 1.15). *Appendix II* lists the parameters that are tested and the acceptable level at which they are assessed.

Table 1.15 Watershed Areas with Marine Sites within Acceptable Standards/Range: 2015-2019

	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
	Nitrate (0.007–0.014mg/l)					Phosphate (0.001–0.003 mg/l)				
All	3	N/D	0	0	0	3	N/D	0	0	0
Most	9	N/D	0	0	4	10	N/D	1	0	1
Few	12	N/D	11	11	6	11	N/D	10	11	9
Total no. of WS areas	**24**	**N/D**	**11**	**11**	**10**	**24**	**N/D**	**11**	**11**	**10**
	BOD (0.0–1.16mg/l)					Faecal coliform (<2–13 MPN/100ml)				
All	4	2	0	0	1	6	4	0	0	0
Most	15	8	5	5	7	16	9	6	7	6
Few	4	4	6	6	2	1	1	5	4	4
Total no. of WS areas	**23**	**14**	**11**	**11**	**10**	**23**	**14**	**11**	**11**	**10**

Source: National Environment and Planning Agency

BOD – biological oxygen demand
WS – watershed
ND: No data available
Note:- MPN – most probable number
All - 100% of the samples met all the standards
Most - 50% - 99% of the samples\ met all the standards
Few - Less than 50% of the samples met all the standards

Plastic waste and other marine debris

Jamaica participates in the International Coastal Clean-up Day Initiative through the efforts of the Jamaica Environment Trust, a non-governmental organization. There has been a gradual increase in the number of clean-up sites over the five year period, 2015 to 2019. In 2015, 121 coastal clean-up sites were selected. This increased by 61 sites in 2019 (Table 1.16). 72,860 kg of garbage was collected in 2017, this was the highest weight recorded over the five year period, an increase of 101.9 per cent when compared to 2015 (Table 1.16). In 2019, 12,403 volunteers participated in the annual event, this was the highest number of registered volunteers in the event's history (Table 1.16). The most common items collected were beverage bottles (plastic), bottle caps (plastic), foam pieces, plastic pieces, other plastic bags, food wrappers, plastic cups and plates, glass beverage bottles and foam cups and plates. The most frequently collected item for the five years was beverage bottles made of plastic.

Table 1.16 International Coastal Clean-up Day Jamaica: 2015–2019

Parameters	2015	2016	2017	2018	2019
Coastal clean-up sites	121	138	147	150	182
Garbage collected (kg)	36,088	49,638	72,860	46,652	66,300
Garbage bags filled	5,258	6,669	7,425	6,940	9,225
Volunteers (registered)	7,985	9,276	9,675	9,332	12,403
Coastline cleaned (km)	196	151	167	209	201

Source: Jamaica Environment Trust

On September 24, 2018, the Government of Jamaica announced that commencing January 1, 2019, there would be a ban on single-use plastic shopping bags 24" × 24" in size, single-use plastic straws and Styrofoam food and drink containers.

Beach erosion

Beach erosion is a continuous natural process whereby soil and sand are removed by wind and water. Although erosion is a natural process, human activities have caused the rate of erosion to increase. Activities such as illegal sand mining, dumping of mangroves and swamps and construction along the shoreline contribute to beach erosion. Beaches are also eroded as a result of storm surges, sea-level rise, hurricanes and discharge from rivers.

Jamaica's coastline is home to a unique ecosystem formed by the integration of coastal features such as harbours, bays, beaches, rocky shores, estuaries, mangroves, swamps, cays and coral reefs[7]. Beach erosion affects flora and fauna as well as buildings, fishing and recreational activities.

Table 1.17 Cumulative Summary of Beach Erosion: 2016 – 2019

Parish/Localities	No. of Sites	Cumulative Mean Beach Width (m)		% Change	No. of Sites	Cumulative Mean Beach Width (m)		% Change
		2016	2017			2018	2019	
Kingston	9	48.4	52.5	8.47	9	48.8	50.8	4.10
Portland	5	25.4	25.3	-0.39	5	23.3	23.1	-0.86
Trelawny	2	19.0	18.3	-3.68	2	21.0	17.5	-16.67
Westmoreland (Other)	2	15.2	15.3	0.66	2	14.2	14.8	4.23
Negril (Hanover/Westmoreland)	14	32.6	36.3	11.35	14	34.9	36.0	3.15
Clarendon	2	22.4	27.2	21.43	2	25.0	29.2	16.80
Hellshire	5	49.3	_	_	5	36.7	37.6	2.45
St. James	_	_	_	_	4	39.7	26.5	-33.25
Average		**30.33**	**29.15**	**6.31**		**30.45**	**29.44**	**-2.51**

Source: National Environment and Planning Agency

In 2017, there was a 6.31 percentage change in the mean beach width when compared to the previous year (Table 1.17). Of the two beach sites assessed in Clarendon in 2016 and 2017, there was an increase of 21.43 per cent in beach width. The width of assessed beaches in Kingston increased by 8.47 per cent and those in Portland declined by 0.39 per cent. The beaches that were assessed in Trelawny recorded a decrease in width of 3.68 per cent between 2016 and 2017 (Table 1.17).

There was a 2.51 per cent decrease in beach width for the beaches assessed in 2019 compared to 2018 (Table 1.17). Between 2017 and 2018, NEPA added four beach sites in the parish of St James for

[7] National Environment and Planning Agency.

assessment. Of the four beach sites assessed in St James in 2018 and 2019, there was a decrease of 33.25 per cent in beach width. The width of assessed beaches in Trelawny declined by 16.67 per cent and those in Portland declined by 0.86 per cent. Clarendon and Hellshire beaches recorded an increase in beach width of 16.80 and 2.45 per cent respectively, between 2018 and 2019.

All the beaches assessed in 2017 decreased in width when compared to 2019 except for those in Clarendon which increased by 2.0 metres. The beaches in Kingston decreased by 1.7 meters in width when assessed between 2017 and 2019. No assessment was conducted at Hellshire or in St. James during 2017 (Table 1.17).

Table 1.18 Jamaica's Coral Reef Health Index by Location: 2014 – 2015 and 2017 – 2019

Location	2014	2015	2017	2018	2019
Blue Lagoon (Portland)	2.3	2.3	n.a.	n.a.	n.a.
Oracabessa Bay Special Fishery Conservation Area	2.2	1.9	1.9	2.4	2.5
Sandals Boscobel Special Fishery Conservation Area	2.7	2.5	3.1	2.8	2.4
Ocho Rios Marine Park	2.2	2.4	2.4	2.3	2.8
Discovery Bay	1.7	2.2	2.1	2.1	2.3
Falmouth	2.3	2.1	2.4	1.8	3.1
Montego Bay Marine Park	2.3	2.3	2.3	2.4	2.8
Hopewell - Green Island (Hanover)	2.3	3.0	3.8	2.3	3.3
Negril Marine Park	2.2	2.3	2.2	2.2	3.0
Sandals Whitehouse Special Fishery Conservation Area	1.8	2.3	1.8	2.3	3.3
Port Royal Protected Area	1.3	2.1	1.8	1.8	2.4
Belmont	n.a.	2.5	2.0	2.3	2.5
Savanna-la-mar	n.a.	2.3	1.8	n.a.	n.a.
Portland Bight Protected Area	n.a.	2.0	2.0	2.2	2.5
CRHI (overall mean)	**2.1**	**2.3**	**2.3**	**2.2**	**2.7**

Source: National Environment and Planning Agency

Note: CRHI – Coral Reef Health Index
n.a. – not available
N.B. In 2018 and 2019 Monkey Island (Portland) had a CRHI of **2.5** and **4.3** respectively

Natural and human-induced stressors have negatively impacted coastal ecosystems which caused a decline in coral cover from 50.0 per cent in the 1970s to less than 5.0 per cent in the early 1990s[8]. NEPA commenced the monitoring of coral reefs in 2001 to effectively manage and recover Jamaica's reef systems and currently provides data on Jamaica's coral reef health. The data show that there have been improvements in the health of coral reefs over the period 2014 to 2019. *Appendix III* provides further details on the coral health of several sites in 2019.

[8] National Environment and Planning Agency

Table 1.19 Coral Reef Health Index

Rating	Value
Very Good	> 4.2–5.0
Good	> 3.4–4.2
Fair	> 2.6–3.4
Poor	> 1.8–2.6
Critical	1.0–1.8

Source: National Environment and Planning Agency

Table 1.19 shows the index used to assess the health of coral reefs in Jamaica. In 2019, the overall coral reef health index was 2.7 (Table 1.18). Prior to 2019, Jamaica had consistently recorded a poor rating based on the coral reef health index (Table 1.18).

COMPONENT 2: ENVIRONMENTAL RESOURCES AND THEIR USE

Environmental resources are naturally occurring materials of living and non-living components which are valuable to mankind. These can be anything useful, including food from plants and animals to wood for heating, cooking and building, metals, fossil fuels, water, air and land. Often, these resources have competing uses and values. For example, land can be used for human settlements, agriculture and recreation or commercial activities.

Some resources are infinite or renewable; others are finite or non-renewable. Resources such as energy from the sun are renewable and will be available for a long time. Finite resources such as fossil fuels and most minerals, once extracted, cannot be used more than once and are usually in limited supply. Statistics on environmental resources and their use examine the stocks, changes and use of the resource.

SUB-COMPONENT 2.1 MINERAL RESOURCES

Minerals can be metallic or non-metallic. Metallic minerals are minerals such as iron, aluminium and copper. Examples of non-metallic minerals are sand, stone, salt and phosphates.

Minerals occur naturally in the Earth's crust and are an integral part of people's daily lives. “Development Minerals are defined as minerals and materials that are mined, processed, manufactured and used domestically in industries such as construction, manufacturing, and agriculture.” For example, steel is an essential building material and is a blend of iron and other metals. Also, aluminium is used in the manufacture of beverage cans, aircraft, automobiles and buildings. Copper, a conductor for electricity, is used for electrical and communications wiring; concrete is made from sand and gravel; and cement contains crushed limestone. Limestone is Jamaica's largest mineral resource covering approximately 85 per cent of its surface coverage which has resulted in more than 100 limestone & sand quarries operating across the island.

PRODUCTION AND TRADE OF MINERALS

Table 2.1 shows the production of minerals in Jamaica for the five years from 2015 to 2019. Although limestone is Jamaica’s largest mineral resource, bauxite was the mineral with the largest production during the period with over 10 million tonnes in 2018, an increase of 22.0 per cent over 2017. However, there was a decrease of 10.3 per cent in 2019 when compared to 2018. The production of silica sand, which is used in several construction materials such as cement and roofing, increased from 16,000 tonnes in 2018 to 25,000 tonnes in 2019, an increase of 56.3 per cent. Marl and fill increased by 25.9 per cent from 2018 to 2019, while pozzolan production decreased by 14.0 per cent.

Table 2.1 Production of Minerals: 2015 - 2019, '000 tonnes

Minerals	2015	2016	2017	2018	2019
Bauxite[a]	9,628.8	8,540	8,245	10,058	9,022
Alumina	1,864.6	1,865	1,782	2,484	2,173
Silica Sand	15.6	20	21	16	25
Limestone	1,960.9	2748.1	2,151	2,080	2,379
Sand and Gravel	2,208.1	1,766.5	988	1,251	n.a.
Marl and Fill	4303.6	3,012.5	441	506	637
Shale	240.5	181	357	255	217
Pozzolan	107.8	129	95	93	80
Gypsum	42.9	50	46	47	55

Source: Jamaica Bauxite Institute and Jamaica Promotions Corporation

Note:- [a] Includes bauxite equivalent of alumina produced (about 2.5 times the alumina production) + crude bauxite

n.a. – not available

The main types of minerals found in Jamaica are limestone, bauxite, sand and gravel and alumina. Bauxite, marl and fill, shale and pozzolan all decreased production within the five year period (Table 2.1). Information on the reserves of sand and gravel is difficult to measure as the reserves change from year to year.

The volume of bauxite mined and exported by Jamaica decreased by 27.3 per cent over the five years (Table 2.2). In 2017 imports of selected minerals accounted for 7,996,800 tonnes and exports of selected minerals accounted for 5,401,600 tonnes (32.5 per cent less than imports). In the reporting years there were increased imports of all but three minerals; limestone flux, other clays and other minerals. Limestone flux, other clays and other minerals. imports declined by 100 per cent, 52.1 per cent and 51.8 per cent respectively.

Table 2.2 Imports and Exports of Selected Minerals: 2013-2017, tonnes

Minerals	2013	2014	2015	2016	2017
Imports					
Limestone flux	0.9	0.0	0.7	0.0	0.0
Gypsum	3.3	0.0	1.0	49.8	13.4
Sandstone	11.5	0.0	2.0	54.0	105.0
Silica, quartz & other natural sands	1,159.2	1,146.8	24,116.0	9,462.3	6,318.7
Quartz (other than natural sands)	2.6	0.0	8.2	78.1	24.5
Granules chippings and powder of marble whether or not heat-treated.	56.5	37.0	32.9	78.0	94.7
Gravel and pebbles	11.0	37.3	18.4	30.6	14.8
Other minerals n.e.s.	410.1	136.1	23.4	124.2	197.8
Bentonite	40.3	33.8	26.3	152.8	159.9
Kaolin and other kaolinic clays	92.4	116.5	143.4	328.5	999.3
Other clays	143.5	127.8	77.0	76.5	68.7
Total	**1,931.3**	**1,635.3**	**24,449.3**	**10,434.8**	**7,996.8**
Exports					
Bauxite	4,706.4	4,812.5	4,558.0	3,402.0	3,423.9
Alumina	1,881.9	1,797.7	1,906.4	178.6	1,690.0
Limestone	189.0	165.8	157.8	158.0	183.6
Sandstone	0.0	0.0	0.0	0.0	13.8
Silica and quartz sands	0.0	0.0	0.0	12.0	4.3
Other natural sands	0.0	0.0	0.0	0.0	3.3
Gravel	0.0	29.2	21.5	68.3	79.0
Pebbles	0.0	0.0	0.0	0.0	3.7
Total	**6,777.3**	**6,805.2**	**6,643.7**	**3,818.9**	**5,401.6**

Source: Statistical Institute of Jamaica

n.e.s – not elsewhere specified

SUB-COMPONENT 2.2 ENERGY RESOURCES

STOCKS AND CHANGES OF ENERGY RESOURCES

Energy resources can be renewable and non-renewable. Non-renewable energy resources come from minerals used for the production of energy and can be completely depleted. Sources of non-renewables include fossil fuels (e.g. natural gas, crude oil, coal and lignite), peat and uranium. Renewable energy resources come from sources that can replenish themselves. These include solar, hydroelectric, geothermal, wind and biomass energy.

Jamaica is dependent primarily on imported fossil fuels for its energy needs. The island's other energy supplies come mainly from solar and wind energy, but these renewable sources account for only a small proportion of energy generated. Estimating energy consumption from renewable sources is difficult due to limited availability of information and the methodologies used for its calculation.

According to the FDES (2013) stocks of mineral resources are defined as the amount of known deposits of non-metallic and metallic mineral resources. Changes in the stocks of environmental resources include

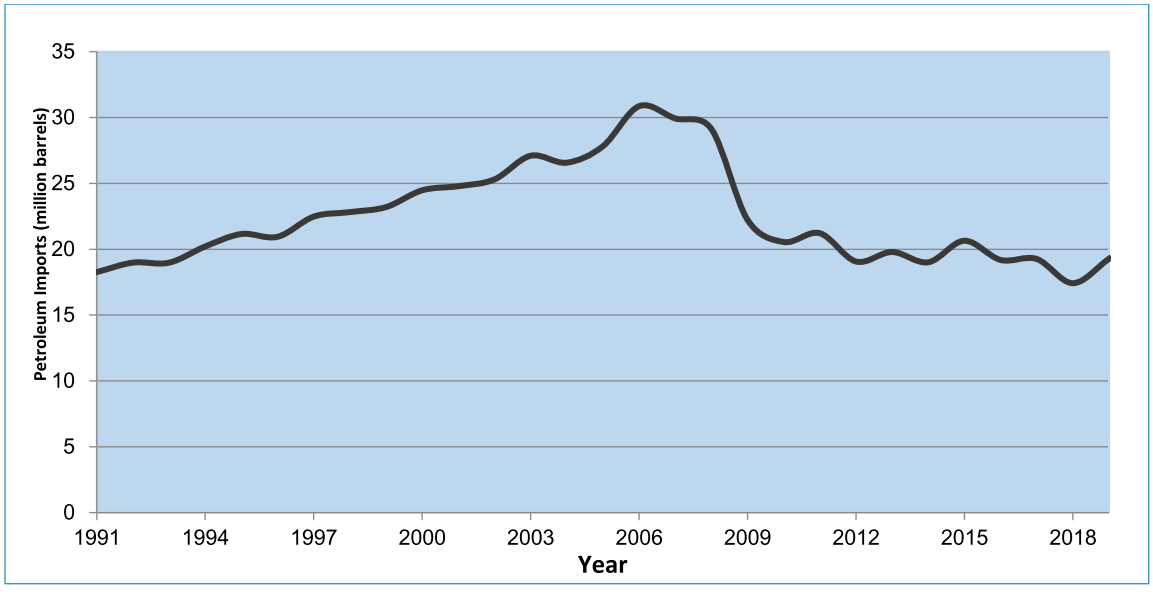
additions and reductions, from both anthropogenic and natural activities. In the case of non-renewable resources, continued extraction usually leads to the depletion of the resource. For renewable resources, if extraction exceeds natural regeneration and human-made replenishment, the resource is depleted. Depletion is the decrease in the quantity of the stock of a natural resource over an accounting period that is due to the extraction of the natural resource by economic units occurring at a level greater than that of regeneration.

PRODUCTION, TRADE AND CONSUMPTION OF ENERGY

Energy consumption is inherent to all human activity. Societies satisfy their need for energy through its production, conversion and consumption/use, which is necessary to ensure development. This must be weighed against the environmental, economic and social impacts, especially concerning carbon dioxide (CO_2) emissions. Energy production processes, for example, electricity generation from fossil sources, release polluting compounds such as sulphur dioxide, nitrogen oxides and particulate matter. These all contribute to the acidification of soil and natural water bodies. Additionally, the final consumption processes of industry, household and tertiary sectors, as well as fuel use in transport, play a part in the emissions of harmful compounds to the atmosphere.

Imports of petroleum

The Jamaican economy is largely dependent on imported oil. Jamaica's total petroleum imports increased steadily from 1992 to 2006, as seen in Figure 2.1. There was a decline of 33.4 per cent between 2006 and 2010 when petroleum imports moved from 30.8 million barrels to 20.5 million barrels. The importation of petroleum has fluctuated between 2011 and 2019.



Source: Ministry of Science, Energy and Technology

Figure 2.1 Total Petroleum Imports: 1992 - 2018, million barrels

Table 2.3 shows a breakdown of the types of petroleum products imported from 2015 to 2019. There has been a 10.6 per cent increase in total petroleum imports between 2018 and 2019. The data also show that there have been fluctuations between 2015 and 2019. Crude oil increased by 28.4 per cent and Bunker C declined by 27.9 per cent, between 2018 and 2019 (Table 2.3).

Table 2.3 Petroleum Imports by Product: 2015 – 2019, '000 barrels

Product	2015	2016r	2017	2018	2019r	Percentage change 2018-2019
Crude Oil	8,778	7,816	7,330	7,455	9,569	28.4%
Refined Products	7,227	7,835	8,346	6,404	6,331	-1.1%
Bunker C	1,299	1,664	1,177	1,253	903	-27.9%
Low Vanadium	1,997	1,525	2,023	1,973	2,079	5.4%
Lubricants	0.148	n/a	n/a	n/a	n/a	n/a
Anhydrous Ethanol	344	345	382	334	392	17.4%
Total	**19,645**	**19,185**	**19,258**	**17,419**	**19, 274**	**10.6%**

Source: Ministry of Science Energy and Technology

n/a: not available

r- revised

Jamaica's energy diversification programme aims to move the country from almost total dependence on petroleum to a strategic mix of other sources to include natural gas and renewable energy. Renewable energy sources such as hydropower, wind and solar power can provide energy without the effects of global warming caused in part by fossil fuels (e.g. petroleum, coal and natural gas).

Primary alternative energy consumption by source

Primary alternative energy in Jamaica is derived mainly from natural gas (since 2017), coal, bagasse, water and wind power. Natural gas accounted for 39.9 per cent of the total alternative energy use in 2019 (Table 2.4). There was a 100 per cent increase in solar energy use and a 13.51 per cent decrease in hydropower use from 2018 t 2019 (Table 2.4).

Table 2.4 Alternative energy use by source: 2015-2019, '000 boe

Source	2015	2016	2017	2018	2019	Percentage change 2018-2019
Natural gas	–	–	508	587	713	21.47%
Hydropower	80	74	96	111	96	-13.51%
Wind	78	128	179	187	169	-9.63%
Coal	511	491	425	398	427	7.29%
Bagasse	621	487	334	265	325	22.64%
Solar	–	9	27	28	56	100%
Total Alternative Energy	**1,290**	**1,189**	**1,569**	**1,576**	**1,786**	**3.17%**

Source: Ministry of Science, Energy & Technology

Note:-* - 2016 was the first year consumption of solar energy was measured

boe – barrel of oil equivalent

– data not available

Petroleum consumption by user

Table 2.5 shows that there has been an 8.6 per cent increase in total petroleum consumption for the period 2015 to 2019. This resulted partially from increased usage in shipping (102.2 %) and other manufacturing (173.7 %). Other contributing activities include cooking and lighting (45.2 %), sugar

manufacturing (25.0 %), and road and rail transport (20.9 %) (Table 2.5). Over the period 2015 to 2019, petroleum consumption decreased in the aviation (27.7 %), electricity generation (20.8 %) and petroleum refinery (4.9 %) sectors (Table 2.5). There was a 126.1 per cent increase in the use of petroleum in other manufacturing and a 62.9 per cent decrease in its use in the cement manufacturing sector between 2018 and 2019 (Table 2.5).

Table 2.5 Petroleum Consumption by User: 2015 – 2019, '000 barrels

Sector	2015	2016p	2017	2018	2019p	Percentage change	
						2018-2019	2015-2019
Road & Rail Transport	5976	6356	6,186	6,782	7,225	6.5%	20.9%
Shipping	1862	1839	2,113	3,027	3,762	24.3%	102.0%
Aviation	2386	2680	2,590	1,757	1,724	-1.9%	-27.7%
Cement Manufacture	12	22	44	35	13	-62.9%	8.3%
Electricity Generation	5668	5634	5,028	4,729	4,488	-5.1%	-20.8%
Bauxite/Alumina Processing	2831	2825	2,869	3,034	2,917	-3.9%	3.0%
Sugar Manufacturing	16	16	17	28	20	-28.6%	25.0%
Cooking & Lighting	828	1308	1,161	1,159	1,202	3.7%	45.2%
Petroleum Refinery	364	334	364	333	346	3.9%	-4.9%
Other Manufacturing	19	17	21	23	52	126.1%	173.7%
Other	143	129	125	136	94	-30.9%	-34.3%
Total	**20,105**	**21,160**	**20,518**	**21,043**	**21,843**	**3.8%**	**8.6%**

Source: Ministry of Science Energy and Technology

Note: r - revised
p – preliminary
Totals do not include figures for lubricants and asphalts which are non-energy products

Petroleum consumption by product

Petrojam Limited is Jamaica's only refinery and supplies a wide range of domestic, transportation and industrial petroleum products. The products are:

- Liquid petroleum gas (LPG)/Cooking gas – used for heating, cooking and making plastics.
- Naphtha - used as a cleaning solvent.
- Gasoline - both the E10-87 and the E10-90 octane grades of petrol are used in the transportation sector.
- Jet fuel/kerosene - used as fuel for jet engines, other aircraft and equipment including domestic lighting.
- Automobile diesel oil/gas oil - used in diesel engine vehicles and to operate generators.
- Heavy fuel oil - used for industrial operations such as power generation and marine transportation.
- Asphalt - used for road construction.

There was an 8.7 per cent increase in the consumption of petroleum products between 2015 and 2019 (Table 2.6). Total petroleum consumption increased by 3.8 per cent in 2019 when compared to 2018. A notable increase was recorded for heavy fuel oil over the five year period (5,392.3 %) and between 2018 and 2019 (1,152.6 %). The combustion of heavy fuel oil produces high levels of pollutants such as particulate matter, black carbon, sulphur oxide and nitrogen oxide. These pollutants have been linked to

an increased risk of heart disease as well as premature death. Lubricants declined by 66.7 per cent over the five year period and auto diesel by 47.6 per cent between 2018 and 2019 (Table 2.6).

Turbo fuel and aviation gasoline are often used in air crafts. There was a 100.0 per cent increase in turbo fuel and a 27.8 decrease in aviation gasoline over the five year period, 2015 - 2019 (Table 2.6).

Table 2.6 Petroleum Consumption by Product: 2015 – 2019, '000 barrels

Product	2015r	2016r	2017	2018r	2019p	Percentage change	
						2018-2019	2015-2019
Aviation Gasoline	1	0	1	2	2	0.0%	100.0%
Turbo Fuel	2,386	2,680	2,589	1,755	1,722	-1.9%	-27.8%
E10-90	1,746	2,256	2,363	2,662	2,941	10.5%	68.4%
E10-87	2,316	2,203	2,109	2,113	2,053	-2.8%	-11.4%
Kerosene	7	9	9	15	19	26.7%	171.4%
Auto diesel	3,098	2,490	1,522	1,706	1,623	-4.9%	-47.6%
Auto Diesel Oil Bunker	121	222	188	330	343	3.9%	183.5%
Ultra-Low Sulphur Diesel	186	397	484	742	998	34.5%	436.6%
Heavy Fuel Oil	13	17	61	57	714	1,152.6%	5,392.3%
Fuel Oil (Bunker-C)	7,706	7,902	8,352	8,764	8,525	-2.7%	10.6%
Fuel Oil (Low Vanadium)	1,341	1,353	1,324	1,419	1,374	-3.2%	2.5%
Liquid Petroleum Gas (LPG)	822	1,300	1,152	1,143	1,183	3.5%	43.9%
Lubricants	6	8	7	2	2	0.0%	-66.7%
Asphalt	173	117	102	155	150	-3.2%	-13.3%
Total	**19,922**	**20,954**	**20263**	**20,865**	**21,649**	**3.8%**	**8.7%**

Source: Ministry of Science Energy and Technology

Electricity consumption

Electricity consumption by major users increased by 6.6 per cent during the period 2015 to 2019 (Table 2.7). Electricity consumption by the largest power users increased by 292.0 per cent from 75,000 megawatts in 2017 to 294,000 megawatts in 2018. There was a 38.5 per cent decrease in net electricity consumption by large power users over the five years.

Residential users consumed the highest amount of electricity out of all sectors for the 2015- 2019 period, consuming over 1,000,000 MWh. Over the period 2015 to 2019, increases in electricity consumption were

recorded for residential customers (8.3 %), industrial customers, which include supermarkets and large wholesalers (4.6 %) and commercial users (5.1 %) (Table 2.7).

Table 2.7 Electricity Consumption by Sector: 2015-2019, '000 mwh

Sector	2015	2016r	2017	2018	2019	Percentage change	
						2018-2019	2015-2019
Residential	1,017	1,079	1,069	1,066	1,101	3.3	8.3
Commercial	585	599	596	598	615	2.8	5.1
Industrial	776	784	786	801	812	1.4	4.6
Large Power	603	626	572	356	371	4.2	- 38.5
Street Lighting	71	71	68	62	59	- 4.8	-16.9
Largest Power*	n.a.	n.a.	75	294	294	0.0	n/ap
Other	21	25	42	35	23	- 34.3	9.5
Total	**3,073**	**3,184**	**3,208**	**3,212**	**3,276**	**2.0**	**6.6**

Source: Jamaica Public Service and
Ministry of Science, Energy and Technology

Note:
n.a. - company use was not reported
n/ap – not applicable
r – revised
p - preliminary
* The JPSCo commenced reporting on largest power users in 2017, which was previously subsumed under large power users. Examples of large power users are large factories, while largest power users refer to entities whose electricity usage are billed in megawatts instead of kilowatts.

In 2018, 94.5 per cent of households in Jamaica reported using electricity from the grid as the main source of lighting compared to 93.5 per cent in the previous year (Table 2.8). In the Greater Kingston Metropolitan Area (GKMA), 98.2 per cent of households reported using electricity; in Rural Areas, electricity was used by 91.8 per cent of households.

Table 2.8 Proportion of Households Using Electricity by Region: 2014-2018, per cent

Region	2014	2015	2016	2017	2018
Greater Kingston Metropolitan Area (GKMA)	98.8	99.4	98.9	98.0	98.2
Other Rural Centres	95.0	96.8	94.0	92.8	95.4
Rural Areas	88.5	91.0	90.5	91.0	91.8
Jamaica	**93.3**	**94.9**	**93.8**	**93.5**	**94.5**

Source: Jamaica Survey of Living Conditions 2018

SUB-COMPONENT 2.3 LAND

LAND USE

The way land is used, whether for forestry, agriculture, biodiversity or human settlements, is often dependent on its capacity to sustain various activities. Agriculture depends on the type and structure of the soil and construction for human settlements depends on the drainage and stability of the soil. While forests, agriculture and biodiversity attempt to maintain the natural environment, mining and quarrying activities remove the soil to extract minerals.

Land such as mountainous areas with steep slopes, low-lying areas and watersheds, mangroves and swamps are sensitive areas unsuitable for development. Decisions on how land is used for the development of industries and creating human settlements can result in deforestation and the exploitation of natural resources.

USE OF FOREST LAND

Forests provide essential ecosystem services such as water regulation on and under the Earth's surface, protection of soils and carbon sinks. They are also sources of timber and food; they provide shelter, fuel and medicine. Statistics on forest cover, type and extent can show the changes in this resource.

Trees absorb carbon dioxide (CO_2) from the air and replace it with oxygen, storing carbon in their leaves, branches and trunks. Any damage or destruction of forests causes CO_2 to be released into the atmosphere; if restored, forests help remove (or sequester) CO_2 from the air.

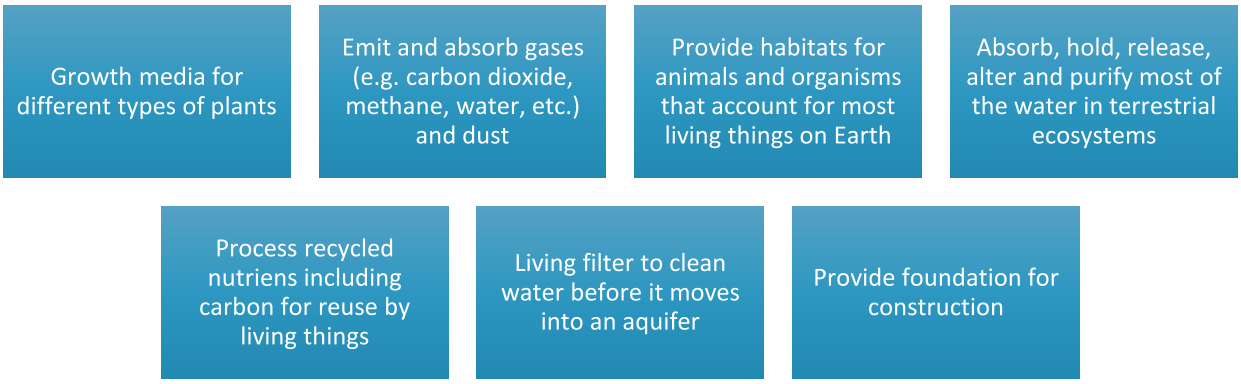
Three broad groups of forest occur in Jamaica: limestone, shale forests and alluvial and wetland forests of the coastal plains. Of the three, shale forests are the most predominant.

SUB-COMPONENT 2.4 SOIL RESOURCES

SOIL RESOURCES

Soil resources form a vital part of the environment. Soils are highly biodiverse and provide the physical base needed to support the productivity of biological resources, presenting a source of nutrients and water for agricultural and forestry systems and a host of other activities, including the storage of water supply (Figure 2.2 Function of Soil).

Soil is comprised of a mixture of minerals, water, air, organic matter, and organisms containing the decaying remains of once-living things. Soil takes many thousands of years to develop and is not an unlimited resource. It forms at the surface of land. It is also capable of supporting plant life and is vital to life on Earth. Soils can be easily destroyed if mismanaged or misused.

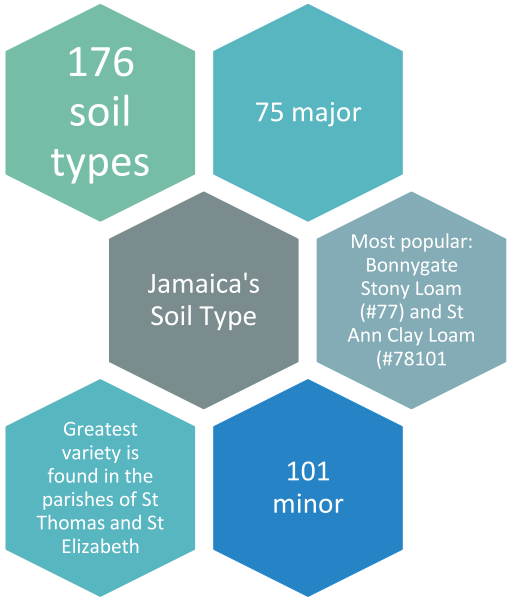


Source: Agricultural Land Management Division, Ministry of Industry, Commerce, Agriculture & Fisheries

Figure 2.2 Function of Soil

The Agricultural Land Management Division (ALMD) in the Ministry of Industry, Commerce, Agriculture and Fisheries is responsible for providing technical advice on soil and agricultural land use management in Jamaica. The division conducts soil and land cover/use surveys, assesses soil fertility and makes recommendations to farmers and special interest groups about fertilizer use and other sustainable soil and agricultural management interventions.

Jamaica has 176 soil types, each comprising of its unique combination of characteristics such as colour, texture, natural fertility and other soil properties. Soil types are classified into two distinct groups, major and minor soil types. Major soil types cover an acreage of greater than or equal to 1,000 acres and minor soil types cover less than 1,000 acres (Figure 2.3).



Source: Agricultural Land Management Division, Ministry of Industry, Commerce, Agriculture and Fisheries

Figure 2.3 Jamaica's Soil Characteristics

SUB-COMPONENT 2.5 BIOLOGICAL RESOURCES

AQUATIC RESOURCES

Fish, crustaceans, molluscs, shellfish, aquatic mammals and other aquatic organisms that live within the boundaries of a country's exclusive economic zone (EEZ) are regarded as that country's aquatic resources. These include both coastal and inland fisheries, the stocks of which may be difficult to measure.

Jamaica's aquatic resources are in danger from natural events (hurricanes) and unnatural practices such as pollution and unsustainable fishing practices. Marine pollution from debris can smother coral reefs and seagrass beds. Plastics and other synthetic materials and destructive fishing methods are also dangerous to marine life.

Imports and exports of fish and fishery products

Jamaica imported 32,506.3 tonnes of fish and fishery products in 2017, an increase of 8.8 per cent in the volume of imports compared to 2016 (Table 2.9). Finfish accounted for 92.7 per cent of imports. Exports of fish and fish products totalled 839.8 tonnes in 2017. Conch and lobster exports accounted for 57.1 and 37.2 per cent of exports in 2017.

Table 2.9 Imports and Exports of Fish and Fishery Products: 2014-2017, tonnes

Type of fish or fish product	2014	2015	2016	2017
	Imports			
Live fish for breeding	0.3	0.3	0.5	2.0
Finfish	27,121.9	25,949.6	28,150.7	30,142.4
Shrimp & Prawn	737.3	729.3	1,121.9	1,384.8
Molluscs	288.9	354.7	428.8	709.1
Crab	70.9	68.4	59.2	102.2
Other aquatic invertebrates and fish products	89.4	93.7	121.0	165.8
Total Imports	**28,306.7**	**27,196.0**	**29,882.1**	**32,506.3**
	Exports			
Live fish	1.5	1.3	2.6	3.2
Finfish	39.0	29.1	32.3	33.2
Shrimps & prawns, frozen or preserved	16.9	31.5	4.5	10.5
Lobsters (incl. for breeding)	341.9	266.4	267.4	312.7
Molluscs	41.1	3.7	0.0	0.0
Conch	308.9	365.0	416.8	479.7
Other aquatic invertebrates and fish products	3.4	2.5	0.0	0.5
Total Exports	**752.7**	**699.5**	**723.6**	**839.8**

Source: Statistical Institute of Jamaica

Molluscs include cuttlefish, squid, octopus, mussels, oysters, scallops.

According to the Food and Agriculture Organization of the United Nations (FAO), imports of fish and fishery products were valued at US$116.6 million and exports at US$ 14.7 million in 2017. Jamaican fisheries contribute mainly to small-scale food security, as well as to the employment of the coastal communities where fishing-related activities are often the most important source of food and livelihood.

In 2017, it was estimated that there were 24,469 fishers of which approximately 6.0 per cent were female (FAO, 2019).

CROPS

Crops are plants or agricultural produce grown for food or other purposes such as fodder. The primary role of agriculture is to provide food and other agricultural products. In its relationship with the environment, agriculture has an essential function of storing carbon, managing watersheds and preserving biodiversity. However, this sector is a significant user of natural resources such as water and contributes to underground water depletion, pollution by agrochemicals and soil exhaustion.

Crop area reaped

The major crops reaped (hectares) and produced (tonnes) in Jamaica are listed in Table 2.10 and Table 2.11. Table 2.10 shows the estimated area of selected crops reaped for the period 2015 to 2019. There was an 8.3 per cent increase in the estimated area reaped, moving from 42,644 hectares in 2015 to 46,164 in 2019. The estimated area reaped (hectares) by selected crops in 2019 has declined by 0.1 per cent since 2018. As shown in Table 2.10, vegetables, yams and legumes were the crops with the largest estimated area reaped for the five year period, while Irish potatoes and sorrel were the crops with the least area reaped.

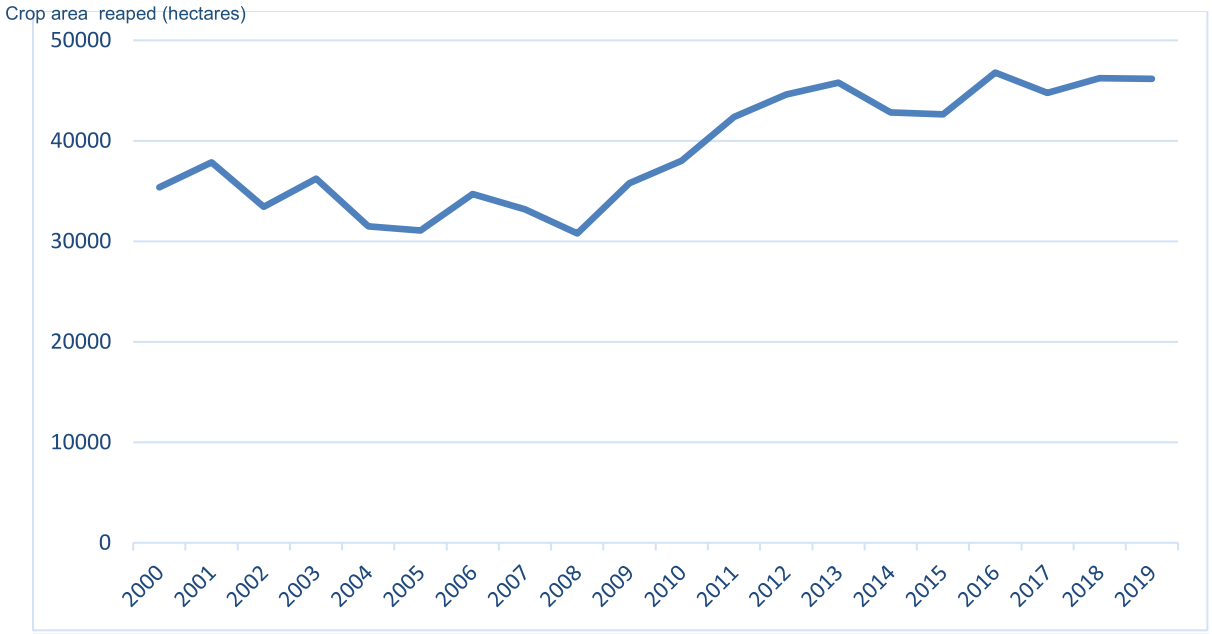
Figure 2.4 shows the crop area reaped (hectares) over twenty years. Between 2000 and 2019 the estimated crop area reaped fluctuated for selected crops.

Table 2.10 Estimated Area Reaped (Selected Crops): 2015 - 2019, hectares

Crop	2015	2016	2017	2018	2019
Legumes	4,269	4,716	4,506	4,267	3,963
Vegetables	13,184	14,828	14,067	14,754	14,664
Condiments	3,499	3,899	3,491	3,888	3,818
Fruits	2,384	2,787	2,647	3,067	3,245
Cereals*	2,069	2,059	2,185	1,896	1,829
Plantains	2,090	2,282	2,392	2,548	2,383
Irish Potatoes	1,107	1,017	1,039	1,122	990
Sweet Potatoes	2,405	2,752	2,438	2,509	2,456
Yams	8,519	9,153	8,761	8,861	9,352
Other Tubers	2,354	2,456	2,506	2,653	2,770
Sorrels	764	842	740	668	694
Total	**42,644**	**46,791**	**44,772**	**46,233**	**46,164**

Source: Ministry of Industry, Commerce, Agriculture & Fisheries

Note:- * Cereals include produce such as hybrid corn, ordinary corn, sweet corn and rice.

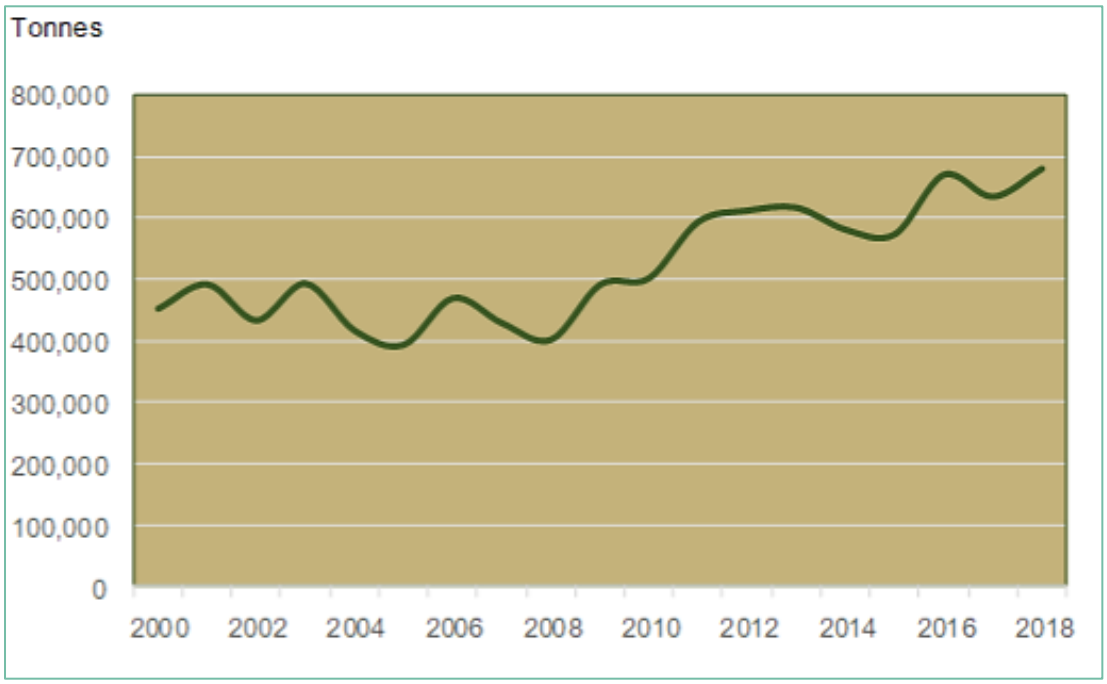


Source: Ministry of Industry, Commerce, Agriculture & Fisheries

Figure 2.4 Estimates of Crop Area Reaped (Selected Crops): 1998 - 2019, hectares

Crops area produced

Figure 2.5 shows nineteen years of Jamaica's estimated crop production. Between 2000 and 2018, the estimated production of selected crops has fluctuated.



Source: Ministry of Industry, Commerce, Agriculture and Fisheries

Figure 2.5 Estimated Crop Production: 2000–2018, tonnes

Table 2.11 shows that of the 689,406 tonnes of crops produced in 2019, 35.1 per cent were vegetables and 23.9 per cent were yams. Yams are a staple in Jamaican meals, with over 70.0 per cent of national production grown in the parishes of Trelawny, Manchester, St. Ann and Clarendon. Fruits, yams, other tubers and sorrels were the only crops that increased in production in 2019 when compared to 2018. There was a 20.6 per cent increase in total crop production over the period 2015 to 2019 (Table 2.11).

Table 2.11 Estimated Production of Selected Crops: 2015 - 2019, tonnes

Crop	2015	2016	2017	2018	2019
Legumes	4,708	5,550	5,278	4,630	4,497
Vegetables	201,866	243,487	230,093	246,159	242,165
Condiments	42,781	52,001	45,884	52,176	51,594
Fruits	43,467	54,255	51,894	62,127	64,533
Cereals	2,365	2,354	2,540	2,177	2,058
Plantains	38,421	43,437	46,093	49,907	46,111
Irish Potatoes	18,215	17,007	17,148	16,184	15,717
Sweet Potatoes	40,535	48,006	41,996	45,410	43,188
Yams	136,732	156,103	144,319	148,675	165,047
Other Tubers	41,166	44,893	46,229	49,850	53,216
Sorrels	1,187	1,408	1,253	1,151	1,280
Total	**571,443**	**668,501**	**632,727**	**678,446**	**689,406**

Source: Ministry of Industry, Commerce, Agriculture & Fisheries

Note:- * Cereals include produce such as hybrid corn, ordinary corn, sweet corn and rice

Fertilisers

There are two main types of fertilisers: natural (organic) and chemical (inorganic). Natural fertilisers include materials such as animal manure, crop residues, bone meal, lime and compost. As the organic material decomposes, the nutrient materials are released. Therefore, natural fertilisers are slow-acting and long-lasting. Chemical fertilisers are made from a blend of chemicals with varying compositions. These types of fertilisers are soluble and become immediately available to plants. However, they are available only for a short time; they leach away quickly and pollute water sources.

Natural fertilisers

The volume of natural fertilisers imported and exported from 2013 to 2017 is shown in Table 2.12. Imports of natural fertilisers totalled 97.7 tonnes in 2017, a 244.0 per cent increase compared to the 28.4 tonnes imported in 2016. For the first time, in 2017, natural fertilisers were exported from Jamaica (Table 2.12).

Table 2.12 Imports and Exports of Natural Fertilisers: 2013-2017, tonnes

Natural Fertiliser (Animal or Vegetable)	Imports	Exports
2013	0.1	0
2014	0.0	0
2015	52.8	0
2016	28.4	0
2017	97.7	111.5

Source: Statistical Institute of Jamaica

Note: that these animal or vegetable fertilisers may be mixed with chemically-treated fertilisers.

Chemical fertilisers

There continues to be a heavy dependence on chemical fertilisers derived mainly from petroleum and natural gas. If applied excessively, these fertilisers burn and destroy plants and are detrimental to both earthworms and micro-organisms in the soil that help in the growth of plants. Chemical fertilisers may cause pollution when they are washed and transported by rain (surface runoff) or below the surface (subsurface runoff) into water sources.

The majority of the chemical fertilisers used in Jamaica are imported. Table 2.13 shows the volume of imports of chemical fertilisers into Jamaica. In 2017, a total of 18,452 tonnes of chemical fertilizer were imported, 6.8 per cent more than the 17,277 tonnes in 2016.

Table 2.13 shows a 31.4 per cent decline in the importation of chemical fertilisers from 2013 to 2017. Potassium chloride import increased by 58,883 per cent in 2017, while other potassic fertilisers (other than potassium chloride or potassium sulphate) declined by 98.9 per cent compared to 2016.

Table 2.13 Imports of Chemical Fertilisers by Type - tonnes, 2013-2017

Type of Fertiliser	2013	2014	2015	2016	2017[p]
Urea	2,077	3,155	2,784	2,291	3,540
Ammonium nitrate	245	1,709	872	308	662
Ammonium sulphate	9,712	6,996	2,174	2,597	3,564
Diammonium phosphates	0	5,876	1,487	4,759	2,558
Potassium chloride	1	2	2	6	3,539
Other potassic fertilisers other than potassium chloride or potassium sulphate	8,815	5,205	3,578	4,523	49
NPK complex	5,982	6,069	1,761	1,908	2,579
Other N and P compounds	0	16	41	61	0
Other N and K compounds	28	29	11	42	278
Other	40	260	360	782	1,683
Total	**26,900**	**23,441**	**13,070**	**17,277**	**18,452**

Source: Statistical Institute of Jamaica

[p] Data is preliminary.

Note:- N: nitrogen; P: phosphate; K: potassium

Totals may not add up due to the rounding of figures.

Pesticides

Pesticide use in agriculture is essential for controlling insects and weeds. However, the use of pesticides can contribute to air pollution and, if overused and improperly stored, may cause soil and water pollution.

Table 2.14 presents data on the pesticides traded from 2013 to 2017. In 2013, herbicides accounted for 65.5 per cent of imported pesticides. However, this changed in 2017 with other anti-sprouting products and plant-growth regulators accounting for more than one half (60.1 %) of the 1.2 million kg of pesticides imported into Jamaica. There was a 57.8 per cent decline in agrochemicals export in 2017 (169,423 kg) compared with 2013 (401,676 kg). Herbicides accounted for 61.1 per cent of exports in 2017.

Table 2.14 Imports and Exports of Agro-chemicals: 2013-2017, kg

Type of Chemical	2013	2014	2015	2016	2017
Imports					
Insecticides	145,226	160,977	194,374	253,032	193,608
Fungicides	184,626	252,014	155,068	219,954	162,844
Herbicides	795,905	169,534	101,502	196,779	93,411
Other anti-sprouting products and plant-growth regulators	819	614,890	502,166	451,995	740,989
Rodenticides	87,891	15,568	157,811	44,808	40,810
Other	83,00	24,545	2,100	2,647	1,426
Total	**1,214,467**	**1,237,528**	**1,113,021**	**1,169,215**	**1,233,088**
Exports					
Insecticides	171,428	1,289	124,853	11,407	12,207
Fungicides	3,449	0	2	297	68
Herbicides	226,799	0	0	29,310	103,586
Other anti-sprouting products and plant-growth regulators	0	492,452	0	12,258	53,562
Total	**401,676**	**493,741**	**124,855**	**53,272**	**169,423**

Source: Statistical Institute of Jamaica

LIVESTOCK

Number of animals slaughtered

Livestock are domesticated animals raised in an agricultural setting to produce items such as food, fibre (for example wool) and labour. Livestock includes cattle, goats, pigs, sheep and poultry. There are four cattle breeds, namely the Jamaica Brahman, Jamaica Hope, Jamaica Red Poll and Jamaica Black.

Between 2015 and 2017, the number of livestock slaughtered increased from 186,998 to 209,143 which then decreased to 190,773 in 2019 (Table 2.15). Poultry production has increased, moving from 112,855,000 in 2015 to 134,299,000 in 2019, or by 19.0 per cent. Egg production has also increased by 11.2 per cent over the five year period. There has been a decline in eggs and milk production between 2018 and 2019 with values of 13.3 per cent and 10.6 per cent, respectively (Table 2.15).

Table 2.15 Estimated Livestock Production: 2015-2019

Category	2015	2016	2017	2018	2019
Cattle	27,724	27,563	25,320	25,397	26,566
Pigs	101,834	129,559	123,810	124,176	121,999
Sheep	712	602	342	386	243
Goats	56,728	60,074	59,671	48,619	41,965
Total Slaughtered	**186,998**	**217,798**	**209,143**	**198,578**	**190,773**
Poultry ('000)	112,855	125,993	128,290	n.a.	134,299
Eggs ('000)	149,993	174,263	184,138	192,205	166,728
Milk (million litres)	n.a.	12.1	13.2	14.2	12.7

Source: Ministry of Industry, Commerce, Agriculture and Fisheries
n.a. – not available

Imports and exports of live animals

The importation of live animals increased by 50.7 per cent in 2017 compared to 2016 (Table 2.16). Sheep for breeding and rearing, goats, swine and laboratory animals, which have not been imported for several years, were imported in 2017. Horses not used for breeding increased by 170.9 per cent in 2017 and pure-bred breeding animals increased by 66.6 per cent compared to 2016.

The volume of live animals exported declined by 73.2 per cent in 2017 compared to the previous year. The export of cats declined by 99.0 per cent and dogs by 50.9 per cent.

Table 2.16 Imports and Exports of live animals: 2014-2017, kg

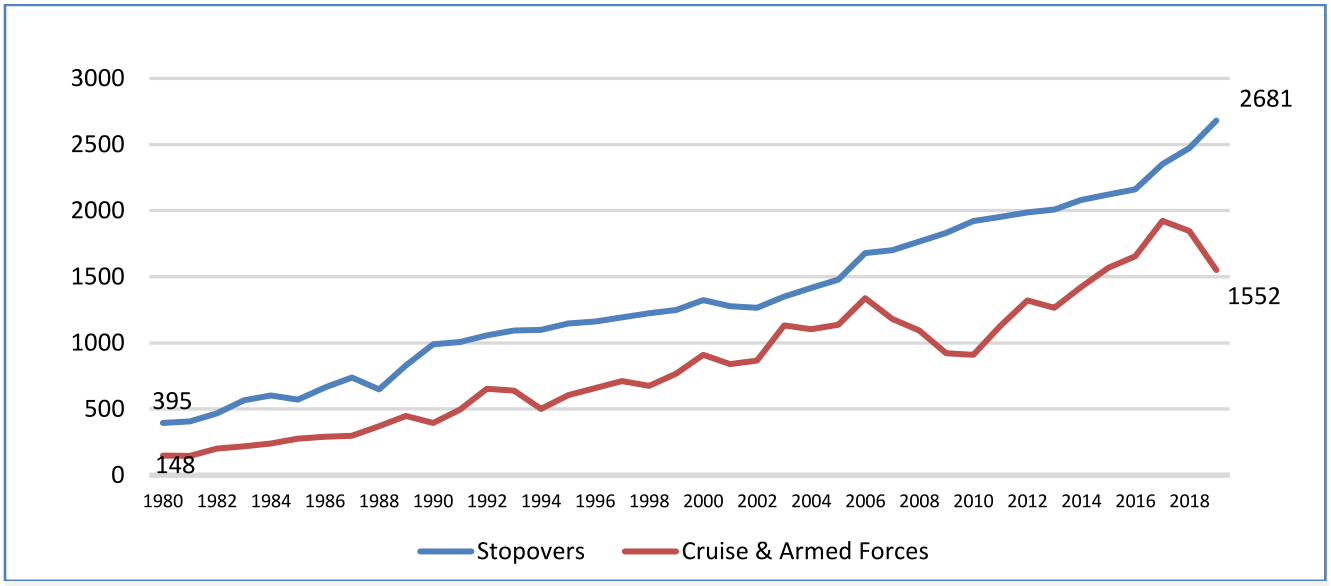
Type of animal	2014	2015	2016	2017
	Imports			
Pure-bred breeding animals	3,313	5,322	8,416	14,025
Horses, not for breeding	3,278	2,522	6,894	18,675
Other horses for breeding	0	0	2,000	1,000
Other asses	1,782	0	0	0
Other primates	0	0	43	0
Fowl for rearing and breeding	17,330	8,848	25,278	29,974
Sheep for breeding and rearing	0	0	0	445
Goats	0	0	0	668
Swine	0	0	0	753
Whales, dolphins and porpoises	1,586	0	804	0
Dogs	5	9	332	487
Cats	0	0	99	72
Laboratory animals	0	0	0	10
Total	**27,294**	**16,701**	**43,866**	**66,109**
	Exports			
Pure-bred breeding animals	5,000	0	0	0
Horses, not for breeding	12,093	19,139	13,050	7,200
Other horses for breeding	0	6	0	0
Live fowl for rearing and breeding	90	1,032	0	0
Goats for rearing and breeding	0	0	2,700	0
Swine, not for breeding	0	0	1,796	0
Dogs	579	852	3,402	1,669
Cats	6	3	15,047	143
Laboratory animals	0	0	0	620
Other live animals, n.e.s.	0	30	122	45
Insects	0	0	0	10
Total	**17,768**	**21,062**	**36,117**	**9,687**

Source: Statistical Institute of Jamaica

Tourism

Tourism is defined as travelling and remaining outside of one's usual place of residence for not more than one consecutive year for leisure, business or other purposes. Like many Caribbean islands, the tourism sector is an important part of Jamaica's economy. The sector plays a significant role in generating foreign exchange inflows and provides labour opportunities. The quality of the environment, both natural and man-made, is essential to tourism. However, tourism exerts pressure on the country's natural resources by creating increased demand for water and energy and generating high volumes of waste. Wetlands may also be lost due to the construction of facilities and the removal of seagrass beds from beaches.

Data in Figure 2.6 show an increase in stopovers and cruise ship visitors to Jamaica over 40 years, 1980 to 2019. During the period, stopovers increased by 578.7 per cent and cruise and armed forces visitors increased by 948.6 per cent. Additionally, cruise and armed forces visits saw a decline of 15.9 per cent in 2019 when compared to the previous year. Armed force is defined as personnel of the naval armed forces of foreign countries who take onshore leave in Jamaica.

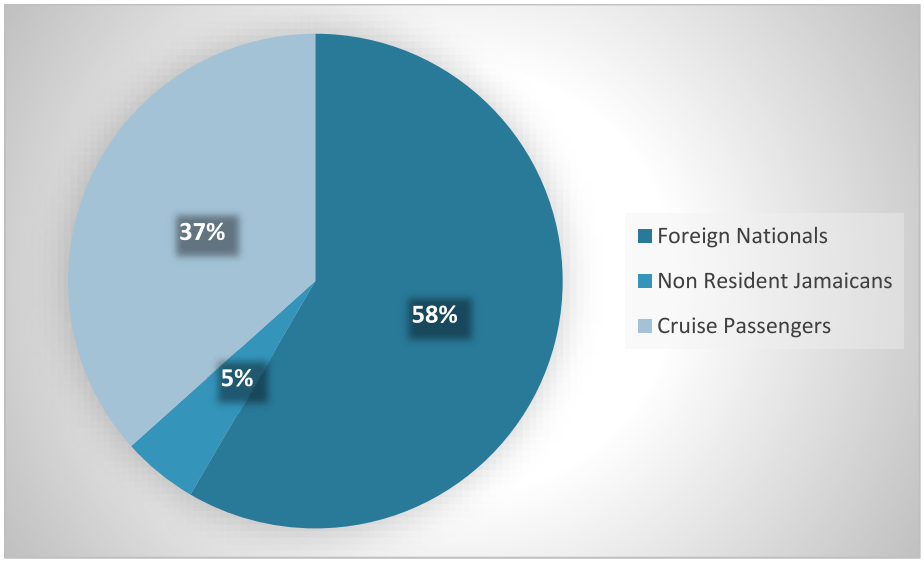


Source: Jamaica Tourist Board

Figure 2.6 Number of Visitors By Type: 1980 - 2019, '000

Note: Cruise passenger figures prior to 2014 do not contain armed forces.

Figure **2.7** shows that foreign nationals accounted for the highest percentage of visitor arrivals to Jamaica in 2019, approximately 58.0 per cent. Cruise passenger arrivals were the second-highest group, accounting for approximately 37.0 per cent, while non-resident Jamaicans accounted for approximately 5.0 per cent of all visitor arrivals in the reporting year.



Source: Jamaica Tourist Board

Figure 2.7 Visitor Arrivals to Jamaica by Type: 2019

Studies conducted on sex and tourism suggest that females are more likely to engage in leisure travel. At the same time, males are more inclined to visit destinations that offer sports and nightlife activities. Table 2.17 shows that while over two million individuals visited the island in 2019 from North America, 43.3 per cent were males and 56.7 per cent were females. In 2019, of the visitors from the United Kingdom, 45.1 per cent were males and 54.9 per cent were females. The gender ratio of visitors from the United Kingdom was 122 females per 100 males.

Males accounted for 48.3 per cent of visitors to Jamaica from other Caribbean islands, while females accounted for 51.7 per cent (Table 2.17).

Table 2.17 Visitor Arrivals by Sex by Region: 2019

Region	Males	Percentage (%)	Females	Percentage (%)
North America*	966,970	43.3	1,267,495	56.7
Europe^	101,529	45.1	123,508	54.9
Caribbean	34,697	48.3	37,119	51.7

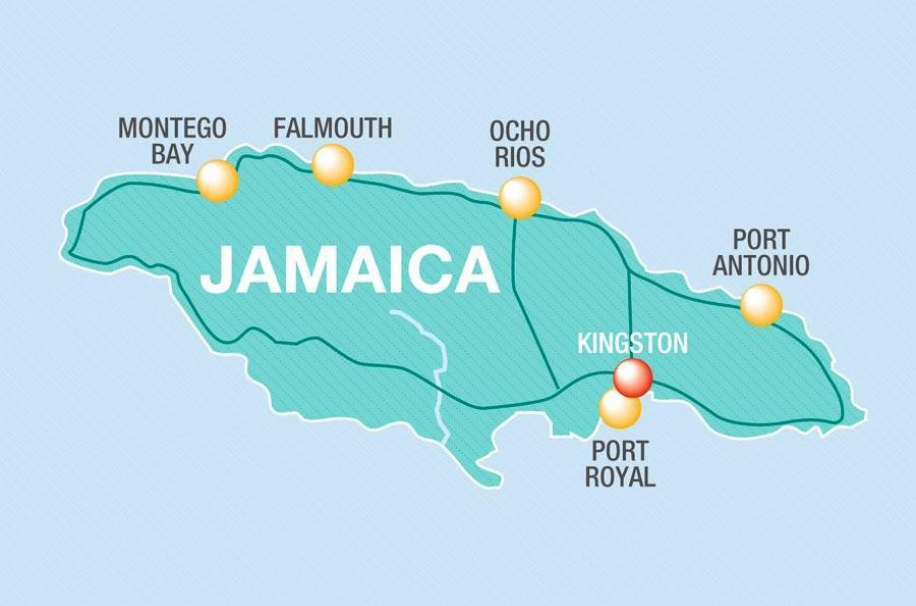
Source: Jamaica Tourist Board

Note:- * United States and Canada

^ United Kingdom

Cruise

Jamaica has five cruise ship ports: Montego Bay, St James; Falmouth, Trelawny; Ocho Rios, St Ann; Port Antonio, Portland and Port Royal in Kingston (Figure 2.9). The Port Royal Cruise Port was built in 2019 with a floating SeaWalk pier that unfolds and is secured alongside ships. This device allows crew and passengers to disembark and walk from the ship to the pier, similar to a jet bridge at an airport. The establishment of the SeaWalk pier allows vessels to be welcomed to the pier without extensive dredging and infrastructure work typically associated with the construction of cruise berths.



Source: Port Authority of Jamaica

Figure 2.8 Ports of Jamaica

Table 2.18 shows a slight decrease (1.0 per cent) in the number of cruise ship passengers to Jamaica from 2015 to 2019 from 1,568,702 to 1,553,230. In 2019, there was a 15.9 per cent decline in the number of cruise ship passengers, moving from 1,845,798 passengers in 2018 to 1,553,230 passengers in 2019. The port of Ocho Rios received the most calls and passengers in 2019.

Table 2.18 Cruise Ship Arrivals by Port of Call: Type: 2015 – 2019

Port	2015	2016	2017	2018	2019
	Number of Calls				
Montego Bay	130	186	238	200	148
Ocho Rios	135	167	176	178	185
Falmouth	190	160	181	161	140
Port Antonio	3	2	9	5	5
Total	**458**	**515**	**604**	**544**	**478**
	Number of Passengers				
Montego Bay	371,487	453,556	527,119	512,563	390,665
Ocho Rios	444,780	491,506	543,845	586,715	595,045
Falmouth	752,205	707,886	845,652	744,671	565,980
Port Antonio & Kingston	230	157	6,658	1,849	1,540
Total	**1,568,702**	**1,653,105**	**1,923,274**	**1,845,798**	**1,553,230**

Source: Jamaica Tourist Board

Length of stay

Data in Table 2.19 indicate that in 2019, the average length of stay of foreign nationals was 7.9 days for foreign nationals which was less than the average of 8.1 nights in 2018. Foreigners who used hotel accommodation had an average length of stay of 6.1 nights and those who stayed in non-hotel accommodation stayed 8.5 nights in 2019. Foreign nationals refer to persons who are not naturalized citizens of Jamaica. On the other hand, non-resident Jamaicans are nationals who reside outside of the country and whose purpose of visit is either business or leisure, lasting less than one year.

Table 2.19 Average Intended Length of Stay: 2015 – 2019, days

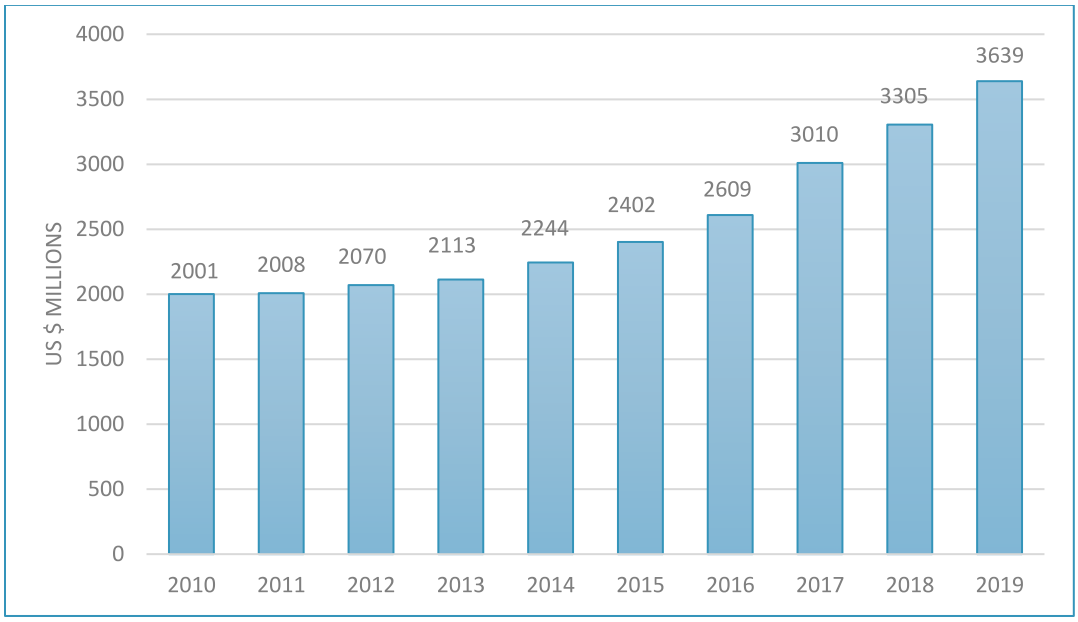
Type of Visitor	2015	2016	2017	2018	2019
Foreign Nationals	8.8	8.8	8.4	8.1	7.9
Hotels	6.9	6.9	6.6	6.2	6.1
Non-hotels	9.2	9.2	9.0	8.7	8.5
Private homes	15.0	15.1	15.2	14.9	14.2
Other	14.3	13.8	15.1	16.5	14.1
Non-resident Jamaicans	16.4	16.8	17.5	n.a.	n.a
Hotels	8.3	8.3	8.3	n.a.	n.a
Non-hotels	12.4	12.4	12.3	n.a.	n.a
Private homes	17.1	17.5	18.2	n.a.	n.a
Other	15.0	12.3	17.6	n.a.	n.a

Source: Jamaica Tourist Board

Note:- n.a. – not available

Visitor expenditure

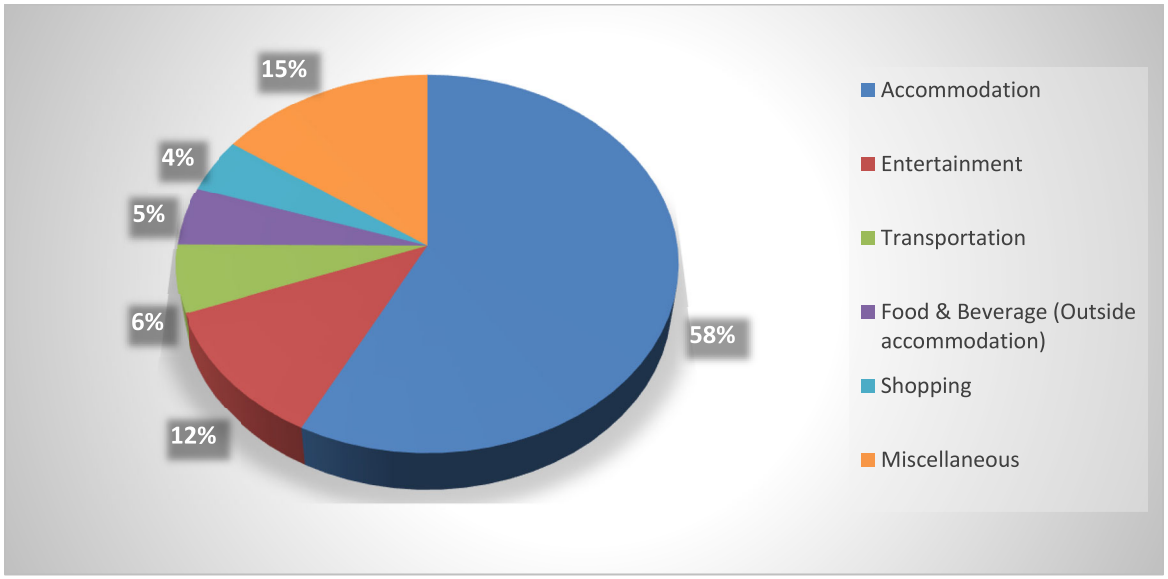
Figure 2.9 shows an increase in visitor expenditure for 2010 to 2019. Visitor expenditure increased by 81.9 per cent over the reporting period. There was a 10.1 per cent increase in 2019 compared to 2018.



Source: Jamaica Tourist Board

Figure 2.9 Visitor Expenditure: 2010 - 2019

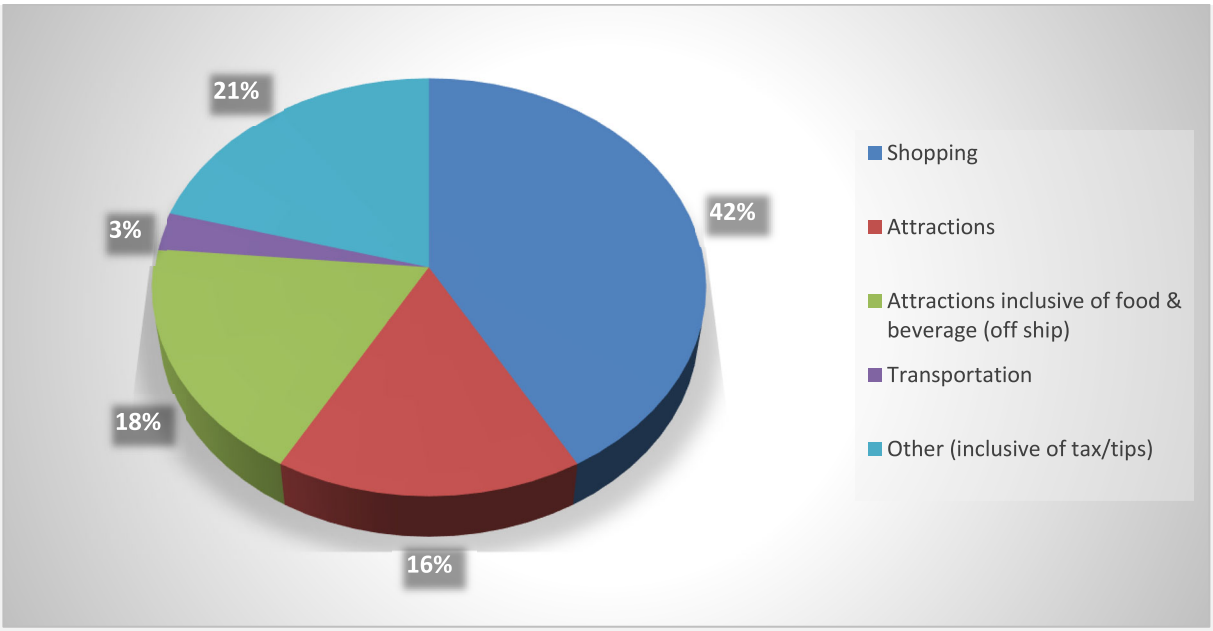
As shown in Figure 2.10, accommodation and entertainment accounted for 58.0 per cent and 12.0 per cent respectively of stopover visitors' expenditure in 2019. Collectively they accounted for 70.0 per cent of stopover visitors' expenditure in 2019.



Source: Jamaica Tourist Board

Figure 2.10 Distribution of Stopover Visitor Expenditure: 2019

'Shopping', 'Attractions' and 'Attractions inclusive of food and beverage (off ships)' accounted for 76.0 per cent of cruise ship passengers' expenditure (Figure 2.12), while transportation accounted for 3.0 per cent in 2019.



Source: Jamaica Tourist Board

Figure 2.11 Distribution of Expenditure Cruise Ship Passengers: 2019

SUB-COMPONENT 2.6 WATER RESOURCES

WATER RESOURCES

Water continuously circulates through the environment from the oceans to the atmosphere to the land and back to the oceans. This hydrologic cycle renews the supply of fresh water on land. Approximately 97.0 per cent of Earth's water is in the ocean and is unsuitable for human consumption. Most of the 3.0 per cent of freshwater is unavailable as it is frozen in polar or glacial ice, in the atmosphere or soil. Water that is readily available in lakes, streams, rivers and groundwater accounts for an estimated 0.03 per cent of all fresh water.

Monitoring water usage is important as access to water is required for agriculture, industry, human consumption and environmental flows. As the world population grows, so too the demand for potable water. This topic is discussed in Component 1.

ABSTRACTION, USE AND RETURNS OF WATER

Imports and exports of water

Under the FDES, trade in water as a commodity is only considered if the water goes through pipelines or on ships or trucks or through artificial open channels, drains or other means. Therefore, for the FDES, imports and exports of water exclude bottled water.

Table 2.20 Imports and Exports of Water for Drinking: 2014-2017, litres

Type of water	2014	2015	2016	2017
Imports				
Mineral waters not containing added sweetening nor flavoured	123.3	76.2	55.8	100.3
Ordinary natural waters not containing sweetening matter nor flavoured	151.5	452.5	28.1	406.1
Other waters not containing sweetening matter nor flavoured ice and snow	314.1	549.4	143.5	78.8
Other waters including mineral waters and aerated waters containing added sweetener or flavoured*	8,230.0	7,731.9	2,504.9	26,902.3
Total	**8,818.9**	**8,810.0**	**2,732.3**	**27,487.5**
Exports				
Mineral waters not containing added sweetening nor flavoured	207.5	353.7	577.0	824.6
Ordinary natural waters not containing sweetening matter nor flavoured	92,226.5	110,289.6	154,903.8	151,045.2
Other waters not containing sweetening matter nor flavoured ice and snow	48.7	156.3	168.0	729.0
Other waters including mineral waters and aerated waters containing added sweetener or flavoured	144.0	516.3	3,222.1	4,504.2
Total	**92,626.7**	**111,315.9**	**158,870.9**	**157,103.0**

Source: Statistical Institute of Jamaica

Note: * The methodology of collecting data was changed in 2016, therefore the data on imports thereafter are not comparable.

In this report, statistics on the imports and exports of selected types of bottled water for drinking are included. Table 2.20 shows that in 2014 and 2015 there was a near-constant importation of drinking water

with only a 0.1 per cent decrease in 2015. The year with the lowest importation was 2016, where there was a 69.0 per cent decrease when compared to the preceding year (2015). In 2017, Jamaica imported 27,487.5 litres of water for drinking.

'Other waters including mineral waters and aerated waters containing added sweetener or flavoured' was the leading importer in 2017 with accounted for 97.9 per cent (26,902.3 litres). This was consistent for the previous 2014-2016 period, the same category accounted for more than 85 per cent of the total imports

In 2017, the total export of water for drinking was 157,103.0 litres. Of this amount, 96.1 per cent (151,045.2 litres) was ordinary natural water the leading exporter. The previous years also recorded the same leading exporter. There was a 524.1 per cent increase of 'Other waters including mineral waters and aerated waters containing added sweetener or flavoured' in 2016 when compared to the previous years (Table 2.20).

COMPONENT 3: RESIDUALS

Production and consumption of the Earth's resources by humans result in the discharge, discard or emission of residuals (waste). This waste can be in the form of the disposal of chemicals and other residuals, which can contaminate soil, water and air. This component of the FDES looks at statistics on the amount and characteristics of residuals that are generated by the production and consumption activities of humans. It also looks at the management of residuals and their final release to the environment.

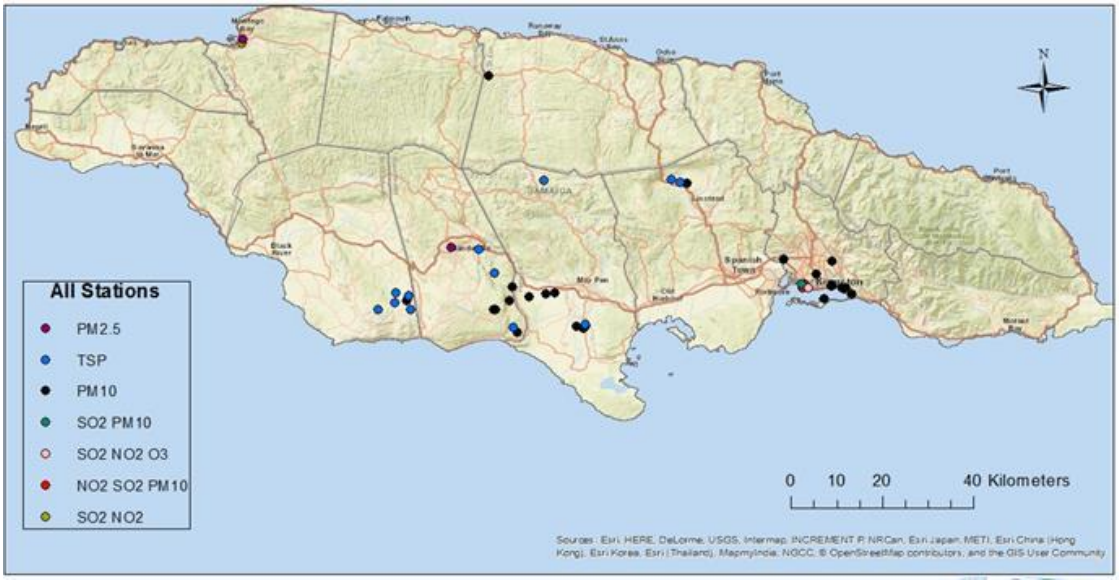
SUB-COMPONENT 3.1 EMISSIONS TO AIR

Emissions can be defined as the discharge of gases and particles that are released into the air from various sources. The air can become polluted through emissions of gases, liquids or solids in high enough levels to cause harm to humans, organisms or materials. Air pollutants can come from natural sources but human activities contribute significantly to air pollution, especially those concentrated in densely populated areas. The major classes of primary air pollutants are particulate matter, nitrogen oxides, sulphur oxides, carbon oxides, hydrocarbons, ozone and hazardous air pollutants.

The National Environment and Planning Agency (NEPA) is responsible for monitoring air quality across Jamaica through its Jamaica Air Quality Management Programme (JAQMP). The criteria air pollutants (CAPs) that are measured in Jamaica are:

- Total suspended particulate matter (TSP)
- Particulate matter with a diameter less than 10 microns (PM_{10})
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Ozone (O_3)

Figure 3.1 shows the locations of NEPA's air quality monitoring stations.



Source: National Environment and Planning Agency

Figure 3.1 Air quality monitoring network layout, 2018

Emissions can cause ambient air pollution in both rural and urban areas. Ambient air pollution is a broad term used to describe air pollution in outdoor environments. Urban outdoor pollution is a more specific term, referring to the ambient air pollution experienced by populations living in urban areas, typically in or around cities. Outdoor (ambient) air pollution can lead to cardiovascular and acute respiratory problems and premature mortality.

Indoor air refers to air found in a home, workplace, school or other buildings. Pollutants that impact air quality are normally derived from inside, although outside air can also be a factor. These pollutants can include biological agents such as mould, carbon dioxide, pet dander, tobacco smoke, ozone (found in certain air cleaners) and perfumes. Anthropogenic emissions are emissions caused by human activities.

EMISSIONS OF GREENHOUSE GASES (GHGS)

Greenhouse gases (GHGs) are gases in the Earth's atmosphere that trap heat. GHGs allow sunlight to pass through the atmosphere but prevent heat from the sunlight from leaving the atmosphere. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and chlorofluorocarbons (CFCs).

Jamaica has committed to decreasing the level of anthropogenic emissions and greenhouse gases through the signing of the United Nations Framework Convention on Climate Change (UNFCCC). The level of GHGs released into the atmosphere, resulting from human activities, is considered the primary contributor to global warming and climate change.

In 2017, the National Environment and Planning Agency (NEPA) released a list of primary air emissions in Jamaica, shown in Table 3.1. Carbon dioxide (CO_2) was the leading pollutant, followed by sulphur oxides (SO_x), nitrogen oxides (No_x) and particulate matter (PM). Methane (CH_4) and nitrous oxide (N_2O) were the pollutants with the least amount of emissions recorded in Jamaica (Table 3.1).

Table 3.1 Emissions to Air: 2017, tonnes

Pollutant	Total Emissions
Particulate Matter (PM)	12,723
Sulphur Oxides (SO_x)	63,408
Nitrogen Oxides (No_x)	39,020
Volatile Organic Compounds (VOC)	1,477
Carbon Dioxide (CO_2)	4,893,295
Nitrous Oxide (N_2O)	41
Methane (CH_4)	62

Source: National Environment and Planning Agency

CONSUMPTION OF OZONE DEPLETING SUBSTANCES (ODSs)

Ozone (O_3) is a special form of oxygen that forms a layer in the stratosphere. This layer shields the surface of the Earth from ultraviolet radiation from the sun. Without the ozone layer, Earth would become inhabitable for most forms of life. Ozone depletion or loss in the stratosphere is caused by chlorofluorocarbons (CFCs) used in aerosol cans, air conditioners and refrigerators, insulation and packaging (e.g., Styrofoam) and in solvents. Other ozone-depleting substances (ODS) are halons, methyl bromide, methyl chloroform, carbon tetrachloride and nitrous oxide.

EMISSIONS OF OTHER SUBSTANCES

Particulate matter (PM) consists of solids (dust) and liquids (mist) that are suspended in the air. This includes pollutants such as soil particles, soot, lead, asbestos, sea salt and sulphuric acid droplets. There are different fractions of PM (e.g., $PM_{2.5}$ and PM_{10}) used to measure levels of pollution. The statistics on emissions of PM_{10} are covered in Component 1.

SUB-COMPONENT 3.2 GENERATION AND MANAGEMENT OF WASTEWATER

Wastewater, including sewage, is carried through drains and sewers and contains human wastes from households and businesses. The treatment of these wastes is essential as disease-causing agents in wastewater can pose a serious threat to public health if the wastewater is not properly managed and treated.

There are three types of treatment for raw sewerage at treatment plants. The first is the primary treatment, a physical process where sand and silt are separated from the wastewater and solid matter is allowed to settle. This treatment does not eliminate the inorganic and organic compounds in the water. Secondary treatment is a biological process where micro-organisms are used to decompose the suspended organic material. The tertiary treatment utilises a biological, chemical and physical process to remove other organic and inorganic substances.

COLLECTION AND TREATMENT OF WASTEWATER

The National Water Commission (NWC) operates most wastewater sewerage treatment plants in Jamaica. The agency uses various types of sewerage treatment, including oxidation ditches, activated sludge, waste stabilization ponds and primary treatment. There are central sewerage systems in Kingston and St Andrew, south-east St Catherine (Portmore), St James, St Ann and Westmoreland. The NWC is also responsible for smaller sewerage systems in various housing developments around the island. Information on selected treatment plants and the type of treatment are shown in Table 3.2.

Table 3.2 Types of Wastewater Treatment by Parish: 2018

Parish	Type of Treatment	Number
Kingston & St Andrew	Extended Aeration	6
	Contact Stabilization	5
	Primary Treatment	2
	Sand Filter	1
St Thomas	Extended Aeration	1
	Waste Stabilization Ponds	1
Portland	Oxidation Ditch	2
St Mary	Oxidation Ditch	1
	Septic Tank/Tile Field	1
St Ann	Oxidation Ditch	2
Trelawny	Oxidation Ditch	1
St James	Trickling Filter	1
Westmoreland	Oxidation Ditch	1
	Extended Aeration	1
Clarendon	Aerated Lagoon	2
	Waste Stabilization Ponds	2
	Oxidation Ditch	2
	Contact Stabilization	1
St Catherine	Waste Stabilization Ponds	3
	Contact Stabilization	4
	Oxidation Ditch	5
	Slow Sand Filter	1
	Aerated Lagoon	1
	Extended Aeration	1

Source: National Water Commission

SUB-COMPONENT 3.3 GENERATION AND MANAGEMENT OF WASTE

The United Nations defines waste as materials that are not prime products (that is, products produced for the market) for which the generator has no further use and which he/she wants to dispose of. Waste may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products and other human activities. It should be noted that residuals that are recycled or reused at the place of generation are excluded.

GENERATION OF WASTE

There is no solid waste in nature as waste from one organism becomes nutrients for other organisms. Humans, on the other hand, directly or indirectly produce some solid waste. Waste from households (direct waste) is called garbage. Indirect wastes are produced from mines, factories, agriculture and businesses that supply goods and services. The residues produced are an unnecessary waste of Earth's resources. They are responsible for large amounts of pollutants that affect air, water, soil and degrade the land.

Imports and exports of waste

As a proxy for the volume of waste generated, the amount of selected types of waste and scrap materials exported from Jamaica is shown in Table 3.3. Scrap is defined as discarded or rejected materials that result

from manufacturing or fabricating operations and are suitable for reprocessing. The export of all waste and scrap materials increased in 2017 compared to 2016 except for waste and scrap of precious metal other than gold, and waste and scrap of alloy steel.

Table 3.3 Exports of Waste and Scrap: 2013-2017, tonnes

Type of waste & scrap	2013	2014	2015	2016	2017
Waste & scrap of stainless steel	0	0	24	21	78
Waste & scrap of tinned iron or steel	0	0	2,662	8,856	14,959
Other ferrous waste & scrap n.e.s.	7,871	9,197	10,449	17,572	25,471
Aluminium waste & scrap	679	201	393	969	1,186
Waste & scrap of gold	1	20	…	…	18
Waste & scrap of precious metal other than gold	…	…	…	49	…
Waste & scrap of alloy steel	0	0	0	84	1
Waste & scrap of cast iron	32,691	66,088	12,839	965	2,570
Copper waste & scrap	29	280	153	118	149

Source: Statistical Institute of Jamaica
… Volumes less than one tonne.

Hazardous waste

Hazardous waste is considered to be any substance which, due to its chemical activity, toxicity, explosivity, corrosivity or other characteristics, cause or is likely to cause danger to health or the environment, whether of itself or on contact with other waste[9]. Examples of hazardous waste are radioactive waste, mining waste, dry-cell batteries, pesticides, used motor oil, paints and paint strippers and septic tank cleaners.

Jamaica is a signatory to several multilateral environmental agreements (MEAs) [10] related to the management of chemical and hazardous wastes. These include the:

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal,
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade,
- Stockholm Convention on Persistent Organic Pollutants (POPs), and
- Minamata Convention on Mercury and the Strategic Approach to International Chemicals Management (SAICM).

[9] National Policy for the Environmentally Sound Management of Hazardous Waste (Green Paper), (GOJ,2017)
[10] See Component 6

In 2017, the Government of Jamaica tabled the National Policy for the Environmentally Sound Management (ESM) of Hazardous Waste in Parliament. This policy guides public sector decision-makers, the private sector, public interest and non-governmental organizations on issues related to the management of hazardous waste, including the special requirements for labelling, packaging, storage, transportation and treatment of such waste.

Imports and exports of hazardous waste

The National Environment and Planning Agency (NEPA) receives applications for the export and transhipment of hazardous waste. In 2018, of the nine applications received to export hazardous waste, six (66.7%) were approved. There was only one application for the transit of hazardous waste in 2018 (Table 3.4). Table 3.4 shows that of the 11 applications received in 2019 by NEPA to export hazardous waste, nine (81.8%) were approved. Additionally, all three applications submitted for the transit of hazardous wastes were approved. More transboundary applications were received and approved in 2019 when compared to 2018 (Table 3.4).

Table 3.4 Transboundary Movement Applications Received and Approved: 2018 and 2019

Year	Application Type	Received	Approved
2018	Exports of hazardous waste	9	6
	Transit of hazardous waste	1	1
2019	Exports of hazardous waste	11	9
	Transit of hazardous waste	3	3

Source: National Environment and Planning Agency

The Natural Resources Hazardous Wastes and Control of Transboundary Movements Regulations (2002) includes provisions relating to the import, export and transit of hazardous wastes into and through Jamaica. A permit is required from NEPA to export hazardous waste. Table 3.5 shows that 2,499.42 metric tonnes of used lead acid batteries were exported during the period. The importation of hazardous waste is prohibited within all areas under Jamaica's jurisdiction.

Table 3.5 Hazardous Waste Exported: 2019, metric tonnes

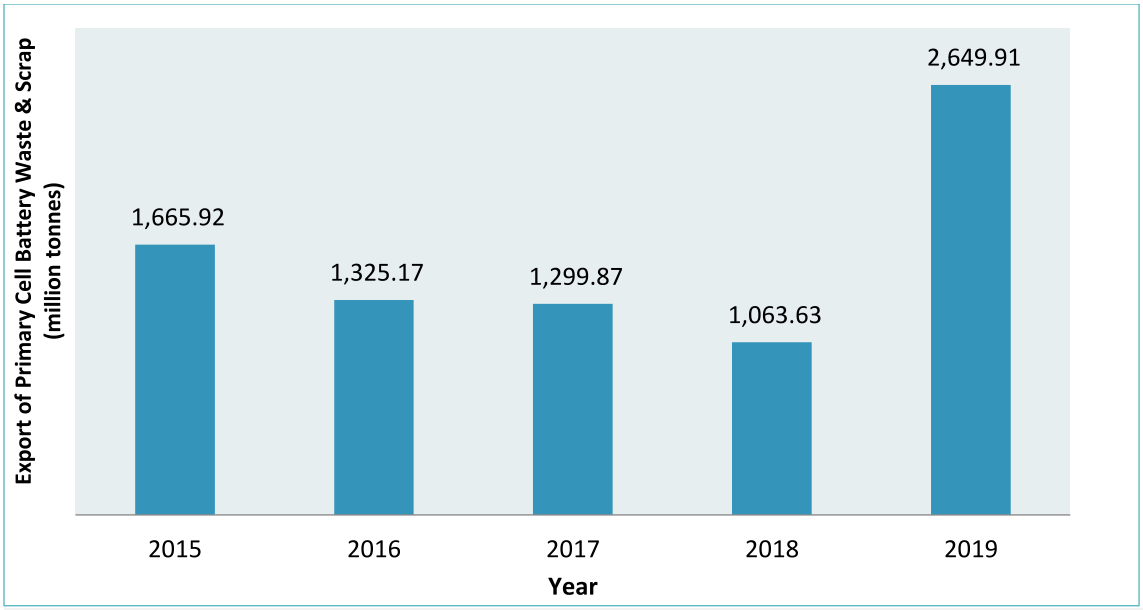
Type of Hazardous Waste	Quantity
Used Lead Acid Batteries	2,499.42

Source: National Environment and Planning Agency

Note: In 2017, 28,000 gallons of paint-related waste was exported.

A primary cell battery, also referred to as 'disposable battery', is one that cannot easily be recharged after use and, as such, is discarded and replaced. Primary cell batteries include zinc-carbon batteries, alkaline batteries, button cell batteries and lithium batteries. These batteries are used in items such as remotes, toys, hearing aids and watches. Proper disposal of these batteries is important to avoid contamination of landfills.

Figure 3.2 shows that from 2015 to 2018, there was a 36.2 per cent decrease in the export of used primary cell batteries and scrap. The data also show a 149.1 per cent increase in exports in 2019 when compared to 2018.



Source: National Environment and Planning Agency

Figure 3.2 Export of Primary Cell Battery Waste & Scrap: 2014 - 2019, million tonnes

SUB-COMPONENT 3.4 RELEASE OF CHEMICAL SUBSTANCES

RELEASE OF CHEMICAL SUBSTANCES

This topic looks at chemical fertilisers and pesticides that can affect water, land and living organisms through the build-up of contaminants. As it is difficult to estimate the volume of chemicals that remain in the environment, the amount of natural and chemical fertilisers, pesticides and other chemicals traded is used as a proxy. Statistics on the volume of fertilisers imported and the amount of pesticides imported and exported for Jamaica are reported in Component 2.

COMPONENT 4: EXTREME EVENTS AND DISASTERS

Statistics on the occurrence of events and disasters from natural phenomena and the failure of technology and the effect they have on human well-being and infrastructure are covered under this component.

SUB-COMPONENT 4.1 NATURAL EXTREME EVENTS AND DISASTERS

Natural extreme events are occurrences over which we have no control. When they destroy lives and property, they are called disasters. A natural disaster is an event resulting from natural processes for which nations require national or international assistance. Types of natural hazards are floods, earthquakes, droughts, landslides, fires, tsunamis, cyclones, volcanic eruptions, typhoons, mudslides, blizzards and avalanches. Some disasters are sudden onset events and cannot be avoided (e.g., earthquakes and volcanic eruptions). Others, such as droughts, may be gradual but are a part of natural climate variations that human actions can be exacerbated.

In recent decades, climate change has been associated with increased extreme events that have led to more frequent, intense, destructive and deadly natural disasters. Climate change has increased global temperatures, rising sea levels, droughts, increased precipitation, floods, hurricanes, tornadoes and other climatic disruptions in many places around the world.

OCCURRENCE OF NATURAL EXTREME EVENTS AND DISASTERS

The extreme events that Jamaica has to contend with are floods, droughts, hurricanes, earthquakes and fires. Natural hazards may be localised or widespread, causing damage across many communities or parishes. Natural disasters can cause deaths and economic loss due to damage to agriculture and infrastructure, including buildings.

Table 4.1 Number of Persons Affected by Natural Disasters: 2002-2017

Year	Name of Event	Persons Affected per 100,000 population	Deaths per 100,000 population
2002	Flood Rains	50,021	0.344
2004	Hurricane Ivan	14,009	0.644
2005	Hurricanes Dennis & Emily	12,521	0.264
2005	Hurricane Wilma	13,669	0.113
2007	Hurricane Dean	6,744	0.225
2008	Tropical Storm Gustav	16,842	0.374
2010	Tropical Storm Nicole	18,873	0.520
2012	Hurricane Sandy	25,150	0.074
2017	March-June Rains	90,613	0.037

Source: Planning Institute of Jamaica

Note: Data shown only for periods when there was an actual event.

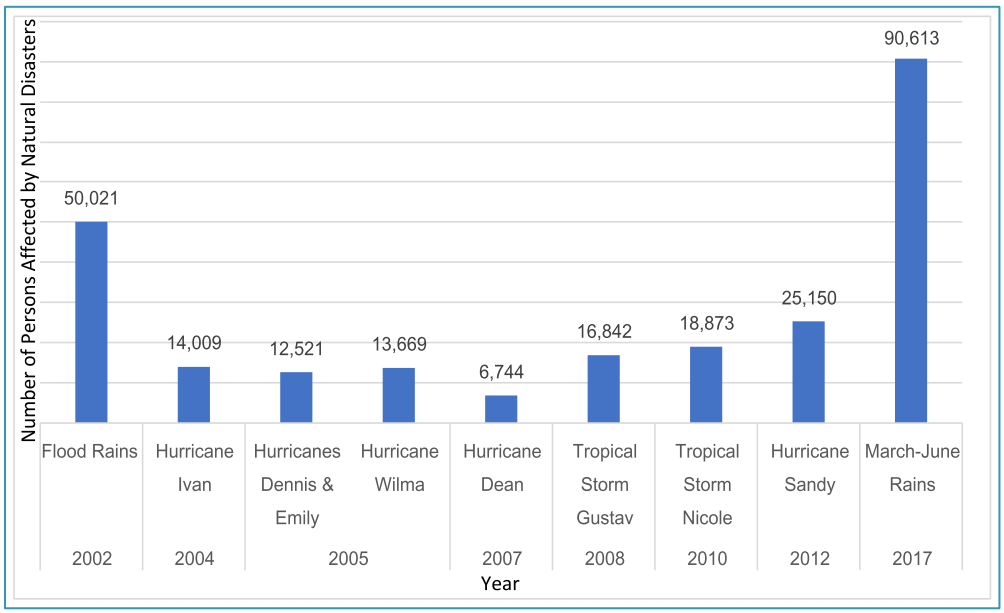
IMPACT OF NATURAL EXTREME EVENTS AND DISASTERS

The country has seen an increase in the number of persons affected by natural disasters from 2008 to 2017, as shown in Table 4.1 and Figure 4.1.

In Jamaica, the event that occurs most frequently is flooding, resulting from various weather systems such as hurricanes, storms, and cold fronts. Factors contributing to flooding include:

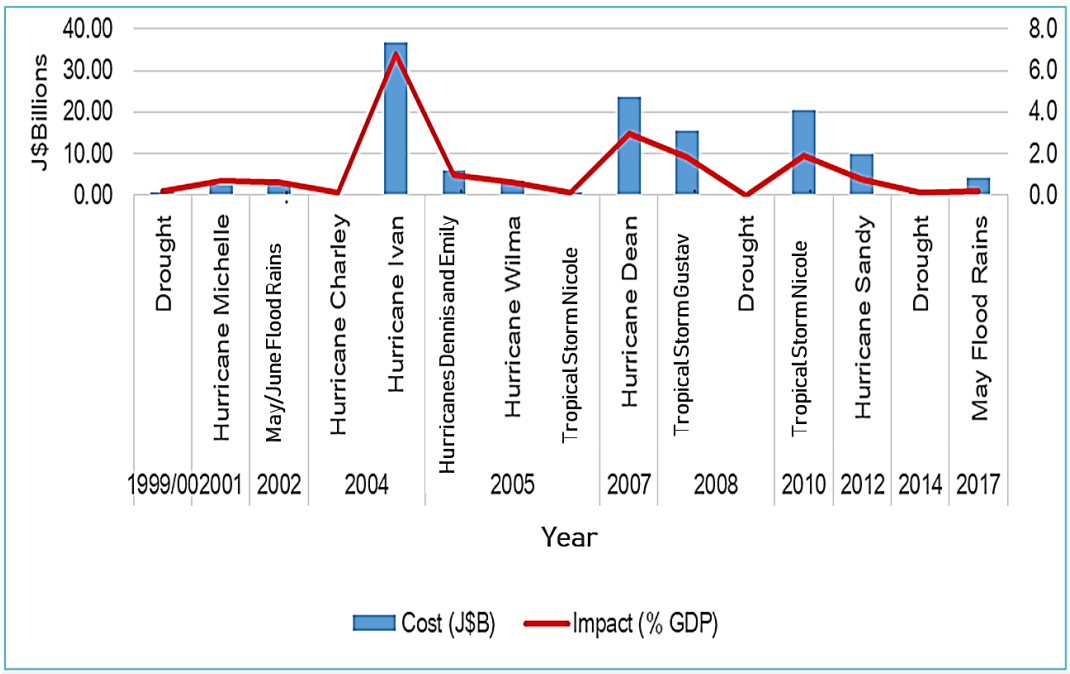
- heavy rainfall;

- 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;
- impervious surfaces such as paved urban areas, and
- clogged or blocked drainage channels.



Source: Planning Institute of Jamaica

Figure 4.1 Number of Persons Affected by Natural Disasters: 2002–2017



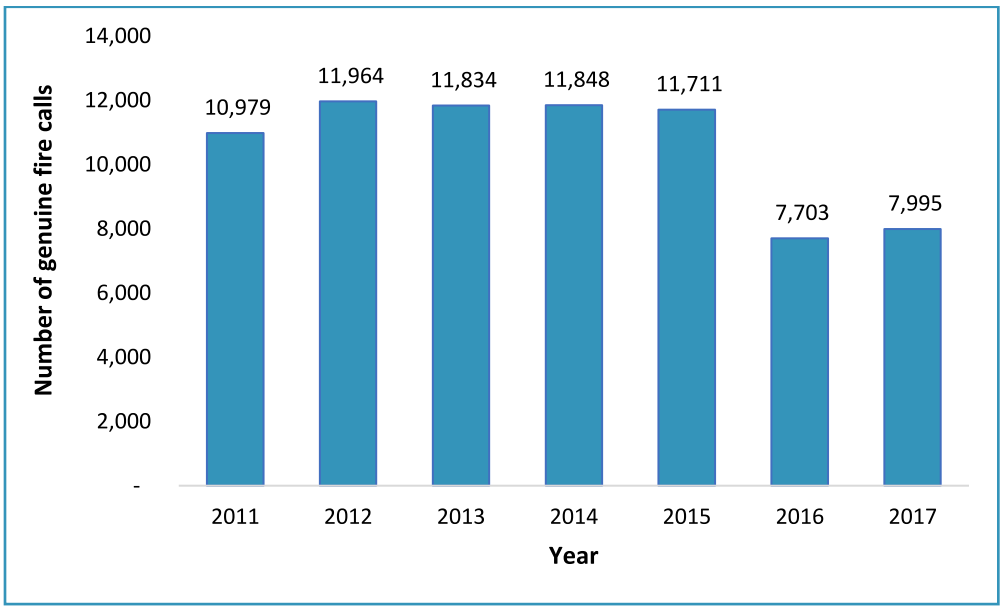
Source: Planning Institute of Jamaica

Figure 4.2 Economic Cost of Extreme Weather Events: 1999–2017

As the occurrence and intensity of natural extreme events and disasters increase globally, countries have faced greater social and economic impacts. In Jamaica, between 1999 and 2017, extreme weather conditions resulted in an estimated cost of J$127.95 billion or an average of 1.8 per cent of GDP per event (Figure 4.2). A significant amount of the damage reported between 1999 and 2017 was related to flooding. The flood rains in May 2017 was estimated to cost over J$4 billion.

Fires

Fires can kill or injure humans, plants and animals. Damaged vegetation may take hundreds of years to recover thus contributing to soil erosion. However, fires can also encourage new vegetation to grow by heating the soil, cracking seed coats and triggering germination of new plants. This will regenerate forested areas and provide food and forest products for animals and humans. There has been a decline in the total number of genuine fire calls since 2012, except in 2014 and 2017, as the data in Figure 4.3 shows. Genuine fire calls are calls to the Jamaica Fire Brigade that are not false alarms.



Source: Jamaica Fire Brigade

Figure 4.3 Number of Genuine Fire Calls: 2011–2017

Table 4.2 Number of Fire Calls by Type, by Parish: 2019

Parish	Genuine Fires	Malicious False Alarms	Fires Put Out Before Arrival of Brigade	Special Service Calls	Total Number of Calls
Kingston & St. Andrew	2,033	444	128	615	**3,220**
St. Thomas	438	35	3	42	**518**
Portland	366	33	13	50	**462**
St. Mary	678	42	15	60	**795**
St. Ann	1,048	19	1	146	**1,214**
Trelawny	365	46	18	81	**510**
St. James	988	96	99	362	**1,545**
Hanover	230	35	8	54	**327**
Westmoreland	326	33	30	58	**447**
St. Elizabeth	647	75	41	143	**906**
Manchester	653	86	32	121	**892**
Clarendon	525	58	6	56	**645**
St. Catherine	1,781	202	46	259	**2,288**
Total	**10,078**	**1,204**	**440**	**2,047**	**13,769**

Source: Jamaica Fire Brigade

Table 4.2 shows that the Jamaica Fire Brigade had a total of 13,769 fire calls in 2019 of which 8.7 per cent or 1,204 were malicious false alarms and 10,078 (73.2%) were genuine fires.

There were 769 more fire calls in 2019 compared to 2018, an increase of 8.3 per cent (Table 4.3). The data showed that fire calls decreased by 9.9 per cent over the five year period of 2015 to 2019. Kingston & St. Andrew and St. Catherine had the most fire calls. Portland and Hanover had the least fire calls (Table 4.3).

During the fully developed stage of a fire, temperatures can exceed 1000 ^{0}C leading to significant degradation in the strength and stiffness of structural materials (concrete, steel, wood, etc.) (Kodur, 2014). This structural degradation can lead to a partial or complete collapse of a building during or after a fire. A structure may be defined as a building constructed from several parts, such as concrete, steel and wood.

Table 4.3 Genuine Fire Calls by Parish: 2015 - 2019

Parish	2015	2016	2017	2018	2019
Kingston & St. Andrew	2,545	1,900	1,598	2,063	2,033
St. Thomas	728	347	353	346	438
Portland	211	140	118	276	366
St. Mary	522	207	160	390	678
St. Ann	653	631	516	826	1,048
Trelawny	359	298	232	331	365
St. James	1,039	626	711	748	988
Hanover	264	213	417	223	230
Westmoreland	512	508	426	290	326
St. Elizabeth	648	550	596	608	647
Manchester	1,055	622	738	549	653

Parish	2015	2016	2017	2018	2019
Clarendon	507	485	690	751	525
St. Catherine	2,147	1,176	1,440	1,908	1,781
Total	**11,190**	**7,703**	**7,995**	**9,309**	**10,078**

Source: Jamaica Fire Brigade

There were 1,526 structural fires in 2019, of which 75.9 per cent were residential (Table 4.4). Of the total structural fires, 26.1 per cent occurred in Kingston and St. Andrew, 14.4 per cent in St. Catherine and 9.0 per cent in St Ann. Four places of amusement and three animal shelters had structural fires in 2019.

Fires that did not occur in a structure, such as bush and motor vehicle fires are labelled as 'Other'. There were 7,783 'Other' fires in 2019, of which 1,689 (21.7%) were in St Catherine and 1,664 (21.4%) in Kingston and St. Andrew. Bush fires contributed to 66.0 per cent of 'Other' fires. The overall number of fires in 2019 was 9,309 (Table 4.4).

Table 4.4 Risk Classification of Fire Calls by Parish: 2019

	Structural								Other							
Parish	**Residential**	**Commercial Buildings**	**Hotels**	**Offices**	**Institutions**	**Places of Amusement**	**Animal Shelter**	**Total**	**Farm / Cultivated Land**	**Bush**	**Refuse Dump/Rubbish**	**Electrical Equipment**	**Motor Vehicle**	**Coal Kiln**	**Total**	**Grand Total**
Kingston & St. Andrew	298	48	2	50	1	0	0	**399**	0	594	756	209	90	15	**1,664**	**2,063**
St. Thomas	42	13	0	0	0	0	0	**55**	26	199	37	17	7	5	**291**	**346**
Portland	40	5	0	1	3	0	0	**49**	0	145	63	11	8	0	**227**	**276**
St. Mary	52	12	0	0	1	2	0	**67**	3	256	37	8	19	0	**323**	**390**
St. Ann	107	23	3	1	2	1	0	**137**	0	542	64	40	33	10	**689**	**826**
Trelawny	27	14	2	0	0	0	0	**43**	18	208	42	7	13	0	**288**	**331**
St. James	85	31	2	0	0	0	0	**118**	1	396	163	45	25	0	**630**	**748**
Hanover	45	7	0	0	0	0	0	**52**	10	110	28	18	5	0	**171**	**223**
Westmoreland	93	13	4	3	2	0	1	**116**	36	89	26	14	9	0	**174**	**290**
St. Elizabeth	63	19	1	0	5	1	2	**91**	54	360	32	35	35	1	**517**	**608**
Manchester	69	11	0	3	2	0	0	**85**	1	380	31	34	16	2	**464**	**549**
Clarendon	70	24	0	1	0	0	0	**95**	9	574	18	33	22	0	**656**	**751**
St. Catherine	167	49	0	0	3	0	0	**219**	46	1,284	208	69	81	1	**1,689**	**1,908**
Total	**1,158**	**269**	**14**	**59**	**19**	**4**	**3**	**1,526**	**204**	**5,137**	**1,505**	**540**	**363**	**34**	**7,783**	**9,309**

Source: Jamaica Fire Brigade

Table 4.5 Deaths and Injuries Related to Fire: 2019

Parish	Deaths						Injuries					
	Firefighters	Adult		Children		Total	Firefighters	Adult		Children		Total
		Male	Female	Male	Female			Male	Female	Male	Female	
Kingston & St. Andrew	0	6	0	2	2	**10**	7	23	0	0	0	**30**
St. Thomas	0	0	0	0	0	**0**	0	0	0	0	0	**0**
Portland	0	1	1	0	0	**2**	0	0	0	1	0	**1**
St. Mary	0	4		0	0	**4**	0	0	0	0	0	**0**
St. Ann	0	2	1	0	0	**3**	0	4	0	1	0	**5**
Trelawny	0	1	0	0	0	**1**	0	3	0	0	0	**3**
St. James	0	2	0	2	0	**4**	4	6	0	0	0	**10**
Hanover	0	0	0	0	0	**0**	0	2	0	0	0	**2**
Westmoreland	0	1	0	0	0	**1**	1	2	0	0	0	**3**
St. Elizabeth	0	1	1	0	1	**3**	0	0	0	0	0	**0**
Manchester	0	3	0	0	0	**3**	0	1	0	0	0	**1**
Clarendon	0	0	0	0	0	**0**	0	0	0	0	0	**0**
St. Catherine	0	3	1	0	0	**4**	2	3	0	0	0	**5**
Total	**0**	**24**	**4**	**4**	**3**	**35**	**14**	**44**	**0**	**2**	**0**	**60**

Source: Jamaica Fire Brigade

As shown in Table 4.5, there were 35 deaths and 60 injuries caused by fire in 2019. Adult males accounted for 68.6 per cent of deaths and adult females 11.4 per cent. Seven children died as a result of fire, four males and three females. Fourteen firefighters (23.3%) sustained injuries. Forty-four adult males and two male children received injuries.

Table 4.6 shows that a total of 2,316 people lost their homes as a result of fire in 2019. Of those who became homeless, 1,531 were adults and 785 were children.

Table 4.6 Loss of Home due to Fire: 2019

Parishes	Homeless			
	Firefighter	Adult	Children	Total
Kingston/St. Andrew	0	576	314	890
St. Thomas	0	17	8	25
Portland	0	56	25	81
St. Mary	0	40	16	56
St. Ann	0	124	58	182
Trelawny	0	37	4	41
St. James	0	99	62	161
Hanover	1	30	20	50
Westmoreland	0	80	30	110
St. Elizabeth	0	79	48	127
Manchester	0	62	32	94
Clarendon	0	71	34	105
St. Catherine	0	260	134	394
Total	**1**	**1531**	**785**	**2316**

Source: Jamaica Fire Brigade

SUB-COMPONENT 4.2 TECHNOLOGICAL DISASTERS

OCCURRENCE OF TECHNOLOGICAL DISASTERS

A technological disaster may result from human intent, negligence, error and defective or failed technological applications. These are serious as natural disasters. The effects may appear gradually over a few years or immediately, disrupting society and the economy.

A technological disaster is an event caused by a malfunction of a technological structure and/or some human error in controlling or handling the technology (Emergency Disaster Information Service (EDIS)). Examples of such disasters are: a train crash, a boat capsizing, chemical emissions leading to illness or death etc.

Over the past two years, Jamaica has been undergoing major infrastructure development, particularly roads within the corporate area. In December 2018, the rupture of a major 18-inch pipeline that served communities within the corporate area caused the service of approximately 17.0 per cent (105,000) of the National Water Commission's customers in Kingston and St Andrew to be disrupted. The pipeline was deemed impossible to repair and had to be replaced.

IMPACT OF TECHNOLOGICAL DISASTERS

The 2017 Cybercrime Report by the Herjavec Group, states that cybercrime will cost the world US$6 trillion annually by 2021, a 100 per cent increase from US$3 trillion in 2015.

With the increased utilisation and reliance on technology, technological recovery should be included as an important part of the overall disaster recovery process. Access to telephone services, automated teller machines (ATMs), traffic lights and e-mails is impossible without technological systems. There is growing concern globally about cyber threats, the tactics, techniques and procedures used to gain access to a computer or network systems with the malicious intent to steal, corrupt or disrupt. It is estimated that Jamaica lost US$100 million in 2016[11] due to cybercrime.

[11] Statement from Trevor Forrest, Senior Adviser, Ministry of Science, Energy and Technology

COMPONENT 5: HUMAN SETTLEMENTS AND ENVIRONMENTAL HEALTH

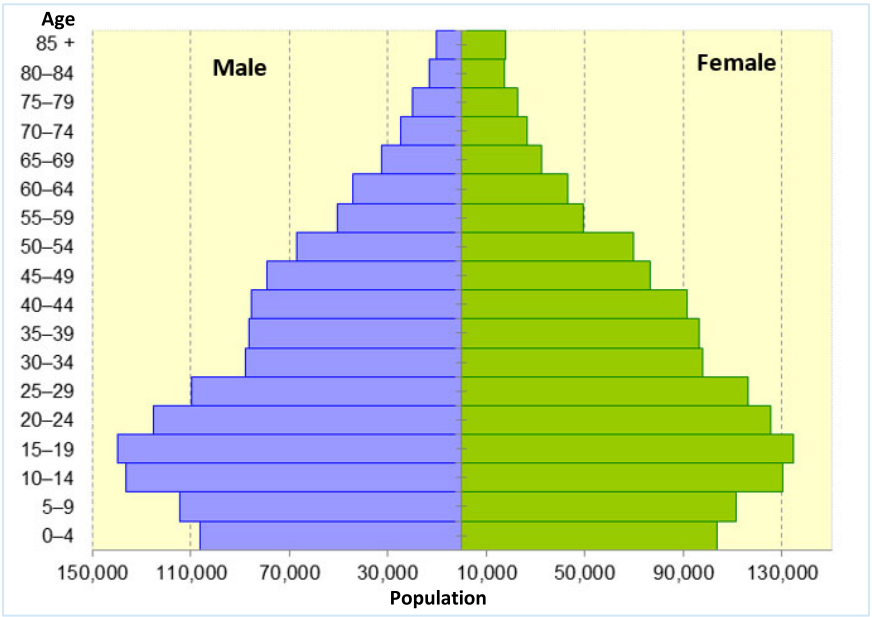
Component 5 contains statistics on the environment in which humans live and work, focusing on living conditions and environmental health. Statistics contained here are important for the overall management and improvement of conditions that are associated with human settlements, shelter conditions, safe water, sanitation and health, as well as issues relating to rapid urbanization (e.g. increased pollution and extreme events).

SUB-COMPONENT 5.1 HUMAN SETTLEMENTS

A human settlement is defined as "a group of persons in a specified place. A national system of settlements includes metropolitan areas, towns, villages, plantation estates, mining camps and recreation areas. The structural areas of human settlements include industries, transport facilities, storage, housing, community facilities, parks and recreation" (UN-Habitat).

The physical elements of a human settlement include shelter, infrastructure and services. The impact that human societies have on the environment relates to its size, production and consumption patterns, demand and use of technology and resources to supply goods and services and the effectiveness of preventing environmental degradation.

Data from the 2011 Population and Housing Census of Jamaica indicated that the population is ageing. The pyramid (Figure 5.1) shows that after the 10-14 and 15-19 age groups there is a visible decrease in the successive 0-4 and 5-9 age groups. This trend is consistent for both males and females.



Source: Statistical Institute of Jamaica

Figure 5.1 Population Size by Five-Year Age Group: 2011 Population and Housing Census, 2011

There was minimal growth in Jamaica's end of year population (0.5%) between 2015 and 2019 (Table 5.1). There are consistently more females than males over the five year period.

Table 5.1 End-of-Year Population by Sex: 2015 – 2019

Sex	2015	2016	2017	2018	2019
Female	1,373,191	1,374,518	1,377,065	1,380,063	1,381,983
Male	1,346,279	1,347,146	1,348,817	1,350,919	1,352,109
Total	2,719,470	2,721,664	2,725,882	2,730,982	2,734,092

Source: Statistical Institute of Jamaica

URBAN AND RURAL POPULATION

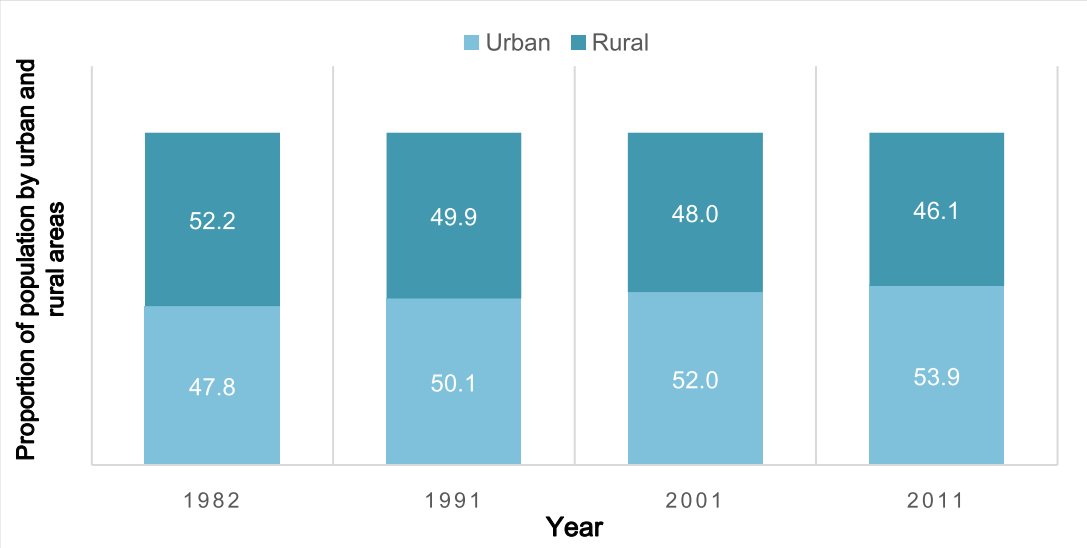
The United Nations estimates that urbanization, the gradual shift in the residence of the human population from rural to urban areas, combined with the overall growth of the world's population, could see the addition of approximately 2.5 billion people to urban areas by 2050, with close to 90.0 per cent of this increase taking place in Asia and Africa.

The growth in the number and size of urban areas has created several pressures on cities and the natural environment. One such pressure is the increased number of urban residents who live in slums due, in part, to urbanization, population growth and a lack of appropriate land and housing policies.

A lack of proper access to essential services such as water supply and sanitation, safe energy and adequate public transport may result from rapid urban population growth and increasing urban poverty. Additionally, rapid urban growth, coupled with more frequent and extreme weather events, gives rise to environmental threats and strains on basic infrastructure. Environmental threats such as flooding, heat waves and epidemics can cause major financial loss and deaths. Urban sprawl in Jamaica has seen a decline in resources such as uninterrupted water supply, agricultural lands, green spaces and an increase in energy demand.

Source: Statistical Institute of Jamaica

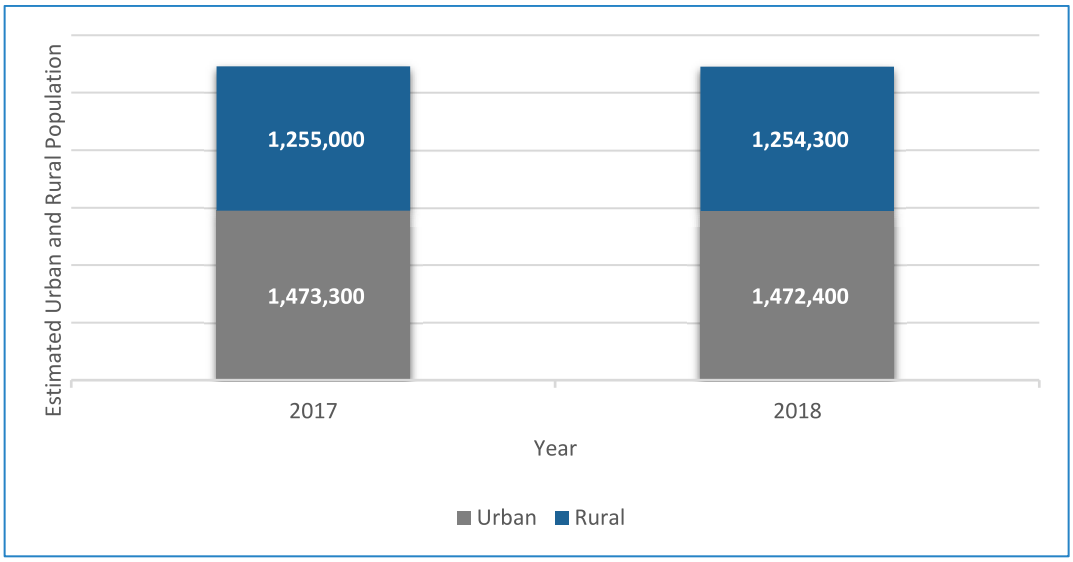
Figure **5.2** shows an increase in urban areas in the country. In 1982, 47.8 per cent of Jamaicans were urban dwellers. However, by 2011, approximately 53.9 per cent of the population lived in urban areas.



Source: Statistical Institute of Jamaica

Figure 5.2 Proportion of Population in Urban and Rural Areas: 1982, 1991, 2001 and 2011 Censuses, per cent

It is estimated that 55.0 per cent of the global population live in urban areas. This is expected to increase to 68.0 per cent by 2050. Figure 5.3 shows the estimated population living in urban and rural areas in 2017 and 2018, respectively. In both years, it was estimated that 54.0 per cent of the population resided in urban areas coinciding with the global estimate.



Source: Statistical Institute of Jamaica

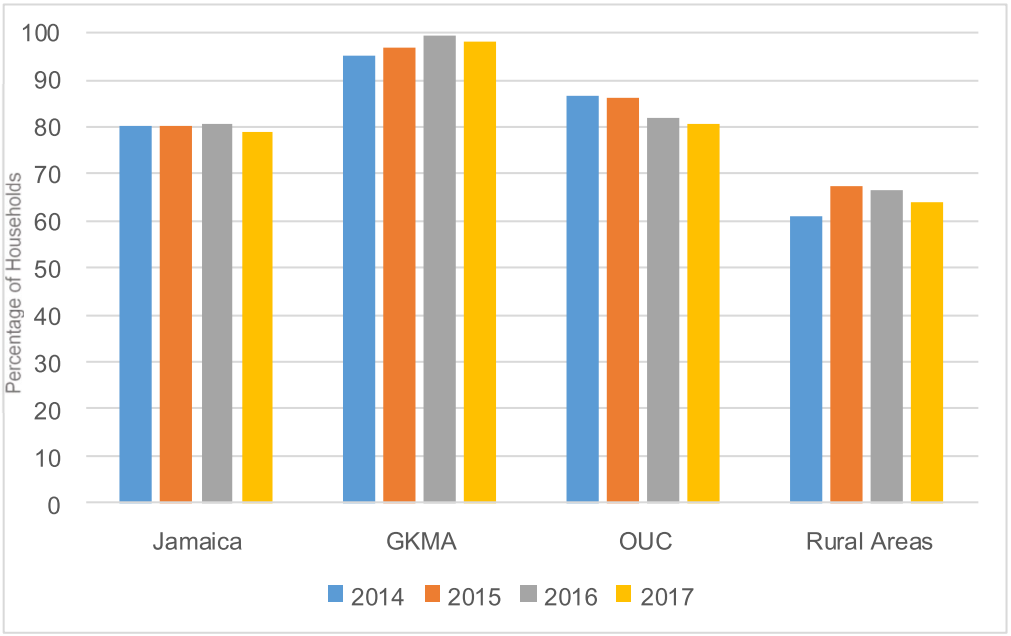
Figure 5.3 Estimated Urban and Rural Population: 2017 and 2018

Note: Data for 2018 is preliminary.

ACCESS TO SELECTED BASIC SERVICES

Water

Approximately 80.0 per cent of the population had access to clean drinking water in 2017. The area with the greatest access was the Greater Kingston Metropolitan Area (GKMA), with 98.1 per cent of households having access to a safely managed drinking water source compared to 64.1 per cent in rural areas (Figure 5.4).

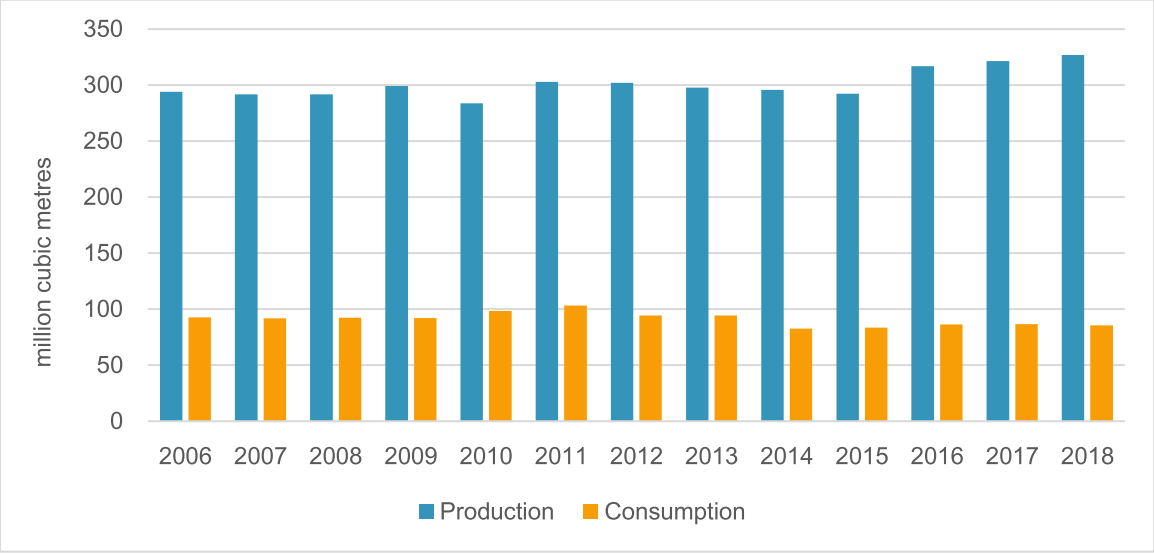


Source: Jamaica Survey of Living Conditions 2018

Figure 5.4 Proportion of Population Using Safely Managed Drinking Water by Region: 2014–2017, per cent

Note: OUC – Other Urban Centre

The volume of water produced by the National Water Commission is not commensurate with the reported consumption of water (Figure 5.5).



Source: National Water Commission

Figure 5.5 Production and Consumption of Water: 2006–2018, million m^3

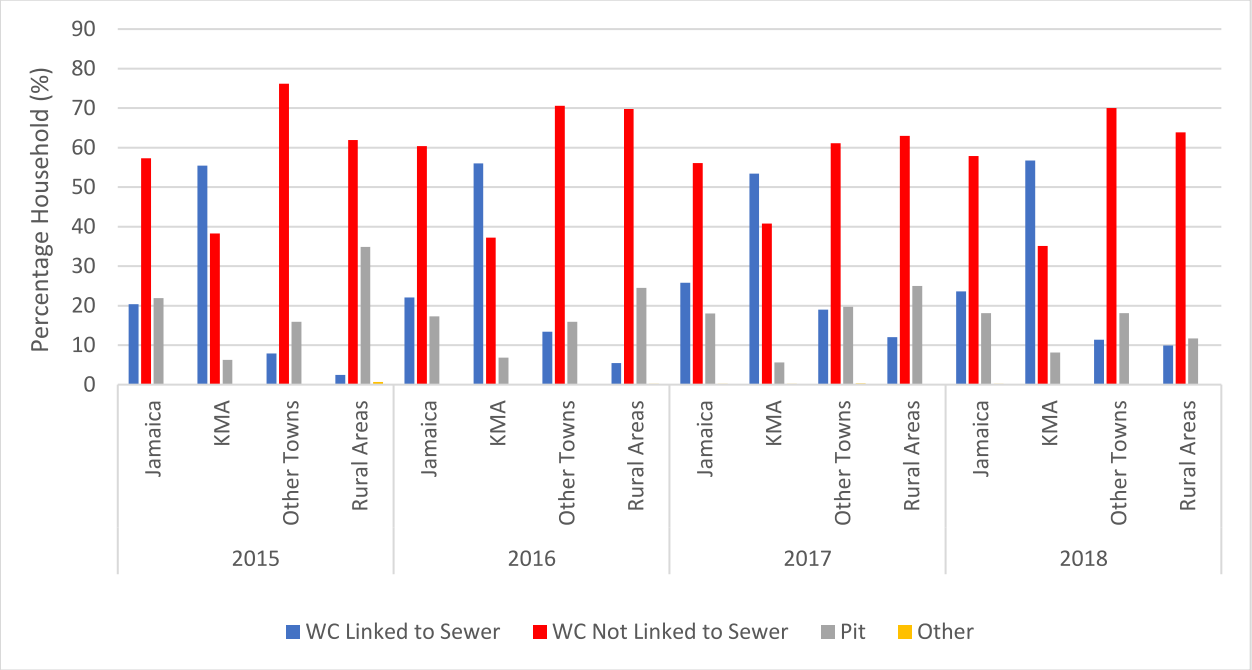
In 2018, of the 327.0 million cubic metres (m^3) of water produced, only 85.6 million m^3 or 26.2 per cent was delivered to customers. The remainder of water produced by the NWC is regarded as being lost during transmission and due to illegal connections. The average water delivered to customers from 2006 to 2018 was 30.3 per cent of what was produced.

Access to toilet facilities

Sanitation systems such as toilets and wastewater treatment facilities are important in containing and treating human excreta and greywater (from kitchen sinks and showers). They aid in the protection of human health and the environment.

An observation of the changes since 2015 showed an increase in the use of water closets coinciding with a decline in the use of pit latrines. For the 2016- 2018 period approximately 82 per cent of households had access to water closets (flush toilets), an overall estimated increase of 4.0 per cent when compared to 2015. On the other hand, the use of pit latrines for the 2015-2018 period showed an overall decline of 3.8 per cent.

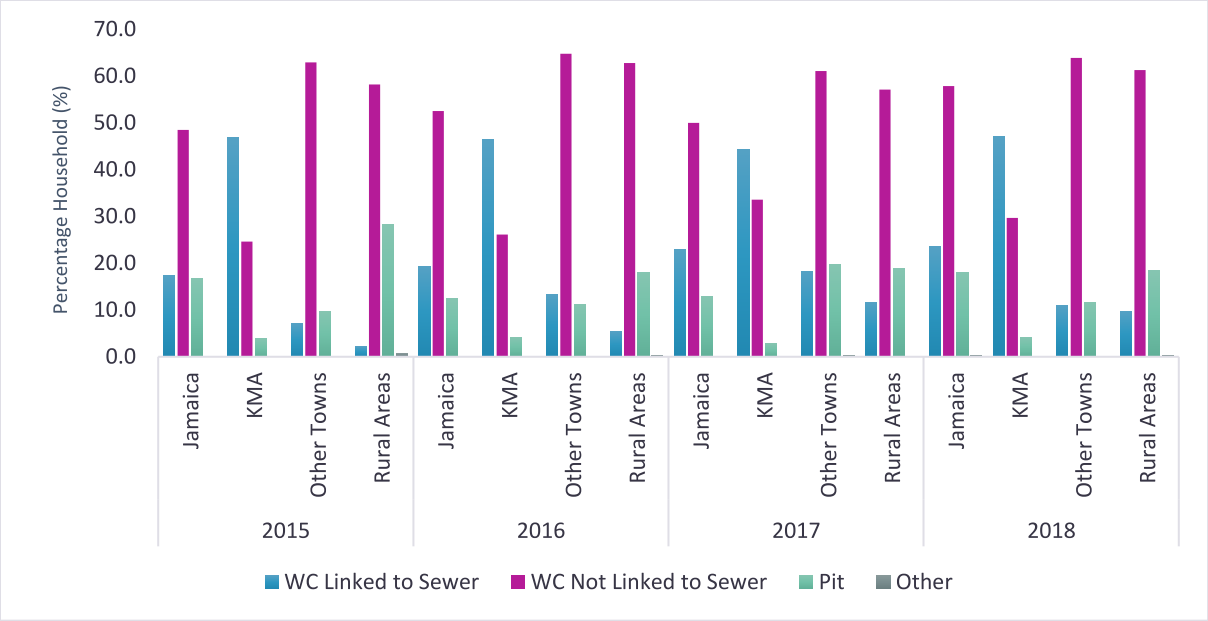
There are marked differences in access to flush toilets between the urban and rural areas. In 2018, approximately 91.8 per cent of the households in GKMA had access to flush toilets compared to approximately 73.8 per cent of rural households.



Source: Jamaica Survey of Living Conditions, 2015 - 2018

Note: Persons who responded "none" were not included.

Figure 5.6 Proportion of Households with Access to Toilet Facilities: 2015–2018, per cent



Source: Jamaica Survey of Living Conditions, 2015 - 2018

Figure 5.7 Households With Exclusive Use of Toilet Facilities by Region

In 2018, 81.5 per cent of households had exclusive use of their toilet facilities, an 8.6 per cent increase over 2017 (Figure 5.7). Exclusive use means that the households have toilet facilities that are not shared with another household. The proportion of households with exclusive use in the GKMA increased, moving from 71.5 in 2015 to 78.0 per cent in 2017. The highest percentage of households with exclusive use in 2018 (76.8%) was recorded in KMA, followed by Other Towns (74.8%) (Figure 5.7).

Wastewater Treatment

The main reasons for treating wastewater are for:

- The protection of the natural environment, including rivers, seas and coral reefs, from the damaging effects of untreated wastewater.
- The support of important life systems and ecosystems.

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 its 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.

Wastewater is essentially a combination of liquid or water carried waste removed from residences and institutions, and commercial and industrial entities. As human beings come together in closer living communities, the waste generated becomes a real threat to health and well-being. If this waste is not collected, treated and properly disposed of, it may damage the environment and plant life, cause illness and sometimes, even death.

The National Water Commission is the primary provider of wastewater or sewage services in Jamaica and

collects wastewater from over 700,000 customers islandwide. Table 3.2 in Component 3 shows the different treatment types applied to the wastewater by the National Water Commission.

Garbage disposal

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 amount of waste generated per year as illegal dumping of waste also takes place in gullies, rivers, the sea and open lots.

In 2017, 67.7 per cent of persons in Jamaica used a public collection system to dispose of their garbage and 27.4 per cent engaged in burning/burying (Table 5.2). Approximately 4.0 per cent dumped their garbage in places such as gullies, river, sea, ponds, their yards and municipal sites. There is a disparity in the use of public collection systems between Kingston Metropolitan Area (KMA) and Rural Areas across all years, recording 91.3 per cent and 49.0 per cent in 2013 and 88.8 per cent and 51.9 per cent in 2017, respectively.

Table 5.2 Percentage Distribution of Method of Garbage Disposal by Region: 2013–2017

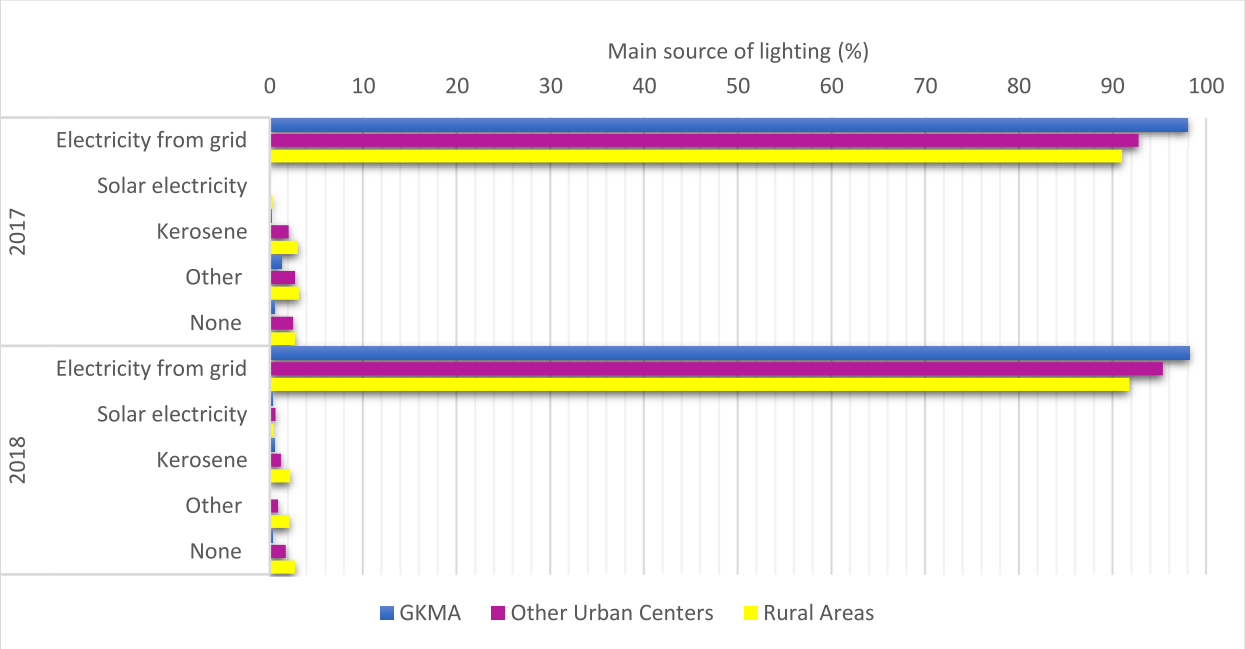
Year	Region	Regular Public Collection	Irregular Public Collection	Private Collection	Burn/Bury	Dumping
2013	KMA	70.7	20.6	0.0	5.5	3.0
	Other Town	64.1	11.9	0.0	17.4	6.7
	Rural Areas	38.7	10.3	0.1	47.6	3.3
	Jamaica	**54.2**	**13.8**	**0.1**	**28.0**	**4.0**
2014	KMA	73.2	17.9	0.0	8.2	0.7
	Other Town	59.1	12.9	0.2	20.9	7.0
	Rural Areas	39.1	8.2	0.1	48.4	4.1
	Jamaica	**54.5**	**12.4**	**0.1**	**29.4**	**3.5**
2015	KMA	76.0	16.0	0.5	7.6	0.0
	Other Town	56.0	14.8	7.0	22.3	0.0
	Rural Areas	31.1	9.3	2.8	56.8	0.0
	Jamaica	**50.4**	**12.6**	**3.0**	**34.0**	**0.0**
2016	KMA	83.8	6.6	0.2	6.4	2.6
	Other Town	56.4	14.4	0.0	25.6	3.6
	Rural Areas	43.5	9.7	0.0	40.4	6.2
	Jamaica	**59.7**	**9.6**	**0.0**	**26.0**	**4.6**
2017	KMA	77.0	11.8	0.3	0.9	2.8
	Other Town	51.2	17.2	0.8	26.4	3.9
	Rural Areas	37.8	14.1	0.1	42.3	5.1
	Jamaica	**53.8**	**13.9**	**0.3**	**27.4**	**4.1**

Source: Jamaica Survey of Living Conditions 2018

Note: Dumping includes disposal in gully, river, sea, pond, own yard, municipal site and other areas.

Electricity

Electricity is important to human health as it sustains medical equipment, assists in keeping food fresh and aids in technological development. Nearly all types of electric power plants have an effect on the environment, as the generation of electric power is a major contributor to pollution. Figure 5.8 shows that the main source of lighting for most respondents was electricity from the grid, 98.2 per cent in the GKMA, 95.4 per cent in Other Urban Centres and 91.8 per cent in Rural Areas in 2018. There was an increase in the use of electricity across all areas with Other Urban Centres showing the greatest increase of 2.6 per cent in 2018 when compared to the previous year.



Source: Jamaica Survey of Living Conditions 2017 & 2018

Figure 5.8 Main Source of Lighting by Region: 2017 & 2018

Population using public modes of transport

The different modes of transport – 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.

According to the 2011 Population and Housing Census, the main form of transportation for 998,990 persons were route taxis and 241,369 persons were transported by the Jamaica Urban Transit Company (JUTC)/Government buses(Table 5.3). Over 800,000 persons utilised other modes of transport such as private motor cars, bikes and company vehicles.

Table 5.3 Population (Three Years and Over) by Usual Mode of Transport

Mode of Transport	Number	Percentage (%)
Route taxi	998,990	39.1
JUTC/Government	241,369	9.4
Robot taxi	189,569	7.4
Minibus	166,624	6.5
Coaster/Hino bus	57,262	2.2
Chartered vehicle	28,250	1.1
Hackney carriage taxi	5,316	0.2
Other modes of transport	816,747	32.0
Never went out	26,934	1.1
Not Stated	23,250	0.9
Total	**2,554,311**	**100.0**

Source: Statistical Institute of Jamaica - Population and Housing Census, 2011

Table 5.4 Mode of transportation for students by region: 2018, per cent

	Mode of Transportation				
Region	Public	Walk	Private Vehicle	School Bus	Other
GKMA	53.7	26.8	18.5	0.4	0.7
Other Urban Centres (OUC)	65.3	19.9	11.9	2.1	0.8
Rural Areas	73.5	17.7	6.2	2.1	0.4

Source: Jamaica Survey of Living Conditions 2018

Students in Rural Areas (73.5 %) and OUC (65.3 %) were more likely to take public transportation compared with those in the GKMA (53.7 %). The GKMA had a higher percentage of students that walked (26.8 %) and used private vehicles (18.5 %) when compared to other regions.

COMPONENT 6: ENVIRONMENTAL PROTECTION, MANAGEMENT AND ENGAGEMENT

The protection and conservation of the natural environment and the resources within a country are mainly the government's responsibilities through initiating and passing policies and laws.

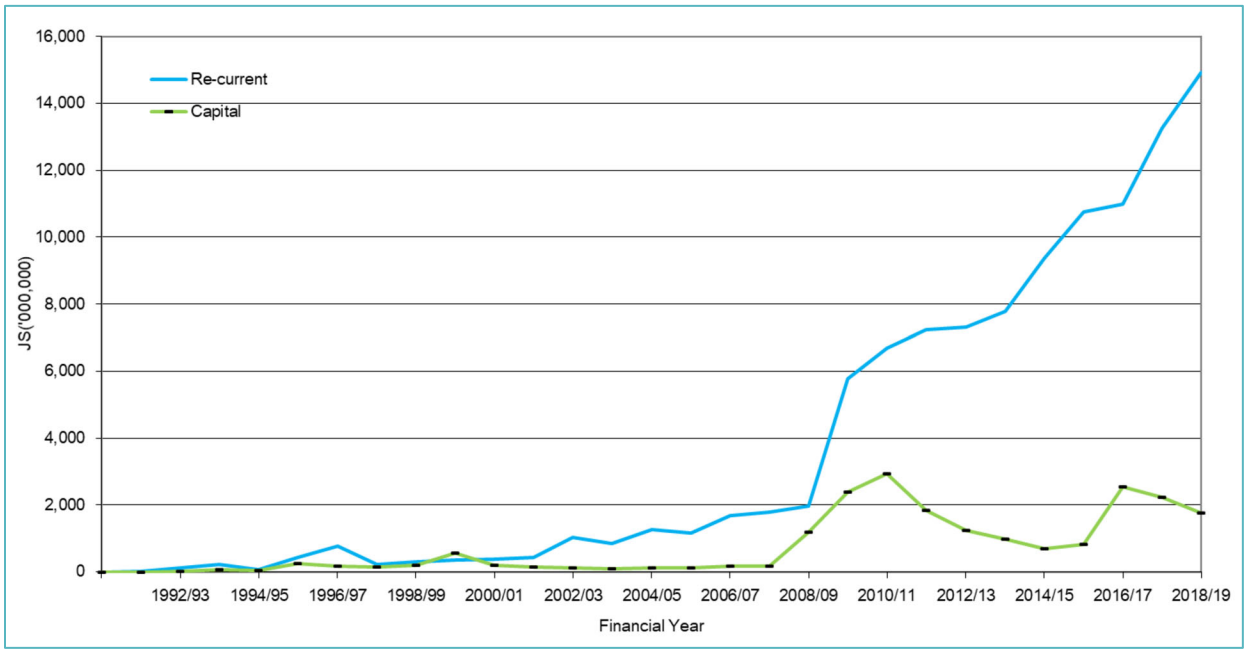
SUB-COMPONENT 6.1 ENVIRONMENT PROTECTION AND RESOURCE MANAGEMENT EXPENDITURE

Environmental protection activities aim to maintain or restore the quality of the environment by preventing the emission of pollutants or reducing polluting substances. These activities may consist of changes in characteristics of goods and services, consumption patterns or production techniques, treatment or disposal of residuals; recycling; and prevention of degradation of the landscape and ecosystems[12].

The primary purpose of resource management activities is to preserve and maintain natural resources to avoid their depletion. Expenditure on environment protection and resource management can be borne by governments, corporations, non-profit institutions and households.

GOVERNMENT ENVIRONMENTAL PROTECTION AND RESOURCE MANAGEMENT EXPENDITURE

The Government of Jamaica (GoJ) continues to allocate funding to strengthen sustainable development in environmental protection, forestry, the management of solid waste, disasters and water resources.



Source: Estimates of Expenditure as passed, Ministry of Finance and the Public Service

Figure 6.1 Government Expenditure on Selected Areas Related to the Environment

Figure 6.1 shows an increase in budgetary allocations to environmental management and related

[12] Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, New York, 1997

programmes over the last ten years, moving from approximately J$2.0 billion in FY 2008/09 to J$15.0 billion in FY 2018/19 (recurrent). Capital expenditure increased by 49.0 per cent between 2008/09 and 2018/19.

SUB-COMPONENT 6.2 ENVIRONMENT GOVERNANCE AND REGULATION

INSTITUTIONAL STRENGTH

The government of a country is responsible for initiating and passing policies and laws to protect and conserve the state's natural environment and resources. Also, it is the government's responsibility to ensure that the country is compliant with any regional and international treaties and laws to which it is a signatory. A list of the treaties, conventions and protocols that Jamaica either signed or ratified is presented in Table 6.4.

The National Environment and Planning Agency (NEPA) is the main agency of the government mandated to manage and protect Jamaica's biodiversity. NEPA was established in 2001 and among its core functions are:

- conserving and protecting the environment, prevention and control of pollution;
- spatial planning; processing of environmental licences and permits; environmental education;
- monitoring and enforcement; and
- developing a national environment and planning policies, regulations, standards and programmes.

Table 6.1 Applications and Enquiries Received by NEPA, by Type: 2015 – 2019

Application Type	Received				
	2015	2016	2017	2018	2019
Air Quality	9	4	3	3	11
Beach Licence	185	117	113	152	87
Environmental Permit	382	605	558	624	522
Environmental Licence	521	354	416	394	459
Planning - Non-TCPA	192	186	143	137	250
Planning - TCPA	110	85	100	102	109
Subdivision Applications less than 10 lots	584	592	560	527	528
Subdivision Applications 10 lots and over	107	110	103	107	89
Enquiries	122	76	87	100	139
Total	**2,212**	**2,129**	**2,083**	**2,146**	**2,194**

Source: National Environment and Planning Agency

Note:- TCPA – Town and Country Planning Act

As part of its operations, NEPA has responsibility for the processing of applications and granting of environmental permits and licences and permits and licences for beach use, construction and operation of some industrial facilities and sewerage and industrial waste discharge. In 2019, the NEPA received 2,194 applications and approved 918 applications (Table 6.1 and Table 6.2).

The highest number of applications received during the period 2015 to 2019 was for subdivisions with less than ten lots, amounting to over 500 since 2015. Applications received for subdivisions of ten lots and above have averaged 103 over the five years (Table 6.1).

In 2019, 36.0 per cent of the applications submitted for subdivision of ten lots and over were approved by NEPA. A total of 62.9 per cent of applications were approved for subdivision of less than ten lots (Table 6.1 and Table 6.2).

Table 6.2 Applications Approved by NEPA, by Type: 2015 – 2019

Application Type	Approved				
	2015	2016	2017	2018	2019
Air Quality	6	0	0	0	0
Beach Licence	120	72	139	61	22
Environmental Permit	183	234	307	298	244
Environmental Licence	232	218	206	124	179
Planning - Non-TCPA	66	64	68	58	75
Planning - TCPA	43	30	53	61	34
Subdivision Applications less than 10 lots	513	506	570	406	332
Subdivision Applications 10 lots and over	38	40	57	44	32
Enquiries	N/A	N/A	N/A	N/A	N/A
Total	**1,201**	**1,164**	**1400**	**1052**	**918**

Source: National Environment and Planning Agency

Note:- TCPA – Town and Country Planning Act

NEPA employs various measures to enforce the environmental regulations, standards and guidelines, including issuing warning letters, stop and cessation orders and court actions. Table 6.3 presents the number and types of enforcement action taken over five years.

Table 6.3 Enforcement Actions by Type of Notice: 2015 – 2019

Type of Notice	2015	2016	2017	2018	2019
Enforcement Notices (NRCA/TCPA)	22	13	43	24	14
Cessation Orders	29	16	6	16	16
Stop Notices	11	8	11	8	0
Notices of Intention to Suspend	21	3	1	0	0
Notices of Intention to Revoke	0	0	0	0	0
Suspension Notice	5	2	0	0	0
Onsite Breach/Warning Notices	770	763	419	669	823
Warning Letters	204	326	578	418	223
New Court Matters	13	1	14	10	38
Notices Under the Air Quality and Waste Water Regulations*	11	18	87	1	4
Total	**1,086**	**1,150**	**1,159**	**1,146**	**1,118**

Source: National Environment and Planning Agency

Note *Notices under the Air Quality and Waste Water Regulations commenced in 2014

There was no notice of intention to revoke or notice of suspension issued since 2015 (Table 6.3). Onsite breach/warning notices and warning letters were the most utilized enforcement actions over the period. There were 28 more new court matters in 2019 when compared to the previous year, while cessation orders remained at 16. Notices under the Air Quality and Wastewater Regulations increased by 300.0 per cent between 2018 and 2019, three more than recorded in 2018 (Table 6.3).

PARTICIPATION IN MEAS AND ENVIRONMENTAL CONVENTIONS

The international and multilateral environmental agreements (MEAs) in force sprung from concern over environmental pollution and the depletion of natural resources. Agreements that were 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) include 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. Table 6.4 lists the conventions, treaties, protocols and obligations to which Jamaica is a party, along with their dates of accession or entry into force.

Table 6.4 Regional and International Agreements to which Jamaica is a party

Name of Agreement/Treaty	Date of Ratification/Accession
International Convention for the Safety of Life at Sea (SOLAS)	14.10.1983
United Nations Convention on the Law of the Sea, Montego Bay (UNCLOS)	21.03.1993
Protocol of 1978 relating to the International Convention for the Safety of Life at Sea, as Amended (SOLAS Protocol 1978)	17.08.2005
Montreal Protocol on Substances that Deplete the Ozone Layer	31.03.1993
Vienna Convention for the Protection of Ozone Layer, Vienna, 1990	31.03.1993(A)
United Nations Framework Convention On Climate Change (UNFCCC)	06.01.1995
Kyoto Protocol to the United Nations Framework Convention on Climate Change	28.06.1999
International Plant Protection Convention, Rome	24.11.1969
Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartagena de Indias	01.05.1987
Protocol to the Cartagena Convention concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region (Oil Spills Protocol)	01.05.1987
Protocol on Land-based Sources and Activities to the Cartagena Convention on the Protection of the Marine Environment of the Wider Caribbean Region	06.10.1999
Protocol on Specially Protected Areas and Wildlife (SPAW)	(No date)
Convention on Biological Diversity, Rio de Janeiro	06.01.1995
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar), 1971	07.10.1997
United Nations Convention to Combat Desertification, Paris (UNCCD)	12.11.1997
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal	25.09.2012
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	(No date)
The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity	(No date)
Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons and Their Destruction	13.08.1975

Name of Agreement/Treaty	Date of Ratification/Accession
Convention Concerning the Protection of the World Cultural and Natural Heritage WCNH)	14.06.1983
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 the Subsoil Thereof	30.07.1986
United Nations Convention to Combat Desertification, Paris (UNCCD)	12.11.1997
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal	25.09.2012
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	(No date)
The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity	(No date)
Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons and Their Destruction	13.08.1975
Convention Concerning the Protection of the World Cultural and Natural Heritage WCNH)	14.06.1983
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 the Subsoil Thereof	30.07.1986
International Convention on the Prevention of Pollution from Ships, London (MARPOL)	13.06.1991
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	22.03.1991
Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks	
International Convention Relating to the Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969	
Protocol Relating to Intervention on the High Seas in Cases of Marine Pollution by Substances Other Than Oil, 1973	
Basel Convention on Trans-boundary Movement of Hazardous Waste and their Disposal	23.01.2003
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, Rotterdam	20.08.2002
Stockholm Convention on Persistent Organic Pollutants (POPs)	01.06.2007
Minamata Convention on Mercury	
Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Underwater, Moscow	22.11.1991

Name of Agreement/Treaty	Date of Ratification/Accession
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	10.08.1970
Convention on the Continental Shelf, Geneva	08.10.1965
Convention on the Territorial Sea and Contiguous Zone, Geneva, 1958	08.10.1965
Convention on the High Seas, Geneva	08.10.1965
Convention on Fishing and Conservation of the Living Resources of the High Seas	20.03.1966

Source: National Environment and Planning Agency

Appendix I. DRAFT AMBIENT WATER QUALITY STANDARDS (FRESHWATER): 2009

Parameter	Measured as	Standard Range	Unit
Calcium	Ca	40.0 – 101.0	mg/L
Chloride	CI-	5.0 – 20.0	mg/L
Magnesium	Mg2+	3.6 – 27.0	mg/L
Nitrate	NO3	0.1-7.5	mg/L
Phosphate	PO43-	0.01 - 0.8	mg/L
Potassium	K+	0.74 – 5.0	mg/L
Silica	SiO2	5.0 – 39.0	mg/L
Sodium	Na+	4.5 – 12.0	mg/L
Sulphate	SO42-	3.0 – 10.0	mg/L
Hardness	CaCO3	127.0 – 381.0	mg/L
Biochemical Oxygen Demand	O	0.80 – 1.70	mg/L
Total Dissolved Solids	TDS	120.0 – 300.0	mg/L
pH		7.0 – 8.4	
Conductivity		150.0 – 600.0	µS/cm

Source: National Environment and Planning Agency

Appendix II. MARINE WATER QUALITY STANDARDS, 2009

Parameter	Concentration
Phosphate, PO_4	0.003 (mg/L)
Nitrate, NO_3	0.014 (mg/L)
Total Alkalinity	131–168 (mg/L)
pH	8.0–8.4
Biochemical Oxygen Demand	0.57–1.16 (mg/L)
Total Coliform	48–256 MPN/100mL
Faecal Coliform	<2–13 MPN/100mL

Source: National Environment and Planning Agency

Appendix III. REEF SITES ASSESSED AND PARAMETERS AVERAGED, BY LOCATION: 2019

Location	Hard Coral (%/100m2)	NIA (%/100m2)	Total Herbivorous Fish	Total Commercial Fish
Palisadoes Port Royal Protected Area	24.0	20.0	9467.6	753.2
Palisadoes Port Royal Protected Area	12.0	39.0	3211.5	0.0
Palisadoes Port Royal Protected Area	1.5	52.9	808.0	517.4
East Portland Fish Sanctuary	20.2	24.4	17268.9	8600.5
Sandals Boscobel Special Fishery Conservation Area	16.0	21.0	298.5	269.0
Sandals Boscobel Special Fishery Conservation Area	39.0	6.0	738.2	0.4
Oracabessa Bay Special Fishery Conservation Area	8.0	58.0	2558.6	1738.2
Oracabessa Bay Special Fishery Conservation Area	13.0	48.0	8637.3	55.1
Oracabessa Bay Special Fishery Conservation Area	11.0	58.0	2982.0	298.5
Discovery Bay	24.0	21.0	923.8	408.2
Discovery Bay	6.0	43.0	400.9	419.7
Discovery Bay	10.7	16.3	12774.8	460.9
Ocho Rios Marine Park	29.0	5.0	489.9	0.0
White River Conservation Area	6.0	38.0	801.3	55.8
White River Conservation Area	5.0	57.0	606.8	280.2
White River Conservation Area	11.0	28.0	989.3	216.6
Falmouth	7.0	21.0	14341.3	94.5
Falmouth	24.0	12.0	5082.5	0.0
Montego Bay Marine Park	32.0	36.0	3267.9	628.6
Montego Bay Marine Park	31.0	21.0	3937.2	567.6
Montego Bay Marine Park	38.0	1.0	414.8	421.6
Negril Marine Park	15.0	22.0	28269.6	680.2
Negril Marine Park	28.0	14.0	18263.7	777.5
Hopewell	20.0	9.0	2821.8	249.5
Belmont	24.0	18.0	837.5	94.5
Whitehouse	24.0	36.0	10822.6	94.5
Negril Marine Park	31.0	14.0	6199.4	214.8
Portland Bight Protected Area	18.0	18.0	846.9	230.3
Portland Bight Protected Area	14.0	44.0	13134.1	622.9
Average	**18.7**	**27.6**	**5903.3**	**646.6**

Source: National Environment and Planning Agency

Note: NIA – Nutrient Indicating Algae

Coral Index - Coral Cover is a measure of the proportion of the reef surface that is covered by live stony corals which form the three-dimensional network of the reef.

Reef Biota Index - Herbivorous Fish Abundance measures the biomass of sturgeon and parrot fish; the most important grazers on plants that could overgrow the reef.

Reef Biota Index - Commercial Fish Abundance measures the biomass of commercially significant fish: grunts, groupers and snappers

GLOSSARY

A

Aerobic	Occurring or living in the presence of free or dissolved oxygen.
Afforestation	Artificial establishment of forests by planting or seeding in an area o5 non-forest land.
Agricultural land	Land including arable land, land under permanent crops and land under permanent meadows and pastures.
Air pollutants	Substances in air that could, at high enough concentrations, harm human beings, animals, vegetation or material. Air pollutants may thus include forms of matter of almost any natural or artificial composition capable of being airborne. They may consist of solid particles, liquid droplets or gases, or combinations of these forms.
Air pollution	The presence of contaminant or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare, or produce other harmful environmental effects.
Alumina	The compound aluminium oxide occurring naturally as corundum and emery. Chemical formula: Al_2O_3.
Ambient	Surrounding, environmental.
Anaerobic	Occurring or living in the absence of oxygen.
Aquaculture	The farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators and so forth. It also implies individual or corporate ownership of the stock being cultivated.
Aquifers	Underground geologic formations, or group of formations, containing groundwater that can supply wells and springs.
Atmosphere	Mass of air surrounding the earth, composed largely of oxygen and nitrogen.

B

Bauxite	Claylike mineral containing varying proportions of alumina, the chief source of aluminium.
Bauxite and alumina waste	S*ee* mining waste.

Biochemical oxygen demand (BOD)	Dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water.
Biodegradable	Capable of decomposing rapidly under natural conditions.
Biodiversity	The range of genetic differences, species differences and ecosystem differences in a given area.
Biogas	Mixture of methane and carbon dioxide in the ratio of 7:3 that is produced by the treatment of animal dung, industrial wastes and crop residues. It is used as an alternative source of energy.
Biological diversity	*See* biodiversity.
Biological sewage treatment	Wastewater treatment employing aerobic and anaerobic micro-organisms that results in decanted effluents and separate sludge containing microbial mass together with pollutants. Biological treatment processes are also used in combination or in conjunction with mechanical and advanced unit operations.
Biological treatment technology	Wastewater treatment employing aerobic and anaerobic micro-organisms that results in decanted effluents and separate sludge containing microbial mass together with pollutants. Biological treatment processes are also used in combination or in conjunction with mechanical and advanced unit operations. *See also* mechanical treatment technology.
Biomass	Total living weight (generally in dry weight) of all organisms in a particular area or habitat. It is sometimes expressed as weight per unit area of land or per unit volume of water.
BOD	*See* biochemical oxygen demand.

C

Carbon dioxide (CO_2)	Colourless, odourless and non-poisonous gas that results from fossil fuel combustion and is normally a part of ambient air. It is also produced in the respiration of living organisms (plants and animals), and is considered to be the main greenhouse gas, contributing to climate change.
Carbon monoxide (CO)	Colourless, odourless and poisonous gas produced by incomplete fossil fuel combustion. Carbon monoxide combines with the haemoglobin of human beings, reducing its oxygen carrying capacity, with effects harmful to human beings.
Catchment area	Area from which rainwater drains into river systems, lakes and seas.
Charcoal	Solid residue consists mainly of carbon obtained by the destructive

	distillation of wood in the absence of air.
Chemical oxygen demand (COD)	Index of water p0llution measuring the mass concentration of oxygen consumed by the chemical breakdown of organic and inorganic matter.
Chloro-fluorocarbons (CFCs)	Inert, non-toxic and easily liquefied chemicals used in refrigeration, air conditioning, packaging and insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone. They are also among the greenhouse gasses that may affect climate change.
Climate	Condition of the atmosphere at a particular location (microclimate) or region over a long period of time. It is the long-term summation of atmospheric elements – such as solar radiation, temperature, humidity, precipitation type (frequency and amount), atmospheric pressure and wind (speed and direction) – and their variations.
Climate change	Term frequently used in reference to global warming due to greenhouse gas emissions from human activities.
Coal	A piece of carbon or charred wood or other combustible substance glowing without flame.
Coastal zone	Land and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology or, inversely, whose uses and ecology are affected by the sea.
COD	*See* chemical oxygen demand.
Coliform	Micro-organism found in the intestinal tract of human beings and animals. Its presence in water indicates faecal pollution and potentially dangerous bacterial contamination.
Collection of waste	*See* waste collection.
Conservation	Management of human use of organisms or ecosystems to ensure that such use is sustainable (IUCN/WWF, 1991).
Contaminant	Any physical, chemical, biological or radiological substance or matter that has an adverse effect on air, water, land/soil or biota. The term is frequently used synonymously with *pollutant*.
Coral	Skeletal deposit produced by certain anthozoan polyps.
Coral reef	Reef often of great extent made up chiefly of fragments of corals, coral sands, algal and other organic deposits and the solid limestone resulting from their consolidation.

Crop rotation	Practice of growing different crops in succession on the same land.
Crustaceans	Group of mainly marine invertebrates, including lobsters, crabs and shrimps, with hard shells.

D

Dam	Body of water impounded and used for the supply of drinking water, electricity generation, irrigation or animal husbandry. Watercourses serving as part of a reservoir system are included.
Deforestation	Clearing of tree formations and their replacement by non-forest land uses.
Disposal of waste	*See* waste disposal.
Dissolved oxygen (DO)	Amount of gaseous oxygen (O_2) actually present in water expressed in terms either of its presence in the volume of water (milligrams or O_2 per litre) or of its share in saturated water (percentage).
Drip irrigation	Water-saving technique of surface irrigation through pipes made of plastics. It delivers the water drop by drop to plants through tiny holes, and prevents water logging of soils.
Drought	Prolonged absence of marked deficiency of precipitation which may contribute to desertification.
Dumping	Waste disposal in an uncontrolled manner.
Dumps or dump sites	Sites used to dispose of solid wastes without environmental controls.

E

Ecology	Totality of pattern of relationships between organisms and their environment.
Ecosystem	System in which the interaction between different organisms and their environment generates a cyclic interchange of materials and energy.
Emission	Discharge of pollutants into the atmosphere from stationary sources such as smokestacks, other vents, surface areas of commercial or industrial facilities and mobile sources, for example, motor vehicles, locomotives and aircraft.
Endangered species	Organisms in danger of extinction and whose survival is unlikely if causal factors continue operating. Included are those organisms whose numbers have been drastically reduced to a critical level or whose habitats have been so drastically impaired that they are deemed to be in immediate danger of extinction. Also included are those that possibly are already

	extinct, in so far as they definitely have not been seen in the wild in the past 50 years.
Endemic species	Species restricted to a specified region or locality.
Environment	The totality of all the external conditions affecting the life, development and survival or an organism.
Environmental impact assessment (EIA)	Analytical process that systemically examines the possible environmental consequences of the implementation of projects, programmes and policies.
Environmental protection	Any activity to maintain or restore the quality of environmental media through preventing the emission of pollutants or reducing the presence of polluting substance in env9ironmental media. It may consist of: • changes in characteristics of goods and services; • changes in consumption patterns; • changes in production techniques: • treatment or disposal of residual sin separate environmental protection facilities; • recycling; and prevention of degradation of the landscape and ecosystem.
Environment statistics	Statistics that describe the state and trends of the environment, covering the media of the natural environment (air/climate, water, land/soil), the biota within the media, and human settlements. Environment statistics are integrative in nature, measuring human activities and natural events that affect the environment, the impacts of these activities and events, social responses to environmental impacts, and the quality and availability of natural assets. Broad definitions include environmental indicators, indices and accounting.
Erosion	Wearing away and transport of the soil by wind or running water, glaciers or waves. Erosion occurs naturally but is often intensified by human land-clearing activities related to farming, residential or industrial development.
Exotic species	Species not native to a particular area. It may pose a risk to endemic species.
Extinct species	Species not definitely located in the wild during the past 50 years.
F	
Faecal coliform	See coliform [organism].
Fallow agricultural land	Arable land not under rotation that is set aside for a period of time

	ranging from one to five years before it is cultivated again; or land, usually under permanent crops, meadows or pastures, that is not being used for such purposes for a period of at least one year. Arable land that is normally used for the cultivation of temporary crops, but temporarily used for grazing, is included.
Fauna	All animal life.
Fertilisers	Organic or inorganic substances containing chemical elements that improve the growth of plants and the fertility of the soil. The percentage content of nutrients in organic fertilisers (manures) is relatively low. In inorganic or mineral fertilisers, the nutrients are inorganic salts, obtained by extraction and/or physical and chemical processes. The three primary plant nutrients are nitrogen, phosphorus and potassium.
Flora	All plant life.
Forest cover	All the trees and other woody plants (underbrush) covering the ground in a forest. It includes (a) trees and all shrubs; (b) herbs and shrubs growing there under or in openings in the forest or brush fields; (c) litter or fallen leaves, branches, fallen trees and other vegetable material on the forest floor; and (d) the rich humus of partially decayed vegetable matter at the surface and top layer of the soil.
Fossil fuels	Coal, oil and natural gas. They are derived from the remains of ancient plant and animal life.
Freshwater	Naturally occurring water having a low concentration of salts. It is generally accepted as suitable for abstraction and treatment to produce potable water.
Fungicide	Pesticide that is used to control, prevent and destroy fungi.

G

Global warming	Phenomenon believed to occur as a result of the build-up of carbon dioxide and other greenhouses gases. It has been identified by many scientists as a major global environmental threat.
Greenhouse gases	Carbon dioxide, nitrous oxide, methane, ozone and chloro-fluorocarbons occurring naturally and resulting from human (production and consumption) activities, and contributing to the greenhouse effect (global warming).

Groundwater	Freshwater beneath the earth's surface (usually in aquifers) supplying wells and springs. Because groundwater is a major source of drinking water, there is a growing concern over leaching of agricultural and industrial pollutants or substances from underground storage tanks.
Gully	Gash cut into a slope of soil or loose, unconsolidated sediment by the concentration of rainfall run-off in a channel. It represents one of the most destructive forms of erosion.

H

Habitat	Place where an organism or population (human, animal, plant, micro-organism) lives.
Hazardous substance	Any substance that poses a threat to human health and the environment. Hazardous substances are toxic, corrosive, ignitable, explosive or chemically reactive.
Hazardous wastes	Wastes that, owing to their toxic, infectious, radioactive or flammable properties pose a substantial actual or potential hazard to the health of humans and other living organisms and the environment.
Heavy metals	Potentially toxic metals used in industrial processes, for example, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. They may damage plant and animal life at low concentrations and tend to accumulate in the food chain.
Herbicide	Substance used to control weeds or the growth of undesirable grass or plants.
Household waste	Waste material usually generated in the residential environment. Waste with similar characteristics may be generated in other economic activities and an thus be treated and disposed of together with household waste.
Human settlements	Integrative concept that comprises: (a) physical components of shelter and infrastructure; and (b) services to which the physical elements provide support, that is to say, community services such as education, health, culture, welfare, recreation and nutrition.
Hydrological	Relating to hydrology, the science of the properties of the earth's water, especially of its movement in relation to land.
Hydrology	1. Science that deals with the waters above and below the land surfaces of the earth, their occurrence, circulation and distribution, both in time and in space, their biological,

chemical and physical properties, and their interaction with the environment including their relation to living beings;

2. Science that deals with the processes governing the depletion and replenishment of the water resources of the land areas of the earth including the various phases of the hydrologic cycle.

Hydropower	Electricity generation using the power of falling water.

I

Idle land	Land that was cultivated but is now in a state of disuse; abandoned land; fallow land.
Incineration	Controlled burning of solid, liquid or gaseous waste materials at high temperatures.
Indigenous	1. a. (Especially of flora and fauna) originating naturally in a region. b. (Of people) born in a region. 2. (Followed by to) belonging naturally to a place.
Industrial waste	Liquid, solid and gaseous waste originating from the manufacture of specific products.
Insecticide	Substance that destroys or controls insect pests.
Invertebrate	Animal that does not have a backbone or spinal column.
Irrigation	Artificial application of water to land to assist in the growing of crops and pastures. It is carried out by spraying water under pressure (spray irrigation) or by pumping water onto the land (flood irrigation).
IUCNS	World Conservation Union (formerly the International Union for Conservation of Nature and Natural Resources), located in Gland, Switzerland. It aims to provide knowledge and guidance about conservation and the sustainable use of natural resources.
IUCN Red List	Listing of animals threatened with extinction. The 1994 IUCN Red List, compiled by the World Conservation Monitoring Centre, includes more than 6,000 animal species known to be at risk.

L

Land classification	Land categories, reflecting quality classes, capability classes or grade, depending upon the characteristics of the land and/or its potential for agricultural use.

Land cover	*See* vegetation cover.
Landfill	Final placement of waste in or on the land in a controlled or uncontrolled way according to different sanitary, environmental protection and other safety requirements.
Land tenure	Right to the exclusive occupancy and use of a specified area of land.
Land use classification	Classification providing information on land cover, and the types of human activity involved in land use. It may also facilitate the assessment of environmental impacts on, and potential or alternative uses of, land. The classification, developed by the Economic Commission for Europe, consists of seven main categories: (a) agricultural land; (b) forest and other wooded land; (c) built-up and related land, excluding scattered farm buildings; (d) wet open land; (e) dry open land with special vegetation cover; (f) open land without, or with insignificant, vegetation cover; and (g) waters.

M

Mangroves	Any tropical tree or shrub of the genus *Rhizophora*, growing in shore mud with many tangled roots above ground.
Manure	Organic material used to fertilise land, usually consisting of barnyard and stable refuse (livestock excreta), with or without accompanying litter from straw, hay or bedding.
Marine park	Permanent marine reservation for the conservation of species. It constitutes an extension, to the undersea world, of the concept of the terrestrial national park.
Marine pollution	Direct or indirect introduction by humans or substances or energy into the marine environment (including estuaries), resulting in harm to living resources, hazards to human health, hindrances to marine activities including fishing, impairment of the quality of sea water and reduction of amenities.
Marsh	Type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh- or saltwater, and tidal or non-tidal. *See also* wetland.
Methane (CH_4)	Colourless, non-poisonous and flammable gaseous hydrocarbon created by anaerobic decomposition of organic compounds. Methane is a potent greenhouse gas.

Micro-organisms	Minute organisms such as viruses, bacteria, fungi and protozoa, some of which cause disease. They are also called microbes or microbiota.
Mining wastes	Mining-related by-product of two types: (a) mining-and-quarrying extraction wastes which are barren soils removed from mining and quarrying sites during the preparation for mining and quarrying and do not enter into the dressing and beneficiating processes; and (b) mining-and-quarrying dressing and beneficiating wastes which are obtained during the process of separating minerals from ores and other materials extracted during mining-and-quarrying activities. These wastes occupy valuable land and cause harm to stream life when they are deposited near the drainable area of a stream.
Monitoring	Continuous or frequent standardised measurement and observation of the environment (air, water, land/soil, biota), often used for warning and control.
Municipal waste	Waste produced by residential, commercial and public services sectors that is collected by local authorities for treatment and/or disposal in a central location.

N

National parks	Large natural areas not materially altered by human activity where extractable resources are not allowed and whose purpose is to protect nature and scenic areas of national and international significance for scientific, educational and recreational use.
Natural disaster	Sudden calamitous event as in the case of earthquakes, tsunamis, floods, volcanic eruptions, cyclones and landslides, or ongoing misfortune as in conditions or processes such as drought and desertification.
Natural gas	Mixture of hydrocarbon compounds and small quantities of non-hydrocarbons, existing in the gaseous phase or in solution with oil in natural underground reservoirs.
Natural habitat	*See* habitat.
Natural resource accounting	Accounting system that deals with stocks and stock changes of natural assets, comprising biota (produced or wild), subsoil assets (proved reserves), water and land with their aquatic and terrestrial ecosystem. It is frequently used in the sense of physical accounting as distinguished from monetary

	(environmental) accounting.
Natural resources	Natural assets (raw materials) occurring in nature that can be used for economic production or consumption.
Nitrates	Nitrogen-containing compound that can exist in the atmosphere or as a dissolved gas in water. It may produce harmful effects on humans and animals.
Nitric oxide (NO)	Gas formed by combustion under high pressure and high temperature in an internal combustion engine. It changes into nitrogen dioxide in the ambient air and contributes to photochemical smog.
Nitrogen oxide (NO_x)	Product of combustion from transportation and stationary sources. It is a major contributor to acid deposition and the formation of ground-level ozone in the troposphere.
Nitrous oxide (N_2O)	Relatively inert oxide of nitrogen produced as a result of microbial action in the soil, use of fertilisers containing nitrogen, burning of timber, and so forth. This nitrogen compound may contribute to greenhouse and ozone-depleting effects.
Non-renewable natural resources	Exhaustible natural resources such as mineral resources that cannot be regenerated after exploitation.

O

Oil spill	Oil, discharged accidentally or intentionally, that floats on the surface of water bodies as a discrete mass and is carried by the wind, currents and tides. Oil spills can be partially controlled by chemical dispersion, combustion, mechanical containment and absorption. They have destructive effects on coastal ecosystems.
Open land	Non-built-up land with no, or with insignificant, vegetation cover.
Organisms	Any living plants, animals or human beings.
Overpopulation	Exceeding of certain threshold limits of population density when environmental resources fail to meet the requirements of individual organisms regarding shelter, nutrition and so forth. It gives rise to high rates of mortality and morbidity.
Ozone (O_3)	Pungent, colourless, toxic gas that contains three atoms of oxygen in each molecule. It occurs naturally at a concentration of about 0.01 parts per million (ppm) of air. Levels of 0.1 ppm are considered to be toxic. In the stratosphere, ozone provides a

	protective layer shielding the earth from the harmful effects of ultraviolet radiation on human beings and other biota. In the troposphere, it is a major component of photochemical, smog, which seriously affects the human respiratory system.
Ozone depletion	Destruction of ozone in the stratosphere, where it shields the earth from harmful ultraviolet radiation. Its destruction is caused by chemical reactions in which oxides of hydrogen, nitrogen, chlorine and bromine act as catalysts.
Ozone layer	Lower region of the stratosphere, 15–25 kilometres above the earth's surface, in which there is an appreciable ozone concentration. It is also termed the ozonosphere.

P

Pelagics	1. Of or performed on the open sea *(pelagic whaling)* 2. (Of marine life) belonging to the upper layers of the open sea.
Permanent crops	Crops that, after each harvest, do not have to be planted for several years.
Pesticide	Any substance or mixture of substances that is used to prevent, destroy or control pests – including vectors of human or animal disease, and unwanted species of plants or animals. Pesticides may cause harm during, or otherwise interfere with, the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs – or that may be administered to animals so as to control insects, arachnids or other pests in or on their bodies.
Pest	Species, viruses, bacteria and other micro-organisms considered harmful to the health of human beings, crops and other living organisms.
Phosphorus	Element that, while being essential to life as a key nutrient factor, nevertheless contributes to the eutrophication of lakes and other bodies of water.
Plastics	Non-metallic chemo-reactive compounds moulded into rigid or pliable materials, fabrics and so forth. Their disposal poses an environmental problem because they are not biodegradable and the incineration of some plastics releases hazardous gases.
Pollutant	Substance that is present in concentrations that may harm organisms (humans, plants and animals) or exceed an environmental

quality standard. The term is frequently used synonymously with *contaminant*.

Pollution	1. Presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects; 2. Activity that generates pollutants.
Population density	Total number of inhabitants per square unit of surface area.
Potable water	Water that is safe for drinking and cooking according to defined standards.
Precipitation	1. Rain or snow falling from the atmosphere and deposited on land or water surfaces; 2. Forced removal of particles from flue gases or waste water.
Primary energy consumption	Direct use at the source, or supply to users without transformation, of crude energy, that is, energy that has not been subjected to any conversion or transformation process.
Protected area	Legally established land or water area under either public or private ownership that is regulated and managed to achieve specific conservation objectives.

R

Rainwater	Water that falls to earth as precipitation from atmospheric humidity. It may contain undesirable quantities of nitrogen, sulphur and heavy metals which give rise to problems of "acid rain".
Rare species	Taxa with small world populations that, though not at present endangered or vulnerable, are at risk. These taxa are localised within restricted geographical areas or habitats or thinly scattered over a more extensive range.
Recreational land	Land used for purposes of recreation, for example, sports fields, gymnasiums, playgrounds, public parks and green areas, public beaches and swimming pools and camping sites.
Reforestation	Artificial or natural re-establishment of forest in an area that was previously under forest cover.
Renewable energy sources	Energy sources including solar energy, geothermal energy, wind power, hydropower, ocean energy (thermal gradient, wave power and tidal power), biomass, draught animal power, fuelwood, peat, oil shale and tar sands.
Renewable (natural) resources	Natural resources that, after exploitation, can return to their previous

	stock levels by natural processes of growth or replenishment. Conditionally renewable resources are those whose exploitation eventually reaches a level beyond which regeneration will become impossible. Such is the case with the clear-cutting of tropical forests.
Reservoir	Place where water is collected and stored in large quantities for use when required.
Rodenticide	Pesticide used to destroy rodents (rats, mice and squirrels, among others).
Rotifers	Any minute aquatic animal of the phylum *Rotifera*, with a characteristic wheel-like ciliated organ used in swimming and feeding.

S

Scrap	Discarded or rejected materials that result from manufacturing or fabricating operations and are suitable for reprocessing.
Secondary treatment	Second step in most waste treatment systems during which bacteria consume the organic parts of the wastes. This is accomplished by bringing the sewage, bacteria and oxygen together in trickling filters or within an activated sludge process. Secondary treatment removes all floating and settleable solids and about 90 per cent of the oxygen-demanding substances and suspended solids. Disinfection by chlorination is the final stage of the secondary treatment process. *See also* tertiary treatment.
Sedimentation	Settling of water to the bottom of a liquid or water body, notably a reservoir.
Sedimentation tank	Holding area for waste water where floating wastes are skimmed off and settled solids are pumped to incinerators, digesters, filters or other means of disposal.
Septic tank	Underground tank receiving waste water directly from the home. Organic sewage/waste is decomposed by bacteria and settles down in the tank; effluents flow out of the tank into the ground; and the sludge is periodically pumped out.
Sewage	Organic waste and waste water produced by residential and commercial establishments.
Sewerage	The physical facilities (pipes, treatments and disposal facilities) through which sewage flows.

Sludge	Muddy, semi-solid deposits remaining after most liquids have been removed from waste water (possibly through filtration and chemical treatment).
Slurry	Watery mixture of insoluble matter that results from certain pollution control techniques.
Soil	Loose and unconsolidated outer layer of the earth's crust, made up of small particles of different sizes.
Soil erosion	*See* erosion.
Solid waste	Useless and sometimes hazardous material with low liquid content. Solid wastes include municipal garbage, industrial and commercial waste, sewage sludge, wastes resulting from agricultural and animal husbandry operations and other connected activities, demolition wastes and mining residues.
Solid waste disposal	Ultimate disposition or placement of refuse that is not salvaged or recycled.
Solid waste management	Supervised handling of waste material from generation at the source through the recovery processes to disposal.
Species	All the individuals and populations of a particular kind of organism, maintained by biological mechanisms that result in their breeding only with their own kind.
Squatter settlements	Areas of housing units that have been constructed or erected on land to which the occupants do not have a legal claim.
Stabilisation ponds	Shallow pond, usually human-made, where sunlight, bacteria and oxygen interact to help purify waste water. The term is synonymous with sewage oxidation pond and sewage lagoon.
Sulphur dioxide (SO_2)	Heavy, pungent, colourless gas formed primarily by the combustion of fossil fuels. It is harmful to human beings and vegetation, and contributes to the acidity in precipitation.
Surface water	All water naturally open to the atmosphere including rivers, lakes, reservoirs, streams, impoundments, seas, estuaries and so on. The term also covers springs, wells or other collectors of water that are directly influenced by surface waters.
Suspended solids	Small particles of solid pollutants in sewage that contribute to turbidity and resist separation by conventional means.
Sustainable development	Development that meets the needs of the present without comprising the ability of future generations while maintaining its potential yield (benefit) for future generations; and/or (b) non-declining

	trends of economic growth and development that might be impaired by natural resource depletion and environmental degradation.
Swamp	Type of wetland with water standing permanently or for a considerable period of time and with a dense cover of native vegetation. Swamps may be freshwater or saltwater, and tidal or n0n-tidal.
Synoptic	Giving a general view of weather conditions.

T

Taxon (plural: taxa)	Unit (group) of organisms used in taxonomy.
Tenure	*See* land tenure.
Tertiary treatment	Advanced treatment process, following secondary treatment of waste water, that produces high-quality water. Tertiary treatment includes removal of nutrients such as phosphorus and nitrogen and practically all suspended and organic matter from waste water. *See also* secondary treatment.
Threatened species	Plants and animals in danger of becoming rare of extinct.
Toxic substances (or pollutants)	Materials contaminating the environment that cause death, disease and/or birth defects in the organisms that ingest or absorb them. The quantities and length of exposure necessary to cause these effects can vary widely.

U

UNEP	United Nations Environment Programme, an international organisation established in 1972 to catalyse and co-ordinate activities to increase scientific understanding of environmental change and develop environmental management tools.
UNSD	United Nations Statistics Division (formerly, United Nations Statistical Office), body responsible for the collection, compilation and dissemination of international statistical data, the improvement of statistical methodology, substantive support for technical cooperation in statistics and the promotion of coordination in international statistical work.
Urbanisation	1. Increase in the proportion of a population living in urban areas; 2. Process by which a number of people become permanently concentrated in relatively small areas, forming cities.

V

Vegetation cover	All trees, shrubs, herbs, deciduous plants and so forth that cover an area or region.
Vulnerable species	Taxa of various types, including: ▪ taxa believed likely to move into the "endangered" category in the near future if the relevant causal extensive destruction of habitat and other environmental disturbances; ▪ taxa with populations that have been seriously depleted and those ultimate security has not yet been assured; and ▪ taxa with populations that are still abundant but are under threat from severe adverse factors throughout their range.

W

Waste	Materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded. *See also* solid waste, industrial wastes and household waste.
Waste collection	Collection and transport of waste to the place of treatment or discharge by municipal services or similar institutions, or by public or private corporations, specialised enterprises or general government. Collection of municipal waste may be selective, that is to say, carried out for a specific type of product, or undifferentiated, in other words, covering all kinds of waste at the same time.
Waste disposal	Waste elimination techniques comprising landfills, containment, underground disposal, dumping at sea and all other disposal methods.
Waste management	Characteristic activities include: (a) collection, transport, treatment and disposal of waste; (b) control, monitoring and regulation of the production, collection, transport, treatment and disposal of waste; and (c) prevention of waste production through in-process modifications, reuse and recycling.

Waste water	Used water, typically discharged into the sewage system. It contains matter and bacterial in solution or suspension.
Wastewater treatment	Process to render waste water fit to meet environmental standards or other quality norms. Three broad types of treatment may be distinguished: mechanical, biological and advanced.
Waterborne disease	Disease that arises from infected water and is transmitted when the water is used for drinking or cooking (for example, cholera or typhoid). It is to be distinguished from water-based and water-related diseases. Water-based diseases are those in which water provides the habitat for host organisms of parasites ingested (for example, schistosomiasis). Water-related diseases are those in which insect vectors rely on water as habitat but transmission is not through direct contact with water (for example, malaria or onchocerciasis).
Water conservation	Preservation, control and development of water resources, both surface and groundwater, and prevention of pollution.
Water cycle	Sequence of climatological events. The hat of the sun evaporates water from land and water surfaces; vapour, being lighter than air, rises until it reaches the cooler upper air level where it condenses into clouds; further condensation produces precipitation that falls to earth as rain, sleet or snow; some of the water is retained by the soil and some run-off returns to rivers, lakes and oceans.
Water erosion	Erosion of soil by water. It occurs in any of three forms: sheet, rill and gully erosion.
Water pollution	Presence in water of harmful and objectionable material – obtained from sewers, industrial wastes and rainwater runoff – in sufficient concentrations to make it unfit for use.
Water quality	Physical, chemical, biological and organoleptic (taste-related) properties of water.
Watershed	Land area that drains into a stream.
Water supply system	System for the collection, transmission, treatment, storage and distribution of water from source to consumers, for example, homes, commercial establishments, industry, irrigation facilities and public agencies for water-related activities (fire-fighting, street flushing and so forth).
Water treatment	1. (Prior to first use) process to render water withdrawn from any source suitable for first use;

	2. Wastewater treatment by mechanical, biological and advanced procedures.
Water use	Use of water by agriculture, industry, energy production and households, including in-stream uses such as fishing, recreation, transportation and waste disposal.
Weather	Day-to-day or sometimes even instantaneous changes of atmospheric conditions over a given place or area. In contrast, climate encompasses the statistical ensemble of all weather conditions during a long period of time over that place or area. Atmospheric conditions are measured by the meteorological parameters of air temperature, barometric pressure, wind velocity, humidity, clouds and precipitation.
Wetland	Area of low-lying land where the water table is at or near the surface most of the time. Wetlands include swamps, bogs, fens, marshes and estuaries.

Y

Yield	1. Total volume of water flow from a drainage basin over a stipulated long period of time, for example, annual yield; 2. (Of renewable resources) see maximum sustainable yield.

Sources: United Nations Department for Economic and Social Information and Policy Analysis, Statistics Division Studies in Methods Series F, No. 67, Glossary of Environment Statistics, New York, 1997.
The Concise Oxford Dictionary, Ninth Edition.