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STATE OF THE ENVIRONMENT REPORT 2017

JAMAICA

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AAL	Average Annual Loss
ACP	African, Caribbean And Pacific
AIA	Advance Informed Agreement
AQI	Air Quality Index
AQMN	Air Quality Monitoring Network
BA	Budgetary Allocation
BCH	Biosafety Clearing-House
BEEP	Banana Export Expansion Programme
BHI	Biodiversity Habitat Index
BOD	Biological Oxygen Demand
BOE	Barrel of Oil Equivalent
BRGM	Black River Great Morass
BUR	Biennial Update Report
CABI	Centre for Agriculture and Biosciences International
CARICOM	Caribbean Community and Common Market
CARPHA	Caribbean Public Health Agency
CBD	Convention on Biological Diversity
CBF	Caribbean Biodiversity Fund
CBO	Community-based Organization
CCADRRP	Climate Change Adaptation and Disaster Risk Reduction Project
C-CAM	Caribbean Coastal Area Management Foundation
CCCL	Caribbean Cement Company Limited
CCD	Climate Change Division
CDEMA	Caribbean Disaster Emergency Management Agency
CDIAC	Carbon Dioxide Information Analysis Centre
CDM	Clean Development Mechanism
CDRMP	Comprehensive Disaster Risk Management Policy
CEA	Cumulative Effects Assessment
CFC	Chlorofluorocarbon
CHM	Clearing-House Mechanism
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLA	Cannabis Licensing Authority
CMU	Caribbean Maritime University
COCZM	Council on Ocean and Coastal Zone Management
COP	Conference of the Parties
CPHDF	Caribbean Plant Health Directors Forum
CRED	Centre for Research on The Epidemiology of Disasters
CRHI	Coral Reef Health Index
CSO	Civil Society Organisations
DO	Development Order
DPSIR	Driver-Pressure-State-Impact-Response

DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EM	Emergency Management
EPA	Environmental Protection Area
EPAct	Environment and Planning Act
EPI	Environmental Performance Index
ESSJ	Economic and Social Survey of Jamaica
EU	European Union
EUD	Delegation of the European Union
FAO	Food and Agriculture Organization
FC	Faecal Coliform
FD	Forestry Department
FMA	Forest Management Areas
FMDF	Fisheries Management and Development Fund
FR	Forest Reserve
GDI	Gender Development Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse Gas
GII	Gender Inequality Index
GIS	Geographical Information System
GoJ	Government of Jamaica
GPS	Geographical Positioning System
HCFC	Hydro-chlorofluorocarbon
HDI	Human Development Indicator
HEART/NTA	Human Employment and Resource Training Trust/National Training Agency
HEP	Hydro-Electric Power
HQI	Housing Quality Index
IABIN	Inter-American Biodiversity Information Network
IAS	Invasive Alien Species
IASNET	Invasive Alien Species Network
ICENS	International Centre for Environmental and Nuclear Sciences
IDB	Inter-American Development Bank
IEA	International Energy Agency
IHDI	Inequality-Adjusted Human Development Index
ILAC	Latin American and Caribbean Initiative for Sustainable Development
INDC	Intended Nationally Determined Contributions
IOJ	Institute of Jamaica
IOM	International Organization for Migration
IUCN	International Union for Conservation of Nature

IWRM	Integrated Water Resources Management
JAAQMP	Jamaica Ambient Air Quality Monitoring Programme
JAAQS	Jamaica Ambient Air Quality Standards
JAMPRO	Jamaica Promotions Corporation
JAQMP	Jamaica Air Quality Monitoring programme
JBGL	Jamaica Broilers Group Limited
JBI	Jamaica Bauxite Institute
JCDT	Jamaican Conservation and Development Trust
JEP	Jamaica Energy Partners
JET	Jamaica Environment Trust
JNHT	Jamaica National Heritage Trust
JPAS	Jamaican Protected Areas System
JPAT	Jamaica Protected Areas Trust Ltd.
JPS	Jamaica Public Service Company
JPSCO	Jamaica Public Service Company Limited
JTB	Jamaica Tourist Board
KBOE	Thousand Barrels of Oil Equivalent
KMA / KMR	Kingston Metropolitan Area / Region
KSA	Kingston - St Andrew
LBS	Land-based Sources (of pollution)
LC	Land Change
LEED	Leadership in Energy and Environmental Design
LFMC	Local Forest Management Committees
LMO	Living Modified Organisms
LPG	Liquified Petroleum Gas
LSDP	Local Sustainable Development Plans
LU	Land Use
MAF	Ministry of Agriculture and Fisheries
MBMPT	Montego Bay Marine Park Trust
Mbp	Million Barrels of Petroleum
MDG7	Millennium Development Goal 7 (Ensure environmental sustainability)
MDZ	Mineral Development Zone
MFAFT	Ministry of Foreign Affairs and Trade
MGCI	Mountain Green Cover Index
MICAF	Ministry of Industry, Commerce, Agriculture & Fisheries
MLGCD	Ministry of Local Government and Community Development
MoH	Ministry of Health
MoT	Ministry of Tourism and Entertainment
MoU	Memorandum of Understanding
MP	Marine Park
MSY	Maximum Sustainable Yield
Mt	Mega Tonne
Mt	Metric Tonne
MTF	Medium-Term Socioeconomic Policy Framework

MTWH	Ministry of Transport Works and Housing
MVA	Manufacturing Value Added
MWh	Megawatts per hour
MWLECC	Ministry of Water, Land, Environment and Climate Change
NAMA	Nationally Appropriate Mitigation Action
NBA	National Building Act
NBCJ	New Building Code of Jamaica
NBC	National Biosafety Committee
NBSAP	National Strategy and Action Plan on Biological Diversity in Jamaica 2016-2021
NCTFJ	National Conservation Trust Fund of Jamaica
NCU	Northern Caribbean University
NDP	Jamaica National Development Plan
NDS	National Development Strategy
NEGAR	National Ecological Gap Assessment Report
NEPA	National Environment and Planning Agency
NEPT	Negril Area Environmental Protection Trust
NFMCP	National Forest Management and Conservation Plan
NGO	Non-Governmental Organization
NHMJ	Natural History Museum of Jamaica
NIC	National Irrigation Commission Limited
NMIA	Norman Manley International Airport
NMP	National Minerals Policy
NOR	Noranda Jamaica Bauxite Partners
NPAS	National Protected Areas System
NPP	National Physical Plan
NQI	National Quality Infrastructure
NRCA	Natural Resources Conservation Authority
NRW	Non-Revenue Water
NSA	Non-state actors
NSDI	National Spatial Data Infrastructure
NSP	National Spatial Plan
NSS	National Spatial Strategy
NSWMA	National Solid Waste Management Authority
NUE	Nitrogen Use Efficiency
NWC	National Water Commission
NWSMA	National Solid Waste Management Authority
ODPEM	Office of Disaster Preparedness and Emergency Management
OECD	Organisation of Economic Corporation and Development
OFWMU	On Farm Water Management Unit
PA	Protected Area
PAC	Protected Areas Committee
PASMP	Protected Areas System Master Plan
PCA	Pesticides Control Authority (Ministry of Health)

PCB	Polychlorinated Biphenyl
PET	Polyethylene terephthalate
PIOJ	Planning Institute of Jamaica
PM_{10}	Particulate Matter at 10 micrometres
$PM_{2.5}$	Particulate Matter at 2.5 micrometres
PPCR	Pilot Programme on Climate Resilience
RADA	Rural Agricultural Development Authority
RiVAMP	Risk and Vulnerability Assessment Methodology Project
SDG	Sustainable Development Goal
SFCA	Special Fishery Conservation Areas
SIA	Sangster International Airport
SIDS	Small Island Developing States
SLC	Jamaica Survey of Living Conditions
SLC	Standard of Living Conditions
SMU	Squatter Management Unit
SNMI	Sustainable Nitrogen Management Index
SOE	State of the Environment
SRC	Scientific Research Council
STATIN	Statistical Institute of Jamaica
STEM	Ministry of Science and Technology, Energy and Mining
STP	Sewage Treatment Plant
STRAP	Sea Turtle Recovery Action Plan
TAC	Total Allowable Catch
TCI	Turks And Caicos Islands
TCPA	Town and Country Planning Authority
TEF	Tourism Enhancement Fund
TEP	Total Exploitable Potential
TFEC	Total Final Energy Consumption
TNC	The Nature Conservancy
TOE	Tonne of Oil Equivalent
TPES	Total Primary Energy Supply
TSE	Treated Sewage Effluent
TSP	Total Suspended Particulates
UDC	Urban Development Corporation
UNCCD	United Nation Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
UNWTO	World Tourism Organization
USEPA	United States Environment Protection Agency
UTECH	University of Technology

UWI	University of the West Indies
VEC	Valued Environmental Component
WASH	Water & Sanitation Hygiene
WIN	Windalco
WLPA	Wild Life Protection Act
WMU	Watershed Management Unit
WRA	Water Resources Authority
WRDMP	Water Resources Development Master Plan
WRI	World Resources Institute
YCELP	Yale Centre for Environmental Law and Policy

EXECUTIVE SUMMARY

This 7th National State of the Environment (SOE) Report covers the four year period 2014 to 2017, and is intended to provide a comprehensive snapshot of Jamaica's natural and built environment. It serves to help us understand the sustainability issues that the country faced during that period (many of which are still very relevant), and allows for a critical look at how successful the country was in addressing these. It is hoped that this will support evidence-based decision-making, prioritize target setting by enabling policy-makers to correct course as necessary, identify opportunities and build on successes. This document provides a synthesis to foster closer alignment with the Vision 2030 Jamaica National Development Plan by providing a basis for determining medium-term priorities which will be included in the fourth medium-term socio-economic policy framework (MTF) for the period 2019 -2022. In addition, Jamaica has intentionally adopted indicators that support reporting and implementation of the United Nations' Sustainable Development Goals (SDGs).

The SOE Report represents the vision of the National Environment and Planning Agency (NEPA) and its many partners in the wider public and private sectors, relating to Jamaica's progress towards orderly development during the review period. It is more than just an update of the sixth Triennial SOE issued in 2013. The document is structured in accordance with the DPSIR (Driver-Pressure-State-Impact-Response) approach, an international standard for SOE reporting. This approach includes social, economic and environmental themes, establishes the linkages between the causes (Drivers and Pressures) that affect the condition (State) of valued environmental components (VECS) which, in turn, impact the services provided by associated ecosystems to society (Impact). An understanding of these linkages can facilitate identification of suitable interventions that can mitigate impacts or enhance benefits and put Jamaica on a path to a more sustainable future (Responses). Additionally understanding how one sector or system drives change in another can help NEPA and its partners in the various Government Ministries, Departments/Divisions and Agencies to see beyond their immediate jurisdictional mandates, and possibly seek out opportunities for more integrated management of natural resources and sectors that both rely on and impact those resources.

Jamaica has made some modest improvements in controlling the intensity of Drivers and Pressures, which directly impact the location, scale and persistence of adverse impacts on VECs. Improvements that occurred during 2014-2017 include:

- **A trend towards a lower carbon future**, with decreasing CO_2 emissions per capita, some inroads into energy efficiency, the addition of renewables to the energy mix and a substantial reduction in crude oil imports (14%).
- **Lower losses from natural hazards**: The **economic cost** of these wasJ$5 billion during the review period, compared to J$30 billion JMD in the prior reporting period. While the costs of disasters are largely controlled by the magnitude and frequency of hazard events, experience/expertise and risk reduction, efforts may have also played a role in offsetting costs. The foundation of this success can be traced back to the 2005 National Hazard Risk Reduction Policy for Jamaica.
- **The continuing decline of Jamaica's 500-year old sugar and rum industry**: A range of adverse environmental impacts are expected to decline as sugar production falls, including the occupation of prime lands (with attendant loss of forest, loss of fertility and erosion of top-soils), impact on air quality (related to cane-field burning and bagasse furnaces), pesticide and

fertilizer use, cane wash water's impact on receiving water bodies from the use of dunder for irrigation. However, these are offset by the potential loss o30,000 sugar industry farm and factory jobs.

Negative trends that were noted in relation to development control issues (Drivers and Pressures) include:

- **Informal settlements in urban areas**, in which there are high population densities (overcrowding), with poor access to municipal services and amenities, as well as high levels of vulnerability. More than half of Jamaica's population now live in urban places, with 61% of this subset living in slums. Lack of basic services like running water, electricity, solid waste collection, sewerage, drainage and transportation exacerbate environmental impact and the vulnerability of these communities.
- **Declining trends in quality of surface freshwater, groundwater and coastal waters**: This is attributed to insufficient sewage/wastewater collection and treatment, increasing levels of agricultural fertilizer use and watershed degradation (associated with mining, deforestation and unsustainable agricultural practices).
- **Climate change**: During the review period there was a general trend towards higher temperatures and lower rainfall. Although four years is insufficient to attribute these trends to climate change, these trends are generally consistent with the global climate models predictions for the region. Drought continued to impact southern and eastern parishes. These trends compound the fact that water stress levels have increased significantly since 2013 (Chapter 4.3.1).
- **Concentration of tourism in environmentally sensitive areas** in the parishes of St. Ann, Trelawny, St. James, Hanover and Westmoreland (Chapter 0): This puts a high degree of pressure on freshwater resources (Chapter 12.3.2), coastal ecosystems (Figure 48), waste disposal capacity (Chapter 12.3.1), food supply and fuel and energy consumption of these parishes.
- **Fossil fuel intensity**: 98% of the Total Primary Energy Supply (TPES) and 88% of Jamaica's electricity come from fossil fuel sources (Chapter 8.3.2). Low efficiency in electricity production (Chapter 8.3.1) is reported with annual losses being 27% of total production (compared to the 12% contributed by renewables).
- **Transportation trends**: Land transportation (road and rail) accounted for 31% of total petroleum consumption, which is the largest use category. The total number of registered vehicles increased by 40% in the review period, and there has been a corresponding increase in the length and density of the road network.

High priority environmental management issues that were identified in terms of the State of VECs and Impacts on ecosystem services (State and Impacts) include:

- **The need for integrated water resources management**. Climate change, climate variability and drought continued to impact freshwater availability. VECs such as aquatic ecosystems, forest ecosystems and air quality were impacted, with an increased risk of wild-fires and increased particulates in the atmosphere. With rising sea levels, falling groundwater tables and increased abstraction, there is an increased risk of salinization of coastal aquifers. The resilience of the island's watersheds to drought, climate change and extreme natural events continues to be compromised by human actions such as deforestation, unsustainable farming and waste disposal practices. Lack of routine data collection and insufficient inter-agency coordination were identified as major constraints in the assessment of watershed changes.

- **Air quality** is generally poor in the industrial and inner-city areas of Kingston; this is associated with industrial emissions, and exacerbated by occasional fires associated with the Riverton City Dump, trash burning, drought and Sahara dust fall events. There is also a general lack of comprehensive and representative data coverage.
- **Life on Land**: The annual rate of loss of primary forest (1998-2013) was estimated at 12.27 km^2. Based on the assumption that this rate did not change, the estimated loss of primary forest in the review period was likely to be in the order of 49 km^2. Disturbance of primary forest is closely linked to degradation of watersheds and habitats of endemic species, some of which are critically endangered. Short dry limestone_forests (Portland Bight Protected Area mainly) are declining at a rapid rate (6 km^2 per year), which means that if current trends persist, this ecosystem would be obliterated from Jamaica in 62 years. This would have a major negative impact on the biodiversity of Jamaica and could result in the extinction of critically endangered endemic species like the tree frog (*Eleutherodactylus cavernicola)*.

  Another rapidly disappearing ecosystem is the swamp forest, with remaining areas (in the Black River Lower Morass, Negril Great Morass and Mason River Protected Area) being severely threatened by invasive alien species. Without focused and aggressive action to protect this ecosystem, any pristine remnants of this ecosystem may be completely eradicated from Jamaica before the next SOE is produced. These swamp forests are important waterfowl and bird habitats, containing important medicinal plants and endemic plant species.

- **Life under Water**: The most critical area that has been flagged for this review period is the health of nearshore coral reefs. Continuing the negative trend noted in the previous review period, coral reef health indices for monitored reefs continue to decline in the current review period. Since 2013 there has been no improvement in the averaged indicators of coral reef health for the monitored reefs. Detailed examination of the individual sites suggests that managed sites (like Boscobel, Oracabessa and those within the marine parks) are doing better than unmanaged sites, where higher levels of pollution stress have been observed (e.g. Falmouth, Discovery Bay and Palisadoes). Land-based sources (LBS) of pollution are likely to impact these sensitive oligotrophic ecosystems more, if the buffering effect of sea grass and mangrove ecosystems is degraded. Aside from pollution, these reefs are under additional stress from artisanal fishing, tourism activities, diseases, invasive alien species, storms and climate change (warming, bleaching, acidification). Beach stability and the sustainability of artisanal fisheries are closely dependent on the health of these coral reefs.

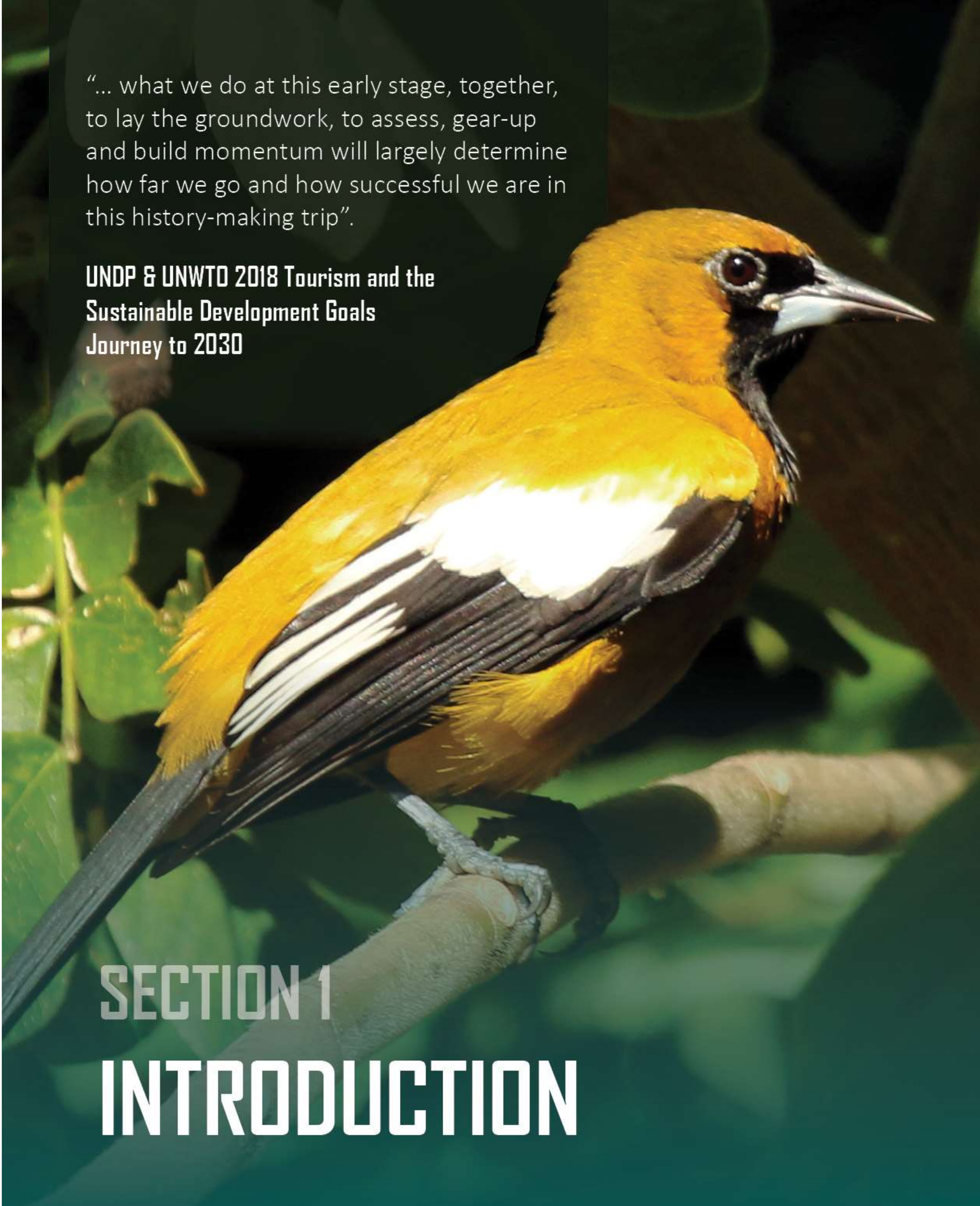
  There are major environmental monitoring gaps in respect of critical coastal and marine resources (fisheries stocks, turtle nesting sites, beach erosion, ecosystems associated with many offshore banks and cays) that provide a range of ecosystem services including fisheries, tourism and shoreline protection

The critical condition of the VECs (described above) suggests that the overall effectiveness of management responses has not been high, despite the promulgation of important national policies and plans, the declaration of protected areas and introduction of various administrative mechanisms designed to improve environmental conservation, development control and pollution management. The conversion of good intentions embodied in the paperwork requires political will, backed up by adequate resourcing and effective data-driven management. Generally, environmental monitoring and data management have been found to be insufficient to support comprehensive assessment and prioritization for research and funding.

This 2017 SOE is intended to serve as a source-book of information on environmental issues, the drivers and pressures that create adverse environmental change, and some of the challenges that have to be addressed in the design of cost-effective interventions moving forward. The document highlights areas that require specific and urgent attention, and it can thus allow for the prioritization of initiatives to improve the condition of the environment. Finally, it establishes a baseline against which progress can be measured in the next SOE report.

"... what we do at this early stage, together, to lay the groundwork, to assess, gear-up and build momentum will largely determine how far we go and how successful we are in this history-making trip".

UNDP & UNWTO 2018 Tourism and the Sustainable Development Goals Journey to 2030



SECTION 1
INTRODUCTION

Photo: Jamaican Oriole (*Icterus leucopteryx*) by Charles J. Sharp, 2015, is licensed under CC BY 2.0

1. Overview

1.1 Purpose and Objectives

This is the 7th National State of the Environment (SOE) Report, covering the four-year period 2014 to 2017. This document is intended to provide a comprehensive snapshot of the 2017 state of Jamaica's natural and built environment, identifying trends and future scenarios, as well as strategies for realizing solutions and achieving defined targets. Underlying this objective is the need to understand Jamaica's sustainability issues, and realistically evaluate environmental performance over the assessment period. The 2017 SOE also sets out to provide an empirical context that will allow Jamaica to take advantage of emerging opportunities and leapfrog along the path towards sustainable development.

Another key objective is to provide policy-makers with the necessary information summaries to support evidence-based decision-making. Using a data-driven approach to performance evaluation and priority-setting enables easier tracking of trends and identification of problems, successes and failures. The 2017 SOE is expected to provide a basis for determining medium-term priorities which will be included in the medium-term socioeconomic policy framework (MTF) for the period 2018 -2021, which is the fourth in a series of medium-term (three-year) strategic plans that facilitate the implementation of Vision 2030 Jamaica National Development Plan.

This current SOE Report is more than just an update of the 6th Triennial SOE issued in 2013. A major point of departure is that this SOE report has adopted the Driver-Pressure-State-Impact-Response (DPSIR) analytical framework, and is structured accordingly. As before, the SOE Report represents a snap-shot of the state of the environment in Jamaica, and seeks to provide the necessary context to guide the way forward in the next medium-term period. In line with the Sustainable Development Goals (SDGs) as the overarching international guideline, environmental health and human well-being are now included as key themes in the report.

1.2 A Quick Look Back

The 2013 SOE Report identified some key successes in environmental performance for the period 2010 to 2013, as well as some poor report-card areas and gaps.

1.2.1 Key Successes (2010 – 2013)

Updated or being updated:
- Ten (10) Development Orders; and
- Draft National Minerals Policy.

Established or implemented:
- National Spatial Data Infrastructure (NSDI);
- Draft Agricultural Land Use Policy;
- Urban Planning and Regional Development Sector Plan;
- Two new Special Fishery Conservation Areas (SFCAs);

- Eight new national monuments;
- Pesticides Control Authority (PCA) signed an agreement with the Food and Agriculture Organization (FAO) in 2013 to eliminate stocks of obsolete pesticides; and
- Memorandum of Understanding (MOU) between the Natural Resources Conservation Authority (NRCA) and the Jamaica Bauxite Institute.

Increased capacity:

- Co-management agreements and community partnerships for environmental stewardship in the period 2011-2013. This includes two new co-management agreements in Special Fisheries Conservation Areas (SFCAs): Jamaica Environment Trust (JET) for the South West Cay SFCA (Pedro Bank) and the Sandals Foundation for the Sandals Whitehouse SFCA

Aichi [1] Targets met:

- 18% terrestrial declared protected areas; and
- 15% coastal marine areas protected

Increased performance:

- Biomass recovery trends for four commercial fish species (snapper, grouper, grunt, parrot fish);
- Households with access to safe drinking water;
- Irrigation water supply; and
- Hydro-chlorofluorocarbons (HCFCs) imports reduced, relative to baseline

1.2.2 Critical Issues in 2013

Poor environmental report cards for:

- Forest cover (closed broadleaf; dry forests);
- Watersheds (Hope, Rio Minho, Wagwater and Yallahs);
- Coral reefs;
- Invasive alien species (28% increase in five years);
- Beach erosion;
- Coastal water quality (phosphate and faecal coliforms);
- Poor freshwater quality in six watershed management units (WMUs);
- Air quality (particulates); and
- Sewage treatment plants compliance.

Gaps in 2013

- Policy or regulation gaps:
  - Jamaica's Protected Areas policy update;
  - Integrated waste management;
  - Integrated coastal zone management.
- Data management and research:
  - No centralized database for validated biodiversity data;
  - Limited research on forested areas;

[1] Aichi Biodiversity Targets: A set of 20 global targets under the Strategic Plan for Biodiversity 2011-2020. They are grouped under 5 strategic goals: 1.Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society 2.Reduce the direct pressures on biodiversity and promote sustainable use.3.Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.4.Enhance the benefits to all from biodiversity and ecosystem services.
5.Enhance implementation through participatory planning, knowledge management and capacity building.

  - Freshwater balance estimation not undertaken at watershed level; and
  - Water management did not take into account climate change and variability.
- Management issues:
  - Insufficient mainstreaming of biodiversity conservation and sustainable use;
  - Lack of guidance on bio safety issues due to inactive Biosafety Committee;
  - Generally poor inter-agency coordination;
  - Insufficient capacity for sustainable use of the natural resources in the development sectors; and
  - Insufficient waste collection and disposal capacity.

1.3 Current International Environmental Performance Index Rank

1.3.1 EPI Ranking

The Environmental Performance Index (EPI)[2] ranks 180 countries on 24 performance indicators along 10 issue areas. These metrics track national performance against environmental policy goals. The EPI identifies environmental health and ecosystem vitality as the two fundamentals of sustainability. The EPI is one of the several systems of indicators that were used to determine the final list of indicators used in this 2017 SOE Report. The EPI score is useful for a quick statistic on Jamaica's general environmental performance, compared to other countries in the region and internationally.

Table 1 shows the last three EPI scores and rankings for 2014 and 2016. Between 2014 and 2016 Jamaica's EPI score improved, while the country's international performance rank remained similar. This indicates that more countries were achieving scores above 77 in 2016 than in 2014. It is uncertain why Jamaica's score improved in 2016, but it is likely due to improvements in score calculation methodologies or data availability for that year.[3]

Table 1 Jamaica's EPI score and ranking (2014 and 2016)

Year	Jamaica's EPI Rank	Jamaica's EPI score	Range of Scores
2016	54th/180	77.02	27.66 (Somalia) to 90.68 (Finland)
2014	55th/178	58.30	15.47 (Somalia) to 87.67 (Switzerland)

According to the Yale Centre for Environmental Law and Policy (YCELP), which generates the EPI, environmental health improves with economic prosperity, while ecosystem vitality comes under pressure from associated development (urbanization and industrialization). Effective environmental governance strikes an acceptable compromise between the development that brings prosperity and environmental loss. High EPI scores generally correlate with commitments to protecting public health, protecting natural resources and decoupling greenhouse gas (GHG) emissions from economic activity (YCELP website).

[2] https://epi.envirocenter.yale.edu/ Retrieved January 14 2019.

[3] It must be cautioned that the data used to calculate the EPI index are not officially provided by the Government of Jamaica, and unofficial and open data sources are used to calculate the EPI. Some of these may be inconsistent with verified data sets.

1.3.2 SDG Ranking

The 2015 MTF set out four medium term themes, and eight priority outcomes for Jamaica. Although the SOE Report generally reports on trends affecting natural resources, the DPSIR framework that has been adopted for the report takes a triple bottom line lens that relates environmental protection to human needs as drivers of environmental change (discussed in Section 2 Drivers and Pressures). Jamaica's performance against the SDGs has been assessed and compared along with other nations that are using the UN SDG system (Sachs et al 2018). The detailed results for Jamaica are reproduced on pages 6 through 8; the report indicates that these results are not comparable to previous assessments, as the data and methodology have been revised for the 2018 index.

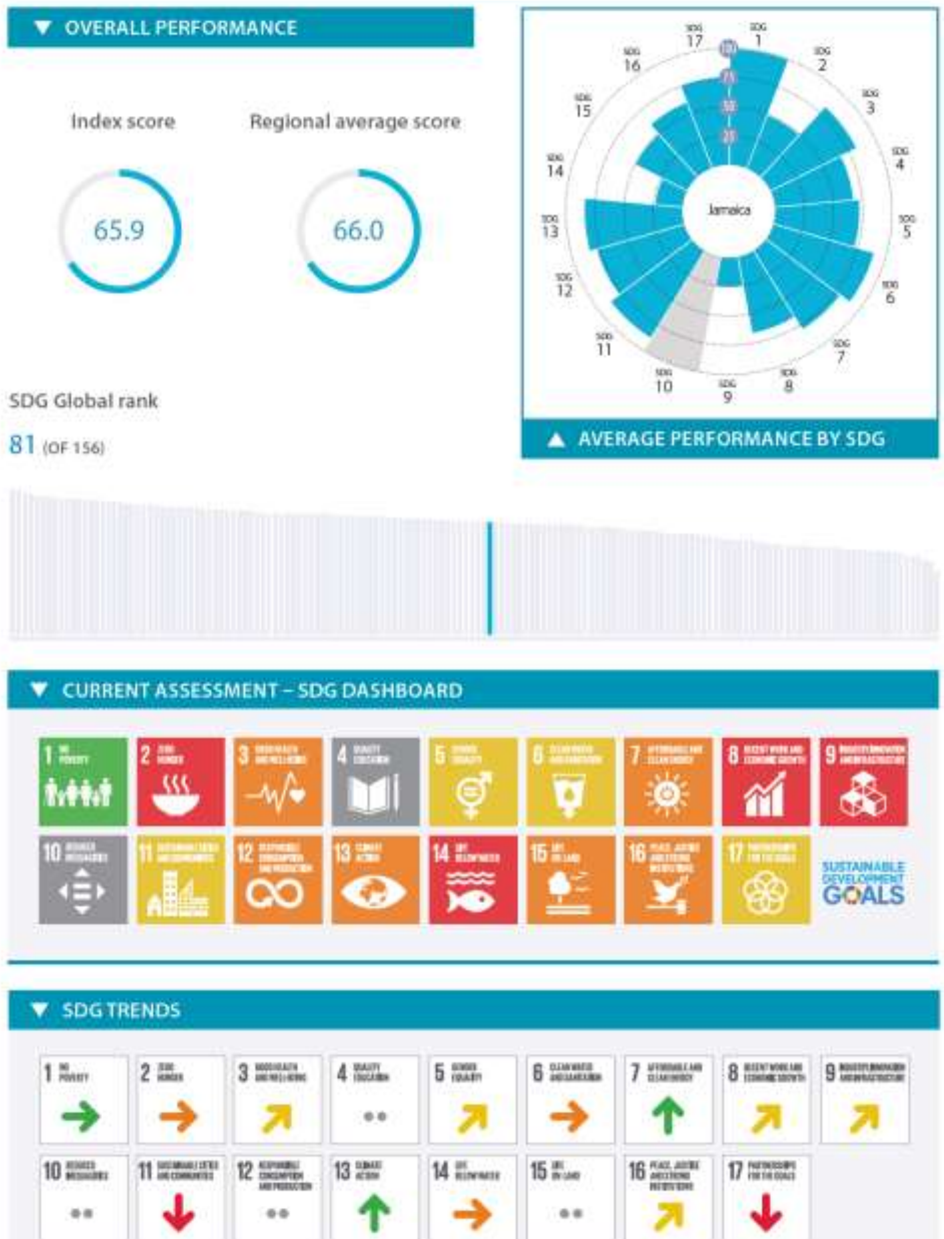
Jamaica's overall Global Rank is assessed as 81st (out of 156), indicating that the country is just below the median value (which would be 78thplace) (see Figure 1). Jamaica's overall performance, expressed as the index score is 65.9, is on par with the regional average of 66. A score of 66 indicates that Jamaica is on average 66% (two thirds) of the way towards peak performance. The Sachs report (Sachs et al 2018) indicates that Jamaica is making good progress towards most goals, with the exceptions of SDG 11 (sustainable cities and communities) and SDG 17 (partnerships for goals), both of which can be flagged for further attention (Figure 1 and Figure 2). Specific areas within the SDG indicators that have been assessed as being in the red or on a downward trend and have environmental implications are highlighted in Table 2 as "*priority areas.*"

Table 2 Mapping of UN SDGs against the MTF (Vision 2030)

Goal 1: Empowering Jamaicans	Goal 2: Secure Just and Cohesive Society	Goal 3: Prosperity	Goal 4: Healthy Natural Environment
National Outcome #1 A healthy and stable population: - SDG 10 Reduced inequality	*National outcome #5 – security and ~~safety~~* - SDG 16 Peace and justice strong institutions	***National Outcome #7 – A stable macro-economy*** - SDG 8 Decent work and economic growth **PRIORITY AREA:** - **Employment rate (12.4% of total labour force)**	***National outcome #13 – sustainable management and use of environmental and natural resources*** - SDG 14 Life below water - SDG 15 Life on land **PRIORITY AREAS:** - **Ocean Health Index – Clean waters (44.1%)** - **Ocean Health Index - Fisheries (23%)** - **Red List Index of species survival (0.7/1.0)**
National Outcome #2 – World-Class Education and Training: - SDG 4 Quality education	*National outcome #6 – effective governance* - SDG 17 Partnerships to achieve the goal	***National outcome #8 – an enabling business environment*** National Outcome #9 – Strong Economic Infrastructure ***National outcome #10 – energy security and efficiency*** - SDG 7 Affordable and clean energy	***National outcome #14 – hazard risk reduction and adaptation to climate change*** - SDG 13 Climate action
National Outcome #3 Effective social protection - SDG 11 Reduced inequalities		National outcome #11 – a technology-enabled society - SDG 9 Industry, innovation and infrastructure	National outcome #15 – sustainable urban and rural development - SDG 1 No poverty - SDG 2 Zero hunger - SDG 3 Good health and well-being - SDG 6 Clean water and sanitation - SDG 10 Sustainable cities and communities **PRIORITY AREAS:** - **Subjective well-being score: 5.9/10** - **Annual mean concentration of particulate matter of <PM 2.5 in urban areas:17.0 µg/m^3** - **93% population have access to piped water:** - **12% anthropogenic wastewater receives treatment**
National Outcome #4 – Authentic and Transformational Culture - SDG 5 Gender equality		National outcome #12 – internationally competitive industry structures: agriculture; manufacturing; mining and quarrying; construction; creative industries; sport; information and communications technology; services; tourism - sdg 12 responsible consumption and production **PRIORITY AREAS:** - **Cereal yield: 1.1 t/ha** - **Sustainable Nitrogen Management Index: 1.1**	

Priority Areas: assessments are indicated in red based on Sachs et al (2018) SDG assessment (see pages7 and 8).
2015-2018 Vision MTF priorities are shown in bold italics.

(a)



(b)

Figure 1 (a) Jamaica's Country Profile (SDG) (Source: Reproduced from page 246 SDG Index and Dashboards Report 2018) (b) Graphic representation of the SDG Trends methodology (Source: from page 44 SDG Index and Dashboards Report 2018)

	Value	Rating	Trend
SDG1 – End Poverty			
Poverty headcount ratio at $1.90/day (% population)	0.7	● green	→
Projected poverty headcount ratio at $1.90/day in 2030 (% population)	0.0	● green	••
SDG2 – Zero Hunger			
Prevalence of undernourishment (% population)	8.4	● yellow	••
Prevalence of stunting (low height-for-age) in children under 5 years of age (%)	5.7	● green	↑
Prevalence of wasting in children under 5 years of age (%)	3.0	● green	→
Prevalence of obesity, BMI ≥ 30 (% adult population)	24.7	● orange	↓
Cereal yield (t/ha)	1.1	● red	↓
Sustainable Nitrogen Management Index	1.1	● red	••
SDG3 – Good Health and Well-Being			
Maternal mortality rate (per 100,000 live births)	89.0	● yellow	↗
Neonatal mortality rate (per 1,000 live births)	10.9	● green	↑
Mortality rate, under-5 (per 1,000 live births)	15.3	● green	→
Incidence of tuberculosis (per 100,000 population)	4.5	● green	→
HIV prevalence (per 1,000)	0.2	● yellow	↑
Age-standardised death rate due to cardiovascular disease, cancer, diabetes, and chronic respiratory disease in populations age 30–70 years (per 100,000 population)	15.2	● yellow	↑
Age-standardised death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	40.1	● yellow	••
Traffic deaths rate (per 100,000 population)	10.0	● yellow	↓
Healthy Life Expectancy at birth (years)	76.2	● green	→
Adolescent fertility rate (births per 1,000 women ages 15-19)	54.4	● red	↗
Births attended by skilled health personnel (%)	99.1	● green	••
Surviving infants who received 2 WHO-recommended vaccines (%)	95.0	● green	↑
Universal Health Coverage Tracer Index (0-100)	61.3	● orange	→
Subjective Wellbeing (average ladder score, 0-10)	5.9	● yellow	↓
SDG4 – Quality Education			
Net primary enrolment rate (%)	NA	● grey	••
Mean years of schooling	9.6	● red	→
Literacy rate of 15-24 year olds, both sexes (%)	NA	● grey	••
SDG5 – Gender Equality			
Unmet demand for contraception, estimated (% women married or in union, ages 15-49)	12.7	● green	→
Female to male mean years of schooling of population age 25 + (%)	101.0	● green	••
Female to male labour force participation rate (%)	74.0	● green	→
Seats held by women in national parliaments (%)	17.5	● red	↗
SDG6 – Clean Water and Sanitation			
High-income countries: population using safely managed water services (%)	NA	● grey	••
Other countries: population using at least basic drinking water services (%)	92.9	● yellow	→
High-income countries: population using safely managed sanitation services (%)	NA	● grey	••
Other countries: population using at least basic sanitation services (%)	85.4	● yellow	→
Freshwater withdrawal as % total renewable water resources	11.3	● green	••
Imported groundwater depletion (m^3/year/capita)	7.3	● yellow	••
SDG7 – Affordable and Clean Energy			
Access to electricity (% population)	97.1	● yellow	↑
Access to clean fuels & technology for cooking (% population)	93.3	● green	↑
CO_2 emissions from fuel combustion / electricity output ($MtCO_2$/TWh)	1.8	● red	↑
SDG8 – Decent Work and Economic Growth			
Adjusted GDP Growth (%)	-4.0	● red	••
Slavery score (0-100)	80.0	● green	••
Adults (15 years +) with an account at a bank or other financial institution or with a mobile-money-service provider (%)	78.5	● yellow	↑
Unemployment rate (% total labour force)	12.4	● red	↓
SDG9 – Industry, Innovation and Infrastructure			
Proportion of the population using the internet (%)	45.0	● red	↑
Mobile broadband subscriptions (per 100 inhabitants)	55.2	● orange	↑
Quality of overall infrastructure (1= extremely underdeveloped; 7= extensive and efficient by international standards)	4.2	● yellow	↓
Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)	2.2	● orange	••
The Times Higher Education Universities Ranking, Average score of top 3 universities (0-100)	0.0	● orange	••
Number of scientific and technical journal articles (per 1,000 population)	0.0	● red	••
Research and development expenditure (% GDP)	0.1	● red	••
SDG10 – Reduced Inequalities			
Gini Coefficient adjusted for top income (1-100)	NA	● grey	••
SDG11 – Sustainable Cities and Communities			
Annual mean concentration of particulate matter of less than 2.5 microns of diameter (PM2.5) in urban areas (μg/m^3)	17.0	● yellow	↓
Improved water source, piped (% urban population with access)	92.9	● yellow	↓
Satisfaction with public transport (%)	72.0	● yellow	↓
SDG12 – Responsible Consumption and Production			
Municipal Solid Waste (kg/day/capita)	0.2	● green	••
E-waste generated (kg/capita)	5.8	● yellow	••
Anthropogenic wastewater that receives treatment (%)	12.0	● red	••
Production-based SO_2 emissions (kg/capita)	NA	● grey	••
Net imported SO_2 emissions (kg/capita)	-0.7	● green	••
Reactive nitrogen production footprint (kg/capita)	17.3	● yellow	••
Net imported emissions of reactive nitrogen (kg/capita)	6.4	● yellow	••
SDG13 – Climate Action			
Energy-related CO_2 emissions per capita (tCO_2/capita)	2.6	● yellow	↑
Imported CO_2 emissions, technology-adjusted (tCO_2/capita)	0.9	● orange	••
Climate Change Vulnerability Index	-0.1	● green	••
CO_2 emissions embodied in fossil fuel exports (kg/capita)	0.0	● green	••
SDG14 – Life Below Water			
Mean area that is protected in marine sites important to biodiversity (%)	30.6	● yellow	••
Ocean Health Index-Biodiversity (0-100)	86.5	● yellow	→
Ocean Health Index-Clean Waters (0-100)	44.1	● red	→
Ocean Health Index-Fisheries (0-100)	22.9	● red	↓
Fish Stocks overexploited or collapsed by EEZ (%)	74.0	● red	••
Fish caught by trawling (%)	NA	● grey	••
SDG15 – Life on Land			
Mean area that is protected in terrestrial sites important to biodiversity (%)	22.0	● orange	→
Mean area that is protected in freshwater sites important to biodiversity (%)	NA	● grey	••
Red List Index of species survival (0-1)	0.7	● red	↓
Annual change in forest area (%)	5.4	● orange	••
Imported biodiversity threats (threats per million population)	3.4	● green	••
SDG16 – Peace, Justice and Strong Institutions			
Homicides (per 100,000 population)	43.2	● red	••
Prison population (per 100,000 population)	138.0	● yellow	••
Population who feel safe walking alone at night in the city or area where they live (%)	62.0	● orange	↑
Government Efficiency (1-7)	3.4	● orange	↓
Property Rights (1-7)	4.5	● green	↑
Children under 5 years of age whose births have been registered with a civil authority (%)	99.5	● green	••
Corruption Perception Index (0-100)	44.0	● orange	↗
Children 5–14 years old involved in child labour (%)	3.3	● yellow	••
Transfers of major conventional weapons (exports) (constant 1990 US$ million per 100,000 population)	0.0	● green	••
SDG17 – Partnerships for the Goals			
Government Health and Education spending (% GDP)	11.4	● orange	↓
High-income and all OECD DAC countries: International concessional public finance, including official development assistance (% GNI)	NA	● grey	••
Other countries: Tax revenue (% GDP)	26.1	● green	↓
Tax Haven Score (best 0-5 worst)	0.0	● green	••

Figure 2 Jamaica's Indicator Performance[4] (Source: Reproduced from page 247 SDG Index and Dashboards Report 2018)

[4] SDG Ratings (coloured circles) indicate the performance of the SDG indicators. All indicators were re-scaled from 0-3, and defined by the average of the two indicator variables on which a country performed worst: 0-0.9 (red), 1-1.49 (orange), 1.5-1.9 (yellow), 2-3 (green). To score green, both indicators needed to score between 2-3 (otherwise the SDG was ranked yellow), and to score red, both indicators needed to score between 0-0.9. If only one indicator was available for a given SDG, the score for that indicator determines the rating for the goal. If a country had less than 50% of the indicators available under a goal, a grey circle was utilized.

The DPSIR Framework

1.3.3 Overview and Definitions

The Driver-Pressure-State-Impact-Response (DPSIR) framework defines the main structure of the 2017 State of Environment (SOE) Report. Developed in Europe in the 1990s, this approach to environmental reporting has wide application, including by United Nations Environment Programme (UNEP) (2016b), the USEPA (United States Environmental Protection Agency) (2015) and most recently by the Government of Australia (Jackson 2017). The DPSIR framework is an integrated approach, covering social, economic and environmental themes, establishes the linkages between the causes (drivers and pressures) that affect the condition of environmental systems (state), which in turn impact the ecosystem services (Box 1and Figure 3) provided by these systems to humans (impact).

Ecosystem Services are defined as "*the benefits people obtain from ecosystems*" and includes both natural and managed services. These are provisional, regulative, cultural and supporting services[i].

Box 1 Definition of Ecosystem Services

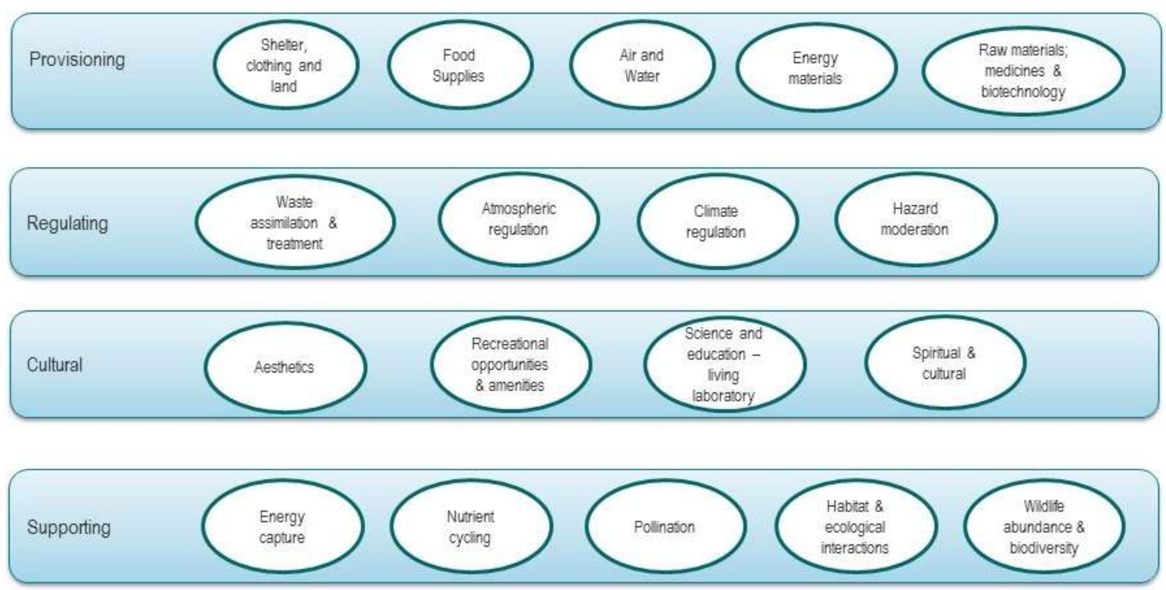


Figure 3 Ecosystem Services (Source: Reproduced from UNEP 2017 and Kelble et al 2013)

To attempt to maintain the services provided by the environment to support human development, it becomes necessary to manage causes, the state of systems or impacts (response) (Figure 4). Key definitions of the DPSIR framework are listed or provided in

Table 3.

Table 3 DPSIR definitions used in this report

Term	Definition
Drivers	**Underlying causes** that: 1. Are fundamental push factors of human activities, including **basic needs** for food, water, population growth, prosperity (economic growth), and shelter (protection from adverse natural conditions such as climate and hazards). Consequently, these drivers can be either anthropogenic or natural; 2. Indirectly cause change in ecosystems by creating or influencing human activities; i.e. are the root causes; 3. Are not realistically manageable within the medium to short-term; 4. Tend to occur at national or larger scales and may act in combination with other drivers and/or less fundamental processes.
Pressures	**Stresses**, perturbations or mechanisms that: 1. Are derived from human activities that support the basic needs: e.g. fuel/energy supply, manufacturing and trade, raw materials (extractive industries); transportation; infrastructural developments; tourism, recreation and sport; 2. Directly affect ecosystems; 3. Comprise three main types of environmental stress: a. Demand/exploitation of environmental resources (activities); b. Changes in land use/cover (footprint); c. Waste streams (pollution). 4. Are manageable in the short- to medium term; 5. Occur at local scales (localized point sources or sub-national scale); 6. May feedback to drivers (intensifying or reducing the effect of the driver).
States (effects on VEC)	The current **condition/status** or quality of ecosystems or valued environmental components (**VECs**), which: 1. Are physical, chemical or biological attributes or specific parameters that can be measured/quantified and monitored (i.e. characterized by specific metrics) but are not reported in terms of monetary or socio-cultural metrics; 2. Are directly affected by pressures within a specific timeframe; 3. Have 'normal' operational ranges of fluctuation (system baseline or reference condition) and carrying capacity (threshold to major system change), which may be changed by pressures; 4. Can be temporally and spatially variable in magnitude.
Impacts (on ecosystem Services)	The **consequences impacting ecosystem services** result in change in the VEC state, which: 1. Change the availability and/or functioning of ecosystem services normally provided; 2. Occur as result of a shift in the baseline/reference conditions of the VEC and is attributable to the occurrence of pressures. Deleterious VEC state shifts represent adverse impacts to ecosystem services (damage and loss). Positive impacts on ecosystem services can be affected by responses designed to remediate or restore ecosystem services; 3. Can be temporally and spatially variable in magnitude; 4. Can affect future state of VECs, depending on resilience (capacity to recover from stresses or return to natural state), risk (likelihood and consequences of impacts), and outlook (likely future state); 5. Have a value or cost that can be measured/quantified and reported in monetary or socio-cultural terms.
Responses	Human **interventions** that: 1. Seek to sustainably maintain ecosystem services that are critical to human well-being; 2. Recognize gaps or oversights that allowed impacts to occur; 3. Reflect social and economic priorities and mandates;

Term	Definition
	4. Are designed to restore ecosystem services/functioning; mitigate exposure to environmental impacts or adapt to impacts (or build coping capacity); 5. Usually involves plans, policies, laws, institutional capacity as well as science & technology; 6. Have clear criteria for selection, and are: • Environmentally sustainable; • Technically feasibility; • Economically viable; • Socially desirable; • Legally permissible; and 7. Administratively achievable within the set time frame.
Sources: Oesterwind et al 2016; Jackson 2016; USEPA 2015; UNEP 2015; Kelble et al 2013; Mateus and Campuzano 2008 after UNEP/GRID-Arendal 2002; Kristensen 2004; Carr et al 2007	

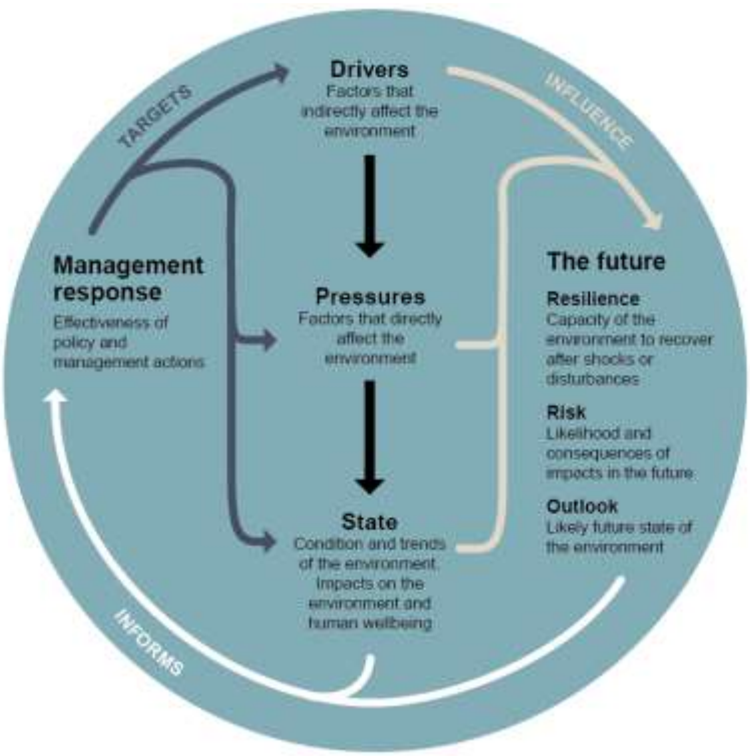


Figure 4 DPSIR Framework (Source: reproduced from Jackson et al 2016)

Although previous Jamaica SOE Reports adopted the Pressure-State-Response (PSR) model, this 2017 version goes further in linking the environment with human concerns and capacities. The PSR model includes human systems as part of the pressures impacting environmental states. The DPSIR approach not only includes humans as part of the environment but also puts human concerns at the centre of the analytical framing by making the linkages between socio-political and economic objectives to environmental protection explicit (USEPA 2015; UNEP 2017).This anthropocentric view defines States and Impacts in terms of the benefits that ecosystem services provide to humans, thereby framing environmental protection and remediation as strategies for self-preservation. A key feature of this approach is that it takes a systems approach, assuming all the components (drivers, pressures, valued environmental component states, impacts on ecosystem services and responses) are all interconnected, and that these linkages are complex and multi-directional. Of necessity, the SOE Report focuses more on national scale, longer-term system dynamics.

1.3.4 Indicators

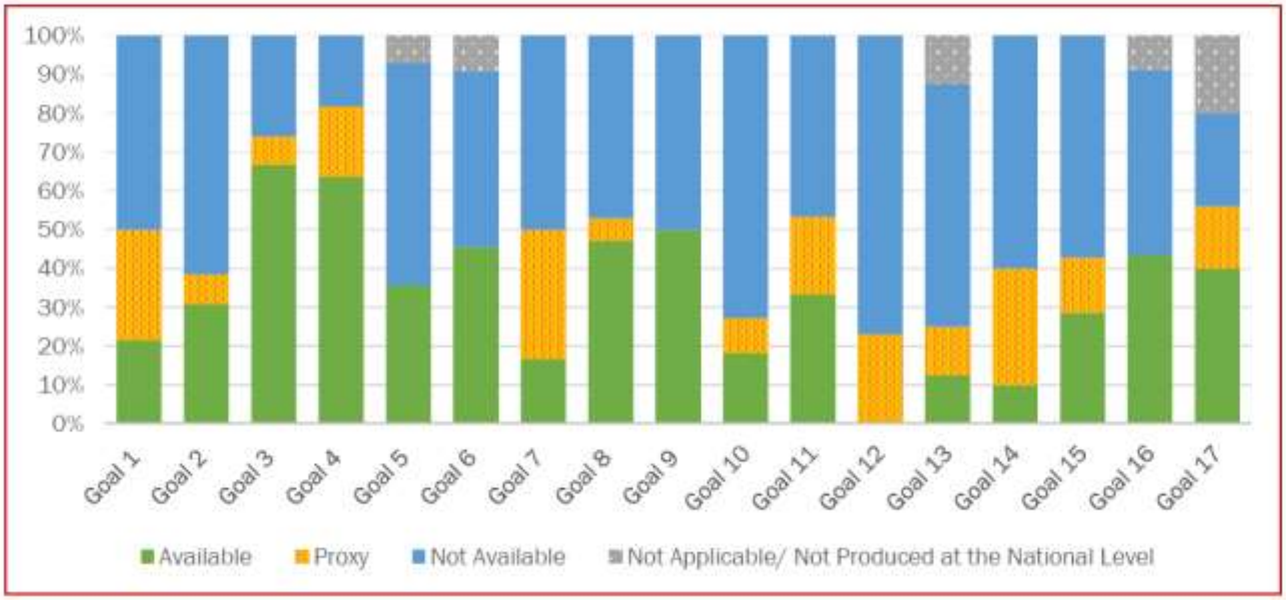
Indicators are key variables[5] that are used to evaluate environmental performance in the various components of the DPSIR framework. The selection of indicators used in this 2017 SOE Report relied on a review of indicators in the two previous SOE reports (2010 and 2013) and a comparison against indicators from the following systems: SDGs (UN), ILAC,[6] and EPI (Yale). Since the Vision 2030 Jamaica National Development Plan is closely aligned to the UN Vision 2030 SDGs, the SDG indicators with environmental implications are given precedence.

The recent Jamaica Voluntary National Report (PIOJ 2018b and STATIN 2018) assessed Jamaica's national statistical capacity to report on the SDG indicators, and found that, in respect of all 17 SDGs there was no complete capacity to produce the necessary indicators (see Figure 5, reproduced from STATIN 2018). Based on the statistical capacity assessment, Jamaica has less than 50% capacity to produce any of the requisite indicators (with the exception of Goal 3 – health). Of the seven main SDGs that can be considered as environmental in theme (red text in Figure 5 the most data have been produced on Water and Sanitation (SDG 6). In general data to support reporting in other environmental areas are generally quite poor:

- SDG 6 Water and sanitation: 45% data available
- SDG11Sustainable cities and communities <35% data available
- SDG 15 Life on land: <30% data available
- SDG 7 Energy: <20% data available
- SDG 13 Climate action: <15% data available
- SDG 14 Life below water: <10% data available
- SDG 12 Consumption and production: no data available

[5]**Indicator:** a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, or to reflect the changes connected to an intervention (OECD, 2002). An indicator is a signal for something that cannot be directly seen. The purpose of an indicator is to describe an issue that someone is concerned about, in a clear and understandable way, and track trend over time (Briggs, 2002). **Metric:** a unique and specific way in which an indicator can be summarized. For instance, a relevant indicator could be savings in disaster spending relative to a baseline, but reported using different metrics (e.g., spending / 1,000 people or spending over a specific unit of time).

[6]ILAC is the English acronym for "***Latin American and Caribbean Initiative for Sustainable Development***" translated from Spanish.



1.Poverty	5.Gender	9.Industry, innovation and infrastructure	**13.Climate action**
2.Hunger	**6.Water and sanitation**	10.Inequalities	**14.Life below water**
3.Health	**7.Energy**	**11.Sustainable cities and communities**	**15.Life on land**
4.Education	8.Work and economic growth	**12.Consumption and production**	16.Peace justice and strong institutions
			17.Partnerships for the goals

Figure 5 Assessment of national statistical capacity for SDGs indicators (Source: reproduced from STATIN, 2018 Figure iii). Red in key indicates areas that are wholly or partly of environmental concern.

Although considerable data and metrics may allow for some level of characterization of a particular theme (driver, pressure, state, etc), it must be noted that not all key performance indicators (KPIs) are indicative of environmental performance, even using a triple bottom line lens (adding in economic and social considerations). The following criteria are applied to evaluate available data sets for use as indicators (Kershener et al 2011; UNEP 2017; Pickard et al 2018). Indicators should:

- be limited in number, as using the least amount of information needed to show change is important to maintain simplicity and ensure effective prioritization in reporting;
- be scientifically valid and verifiable with objective, unambiguous link between cause and effect;
- relate to an existing benchmark with identified reference points and targets. Optimally, data sets should be aligned with existing indicators, previous reports and have relatively wide use so that data sets can be compared with other areas or previous years;
- be relevant to policy and reflect stakeholder/management concerns (comprehensive);
- be sensitive to change and occur within a narrow range of natural process variability where spatial and temporal variations are understood.; as such, data sets should have a relatively high signal-to-noise ratio so that it is possible to estimate the uncertainty associated with each indicator, and to ensure that variability in indicator values does not prevent detection of significant changes;
- rely on available historical data with sufficient spatial and time series coverage, so that numerical quantifiable/quantitative progress to targets can be determined; and
- be clearly-defined so that communication of performance is unambiguous.

1.3.5 Grading System and Environmental Performance Reporting

The following section describes how the environmental grading and reporting has been conducted:

1. **Assessment grades:** The indicators that have been selected for each DPSIR component were graded using the system developed by Jackson et al 2016 (and used in the 2016 Australian SOE). A template for this is given in Table 4. The specific indicator is identified with a brief summary description. Additionally, the following grades are given:
    a. Drivers and pressures grade speaks to level of adverse impact;
    b. State grade speaks to condition (ranging from very poor to very good).The summary discussion will provide empirical evidence of status change relative to baseline or natural parameters, or spatial/range and quality changes since 2013;
    c. Impact grades are stated in terms of change/trend in availability and function of ecosystem services (improving, deteriorating, stable or unclear). The summary discussion will present empirical evidence of trend/change/loss since 2013;
    d. Responses (ineffective to extremely effective).

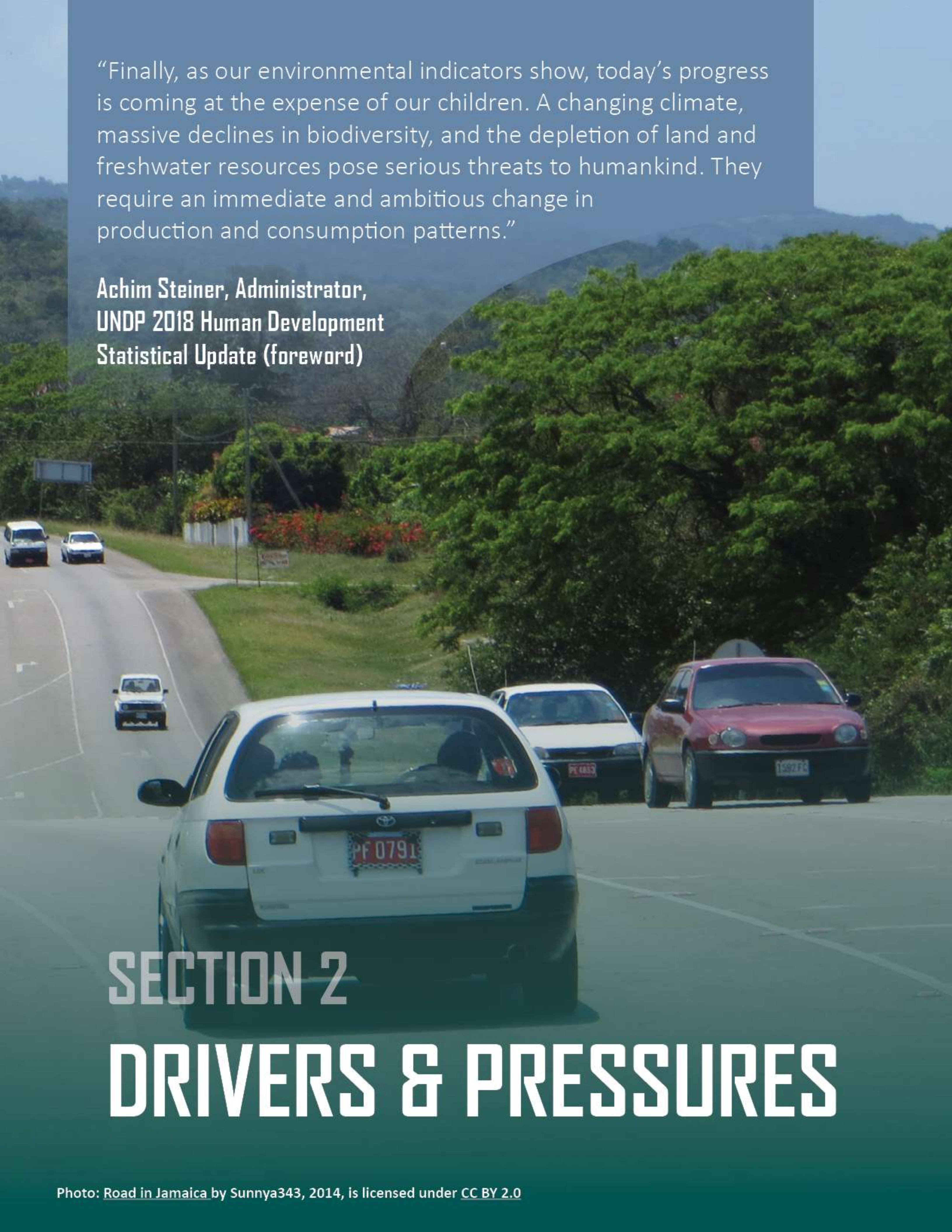
A **red flag** beside the score card indicates that this indicator is on the threshold of a critical change that requires urgent attention.

2. **Assessing Confidence in findings/data:** The simple UNEP (2017) 3-point data checking scale was used (shown in Table 4 below).

Table 4 Data Confidence Guide (Source: UNEP 2017; GoC 2010)

	High (three)	Medium (two)	Low (one)
Data collection methods	Standard/accepted methods.	Unvalidated methods	Unknown
Validation	Many of the sample sites validated	Few of the sample sites validated	No
Metadata	Complete	Incomplete	None
Coverage/scope	Sufficient evidence and understanding of the system	Fair coverage but poor scientific understanding of the system	Limited spatial and temporal coverage or gaps in understanding; limited interpretation

3. **Assessing Risk:** Risk is a measure of the likelihood of loss or damage. It was assessed here based on availability of data for the impacts identified in the five main VEC themes. To the extent possible, the probability of loss occurring and the consequences arising from that loss or the dimensions of that loss are qualitatively discussed.



"Finally, as our environmental indicators show, today's progress is coming at the expense of our children. A changing climate, massive declines in biodiversity, and the depletion of land and freshwater resources pose serious threats to humankind. They require an immediate and ambitious change in production and consumption patterns."

Achim Steiner, Administrator, UNDP 2018 Human Development Statistical Update (foreword)

SECTION 2

DRIVERS & PRESSURES

DRIVERS

As outlined in Table 2, the drivers are the underlying causes or basic human needs that create environmental pressure. These are not usually manageable in the short to medium term because of the spatial and temporal scales at which drivers operate. The main drivers of change identified by UNEP (2016b[7]) included economic trends, demographic and social drivers, climate change and natural hazards. UNEP also included innovation and governance frameworks, which are included in this report under the response section. Responses can be regarded as drivers of change, and, according to the definitions adopted for this report, drivers are not realistically manageable, represent root causes or basic human needs. Consequently, the key drivers of change that have been selected for Jamaica's 2017 SOE report are:

- Population Growth
- Economic Growth
- Food Production
- Water Needs
- Climate Change/Variability and Natural Hazards.

For each of these, the SOE Report:

1. Identifies linkages between the driver and environmental pressures and examines spatio-temporal scale of occurrence;
2. Assesses the indicator trends and patterns occurring since 2013; as discussed before, the assessment grade will speak to impact potential, and will be done using the Table 4 template (Grading System);
3. Outlines national planning frameworks that broadly address these issues within an international context in the medium term;
4. Presents main conclusions within the context of the SDG goals and recommendations (in terms of opportunities/outlooks).

Land use and land cover (LULC) and waste generation are regarded as cross-cutting drivers of environmental change and are addressed further under various themes in the Pressures section (Chapters 7 through 12).

[7]UNEP 2016. GEO-6 Regional Assessment for Latin America and the Caribbean. United Nations Environment Programme, Nairobi, Kenya.

2. Population Growth

Scorecard 2: Population Growth (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
TOTAL CHANGE IN POPULATION	Annual growth rate is 0.1% and emigration exceeds natural increase.	LOW	3	3
PROPORTION OF URBAN POPULATION	More than 58% of Jamaica's population live in urban places, placing high levels of stress on nearshore ecosystems and urban VECs.	HIGH	3	3
POPULATION AGE/SEX/ EMPLOYMENT STRUCTURE	Almost 70% of the population is working age, with a low dependency ratio (12.5%). The male to female ratio in the population averages at 1:1 for all age cohorts except in the > 75 age group. Standardized equality indicators show improvements since 2013.	LOW	3	3
POVERTY	Households below the poverty line in 2015: 15.2%. Human development indicator (HDI) and inequality-adjusted HDI show progress. Inequality-adjustment caused a loss of 17% in 2017. Rural poverty is trending upwards (~28% in 2015).	HIGH	3	3

Photo: Busy street in Kingston, Jamaica by Natascia Tamburello, 2016. Used with permission.

2.2 Environmental linkages

The impact of humans on the planet has been so significant that the era of major human civilization is now being recognized as the current geological period, called the "**Anthropocene.**"[8] This concept takes into consideration the influence of human populations on global cumulative environmental effects such as climate change, loss of biological integrity (including biodiversity and habitat quality), LULC change, bio-geochemical flows, and major shifts in mechanisms and the quality of the oceans and atmosphere.

In understanding the complexity of the relationships between population and the state of the environment it is critical to appreciate that it is not about absolute numbers, but rather about the distribution patterns (rate of growth, age, sex, education, employment levels, location) relative to the availability and access to resources - both natural and societal. The balance between population driven demand and environment-driven supply, and the *rate of change* of these two sides of the equation have implications for tipping points and the extent to which adverse environmental effects are likely to be inter-generational or long-term i.e. sustainable.

Population influences demand for food and clean water, as well the generation of waste products including air emissions, sewage, solid waste, land use, and numerous environmental pressures that arise in relation to addressing basic needs. In addition, the relative importance of meeting human needs competes with aspirational environmental objectives such as habitat or species conservation, or reduction of carbon emissions. This is particularly relevant if environmental change occurs in a more long-term timeframe due to poverty, lack of food or clean water, or poor environmental health. Some demographic trends also have the potential to positively impact areas of the DPSIR framework, for example, improvements in education and employment or land tenure may improve the potential for environmental stewardship.

2.3 Indicator Trends and Patterns

2.3.1 Total Change in Population

Table 5 summarizes the major demographic statistics for the period 2014-2017 for Jamaica. Between January 1 2014 and December 31, 2017, Jamaica's population is estimated to have increased by ~11,000 people, with an average annual growth rate of ~0.1% (Statistical Institute of Jamaica-STATIN[9]). The rate of *natural increase* is the difference between live births and deaths in a population. The rate of *population growth* in a country is the difference between natural increase and migration. For the first time in recent history, the net emigration from Jamaica exceeded the rate of natural increase in 2017 (Figure 6).

[8] The Anthropocene is a proposed geological epoch that began at the commencement of significant impact on the Earth's geology as a result of anthropogenic causes, including land use change, climate change, and changes to biodiversity. The exact start date has not been defined, and is proposed to be as recent as the 1960s, or as early as the agricultural revolution (12 – 15,000 years ago).
http://www.anthropocene.info/Retrieved December 10 2018

[9] http://statinja.gov.jm/Demo_SocialStats/PopulationStats.aspxRetrieved January 11 2019. The last national population census was done in 2011

Table 5Summary of population growth indicators (source: PIOJ 2018a)

Indicators	2013	2014	2015	2016	2017
Population '000 persons	2717.9	2 723.2	2 728.9	2 729.0	2 728.9
Live Births (persons)	38,500	37,000	37,900	36,200	34,111
Deaths (persons)	17,400	19,600	19,300	19,800	18,900
Migration (persons)*	-14,700	-12,200	-14,600	-14,800	-15,400
Life Expectancy (years)	73.1	74.1	74.1	74.1	74.3
*Refers to external movements only					

In general, migration numbers (both inflows and outflows) are variable from year to year and may be controlled by economic and external factors. Between 2013 and 2017, net migration numbers ranged between -14,700 (2013) and -15,400 (PIOJ 2018a, Table 20.1).The net external movements have been negativeand are, effectively, considered emigration.

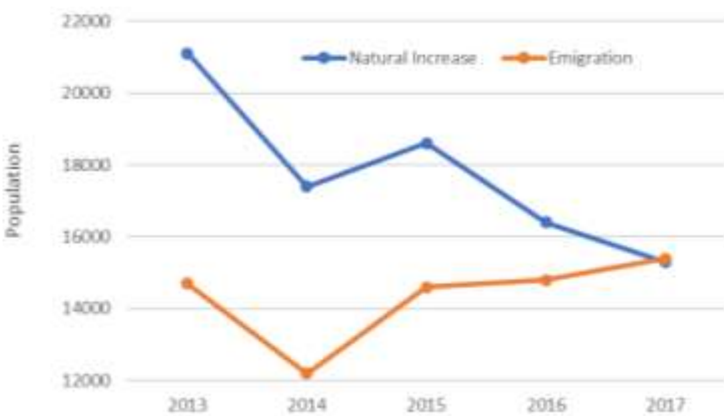


Figure 6 Comparison of natural increase with ***net*** *external movements (2013-2017; Source: reproduced from PIOJ 2018a)*

The graph (Figure 6) shows that, while the rate of natural increase declined from 21,100 in 2013 to 15,300, net migration increased steadily from -14,700 in 2013 to -15,400 in 2017[10]. For the first time in recent history emigration actually exceeded natural increase in 2017. Since the death rate has remained relatively stable (with the 2017 number of deaths being ~1600 greater than in 2003, a 9% increase) and life expectancy has been increasing over time, this declining rate of natural increase is attributed to a declining crude birth rate. Significant strides have been made in reducing the crude birth rate, amounting to a net 25% decline in births since 2003. Based on population forecast to 2045, under current population growth rate trend, the island will not exceed three million persons and will likely eventually experience a significant decrease in population growth.

The effect of this stable population may be generally positive. Although emigration signals loss of human resources, which tends to be selective for the more able-bodied, resourceful and educated, the increasing size of the Diaspora population has resulted in increased inflows of remittances[11] and other resources. The International Organization for Migration (IOM) (2018) estimated that some 1.3 million Jamaica born persons reside outside Jamaica. When their offspring are added to the calculation, the IOM estimates that persons identifying themselves as Jamaican who are not resident in Jamaica may exceed the country's actual resident.

It is generally assumed that, as the population grows, there will be corresponding growth in all major economic sectors and settlements, which fuels demands for natural resources and adds environmental

[10] This net emigration is based on movements of Jamaican nationals to and from the island in any given year (Table 20.1 page 278 Economic and Social Survey of Jamaica 2017, PIOJ (2018a).

[11] The Bank of Jamaica estimates remittances in 2016 to be ~US$2,291 million, accounting for 16% to the GDP (IOM, 2018).

pressures by increasing waste streams[12]. Consequently, if a population is stable, it is fair to assume that there should be no major increases in the cumulative environmental pressures created by natural resources demands and waste generation. However, a cautionary note is that at a sub-national level, urban populations are growing as a result of migration from rural areas, resulting in growing environmental pressures in urban areas.

2.3.2 Population Distribution

Figure 7 shows the population densities by parish in 2017, with the densest populations being located in the parishes of Kingston and St Andrew (KSA), St Catherine and St James. This was calculated using STATIN estimates for the 2017 parish populations, divided by the area of each parish.

Figure 7 Population densities of Jamaican parishes (2017)

In both density and absolute terms, the parishes of Kingston and St Andrew (KSA) jointly have the highest population density and account for ~25% of the estimated 2017 population of Jamaica. Similarly, St Catherine has the second highest population density and accounts for 19% of the estimated 2017 population. Each of the remaining 11 parishes accounts for between 9% (Clarendon) and 3% (St Thomas, Portland, Trelawny and Hanover) of the total population in 2017.

United Nations Development Programme (UNDP) estimated the percentage urban population in Jamaica in 2018 to be 55.4% (UNDP 2018). UN-Habitat projects that, by 2025, this number will be closer to 58% (PIOJ 2018a).The estimated 58% is consistent with the 2011 population Census. Based on the 2011 Census data, STATIN estimated the percentage of the parish populations that was classified as urban (Figure 8).

[12]https://wordpress.clarku.edu/id125-envsus/2017/04/07/how-does-population-growth-affects-the-environment-sustainability/Retrieved January 12 2019

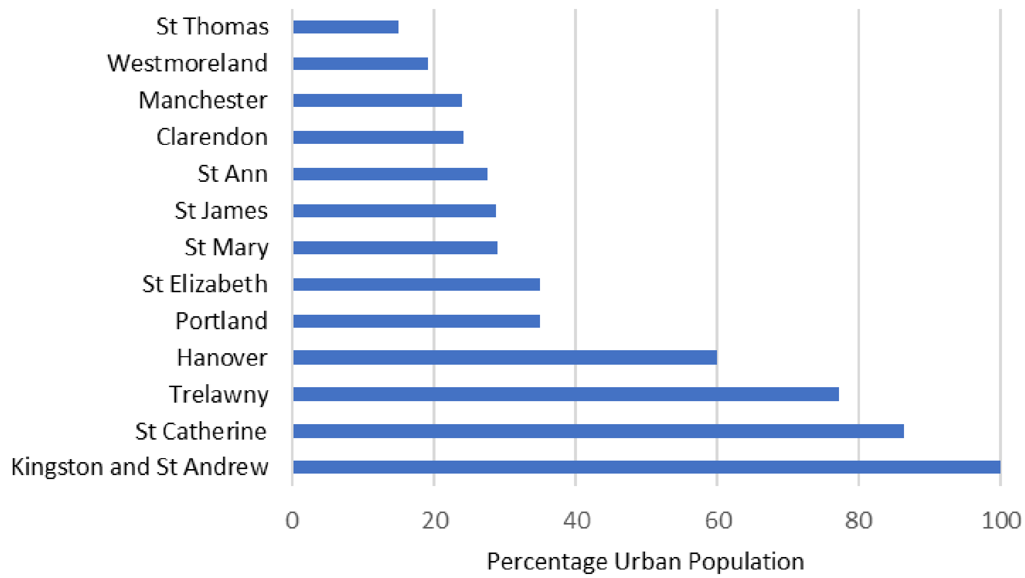


Figure 8 Percentage Urban Population (by Parish) Source: reproduced from STATIN 2011 Census

The parishes with the highest population densities generally tend to be the ones with the largest urban centres, with the combination of Kingston and St. Andrew (KSA; 1,471 persons/km^2) having a population density three times higher than the next most dense parish, St. Catherine (438 persons/km^2). In 2017, almost 44% of the total population of Jamaica resided in these two adjacent parishes, which account for only 15% the total land area of the island. Portmore and several other settlements in St. Catherine are considered satellites of the Kingston Metropolitan Region (KMR), which now includes Kingston, St Andrew and settlements in St Catherine and St Thomas. Available 2011 Census data for these three parishes (Kingston, St Andrew and St Catherine) indicate that the populations were highly concentrated in urban areas, with 68% of Jamaica's total urban population being located there. St James, with the country's second city (Montego Bay) was 59% urban in the 2011 Census. The remaining parishes reported that all had urban populations that were between 11% (Hanover) and 35% of their populations (Clarendon and Manchester), suggesting that these parishes were still relatively rural in character.

Jamaica's population tends to be concentrated in parishes with coastal urban centres. Of the 14 parishes, only Mandeville, in Manchester, is not located on the coastal plain or within 2km of a major river. The environmental implications of this situation include the pressures arising from the physical footprints of urban encroachment into fringing areas that are rural in character, with accompanying impacts on habitats and ecosystems as well as the effects of associated resource consumption and waste streams on the adjacent nearshore ecosystems.

2.3.3 Inequalities and Disparities

Gender and Age: Figure 9 shows the structure of the population based on STATIN estimates for 2017. Since 2013, the male to female ratio in the population is not estimated to have varied significantly, and averages roughly 1:1 (with slightly more females than males in the 2011 Census). This pattern is consistent across all age cohorts, with older women (>75) slightly outnumbering older men.

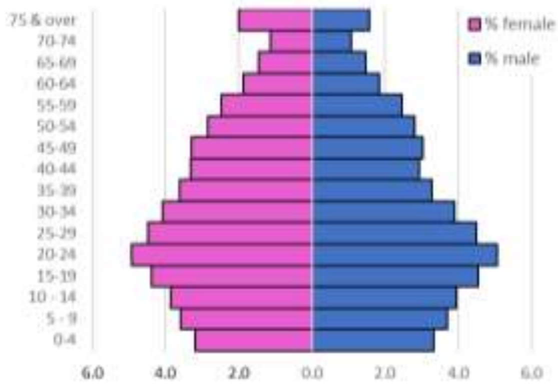


Figure 9 Population Structure (Age and Gender; Source: reproduced from STATIN 2017 estimates)

In terms of age distribution, the estimated working age population (15-64 years) was estimated to be ~70% in 2017; the dependent population (0 to 14 and 65 and over) comprised ~22% and ~9% of the population respectively. Therefore, Jamaica's Age Dependency Ratio[13] is estimated at 43.6%. A Dependency Ratio above 50% indicates that the working population is outnumbered by non-working dependents, which places greater stress on the economy. The World Bank 2017 estimates[14] indicate a (slightly higher) dependency ratio of 47.95%, which is given here to allow for comparison with other countries in the region: Barbados (50.54%), Trinidad & Tobago (44.25%); Antigua & Barbuda (44.56%) and St Lucia (40.07).

Although the difference between males and females is marginal, the gender gap increases, when viewed in terms of educational performance. In 2017, of the 195,498 public school entries in Caribbean Secondary School Education Certificate, 59% were females. Females received higher grades than their male counterparts, although males tended to do marginally better in science subjects (Biology, Chemistry, Integrated Science), technology (Electronics Document Preparation and Management) and Business (Economics and Principles of Business).

Despite representing half the population, women in Jamaica are under-represented in public decision-making, with 11 of 63 members of Parliament (17%) and five of the 18 Cabinet members (28%) being women[15] in 2017. A study commissioned by the Women's Resource and Outreach Centre (WROC) in 2013 on Women on Boards and Committees confirmed that women were on a third of public sector Boards and had a 16% representation on private sector Boards.

The suite of indices reported in UNDP's Human Development Report 2018 (HDR[16]) places Jamaica's performance in a global context (of 189 countries) and can assist with setting national priorities with respect to performance trends. UNDP reports on two composite gender indicators, which are given in Table 6 and defined below.

Table 6 Gender Equality Indicators

Gender Indicator	2013	2014	2015	2016	2017
Gender Development Index (GDI)	0.982	0.980	0.982	0.988	0.988
Gender Inequality Index (GII)	0.436	0.428	0.425	0.412	0.412

The Gender Development Index (GDI), measures gender disparities in the Human Development Index (HDI), life expectancies, expected years of schooling, mean years of school and the Gross National Income (GNI) per capita. A low GDI indicates poor gender development performance (below the global average of 0.942). Jamaica's GDI (0.988) has marginally increased since 2013 (by 0.006). Of the 164 countries for which the GDI is calculated, Jamaica ranked 37th in 2017 (where first was the best score).

13 ((% children under 15) + (% persons over 64) / (percentage of persons 15-64)) * 100 = ((21.6%) + (8.7%) / (69.6%) *100)

14https://www.theglobaleconomy.com/rankings/Age_dependency_ratio/ Retrieved December 10 2018

15https://jis.gov.jm/government/members-of-parliament/ Retrieved December 10 2018

16http://hdr.undp.org/en/countries/profiles/JAMRetrieved December 11 2018

For comparison, both France and Switzerland had scores of 0.987 in 2017, and Barbados' GDI has exceeded 1.0 since 2005.

The **Gender Inequality Index** (GII) is a composite measure of gender inequality, using reproductive health (maternal mortality and adolescent birth rate), empowerment (percentage of seats in Parliament held by women), secondary education and the labour force participation rate. A low GII indicates low inequality levels (and good performance). Jamaica has been steadily improving its GII since 2013. Countries with very low scores include Belgium (0.048) and Switzerland (0.039). Barbados has had GII scores lower than 0.370 since 1995; its present GII is 0.284.

The gender disparity indicators indicate that Jamaica does have gender inequality, although it has been consistently improving over the past four years. A relatively strong GDI score indicates that there is a strong potential for reducing gender inequalities (and the GII scores).

Employment: The unemployment rate is estimated quarterly by the Statistical Institute of Jamaica, and is the proportion of unemployed persons within the labour force. Figure 10 shows the quarterly changes in the labour force and unemployment rate between January 2014 and January 2018. Since third quarter of 2016, there has been a consistent decline in the unemployment rate, to 9.6% by the end of 2017 (reported January 2018). In comparison, up to July 2016 the unemployment rate was above 13%, despite a smaller labour force. Between January 2014 and January 2018, the labour force grew by 3.6%.

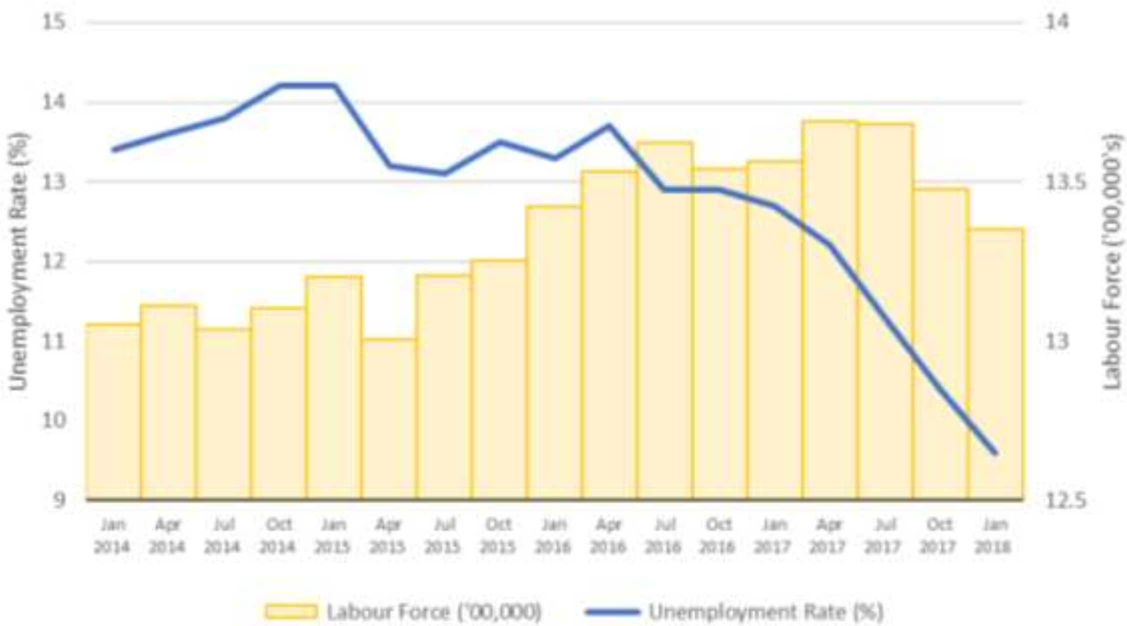


Figure 10 Unemployment Rate in Jamaica, 2014-2018

Figure 11 shows the classifiable labour force divided by industry sector for the last quarter of 2017 (reported January 2018).[17] The most important sector (excluding the low-impact sector), employing more than a fifth of the labour force is the '*wholesale and retail, repair of motor vehicles and equipment'*. This is a sector that is likely to be correlated with urban populations, where vehicle densities are highest. The motor vehicle repair sector is also one where there is likely to be cumulative

[17]Industries classified (herein) as 'low environmental impact sectors' include persons employed in unspecified industries, financial intermediation, private households, electricity, gas and water supply, real estate business, public administration and defense, health and social work, education and other service activities.

adverse environmental impact associated with a range of hazardous wastes including lead acid batteries, oil and grease and paint disposal.

The second most important employment sector is the primary industries (16%). Mining and quarrying is a relatively small sub-sector, contributing only 0.41% to the 16%. Analysis of trends since 2013 indicates that the number of persons employed in primary industry jobs declined by 6% in the review period. Tourism (hotels and restaurant services) contributes roughly the same number of jobs as construction (9%). Analysis of trends since 2013 indicates that the number of persons employed in tourism-related jobs grew by 13% in the review period, and the number of construction jobs increased by 18%. Over the longer term, Jamaica is transitioning from an agrarian society, relying on primary industries, to one that is based more on secondary (value-adding manufacturing and processing) and tertiary industries (service-based).

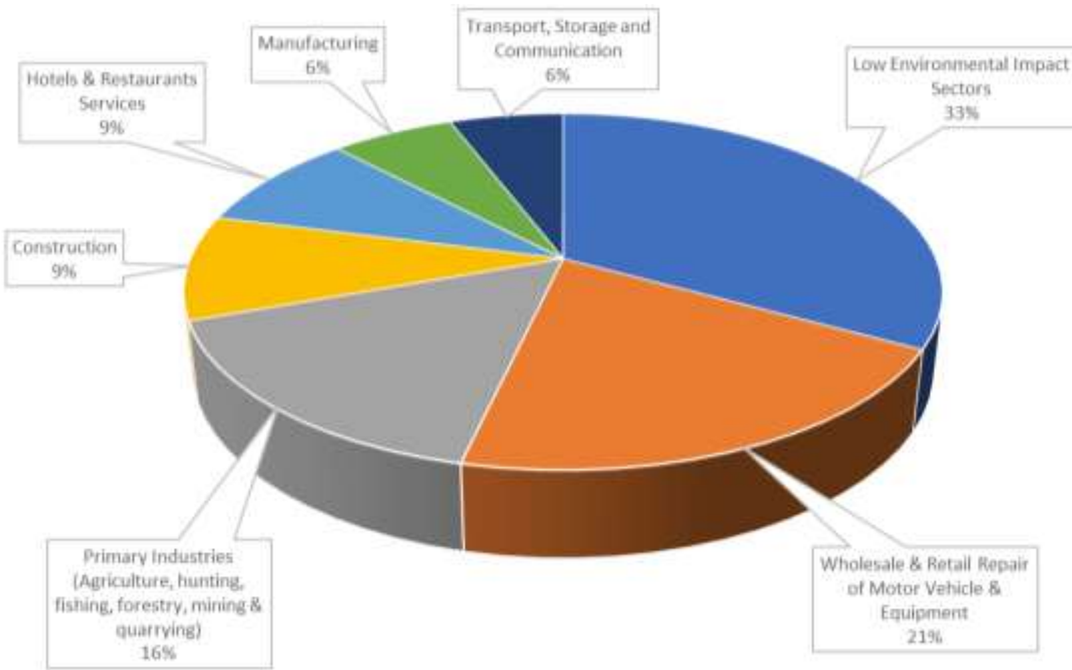


Figure 11 Labour Force by Sector (January 2018; Source: reproduced from STATIN)

While primary industries rely more heavily on natural resources (land, water, forest and marine ecosystems), the shift to reliance on secondary industries can also create environmental pressures, mainly through the waste streams generated (air emissions, solid waste, effluents etc.) and the physical footprint of the industry (e.g. tourism).

Poverty: A critical indicator that links population to the environment is the proportion of the population living below the poverty line (Box 2). The goal of ending poverty in all forms everywhere is the primary SDG and the mission of Vision 2030. The percentage of households that are below the poverty line stood at 15.2% in 2015[18] compared to a general prevalence of poverty in the country in 2015 of 21.2%. In Jamaica, poverty tends to be highest in the rural areas: 20.3% in rural areas compared to 10.4% in the KMA, and 10.5 in other urban areas. Slightly more female-headed households were considered poor (~16% compared to 13% of male-headed households). PIOJ (2018a) noted the prevalence of poverty among small farmers and fishers in particular (24%).

[18] http://statinja.gov.jm/living_conditions_poverty.aspx Retrieved December 11 2018 (source: Jamaica Survey of Living Conditions, 2015)

The Poverty Line: the level of consumption needed to maintain an acceptable standard of living at the lowest cost. It is defined by the costing of the food portion of the minimum basket. PIOJ 2018a National Policy on Poverty and Poverty Reduction.

Box 2 Definition of the Poverty Line in Jamaica

The HDR includes reports on the **Human Development Index** (HDI) and the **Inequality-adjusted Human Development Index** (IHDI), which considers inequalities in life expectancy, education and income.[19] In both cases (HDI and the IHDI), Jamaica is making incremental progress (Table 7). The country was ranked 97th out of 189 countries in UNDP's 2017 HDR, with improved performance in life expectancy and education in particular. For Jamaica, the difference between the HDI and IHDI is a loss of 17% due to inequality, and therefore this difference is important in understanding the level of inequality and how it affects human development.

Table 7 Poverty Indicators

Indicator	2013	2014	2015	2016	2017	Trend
% Households below the Poverty Line - PIOJ 2018a	17.0	13.6	15.2	n/d	n/d	n/d
Human Development Index (HDI) – UNDP 2018	0.726	0.728	0.730	0.732	0.732	⬆
Inequality-adjusted Human Development Index (IHDI) – UNDP 2018	0.588	0.601	0.609	0.607	0.608	⬆
Multi-dimensional Poverty (MPI)[20]	n/d	n/d	n/d	n/d	0.018	n/d

The **Global Multi-Dimensional Poverty Index** (MPI) is referenced in the HDR, and measures acute multi-dimensional poverty in over 100 countries (Figure 12), taking into account data from Jamaica's Survey of Living Conditions (2014). Jamaica ranks 30th on the MPI, outperforming Belize, Barbados, St Lucia and Trinidad and Tobago. The MPI indicator was introduced in 2017, and trends cannot yet be determined.

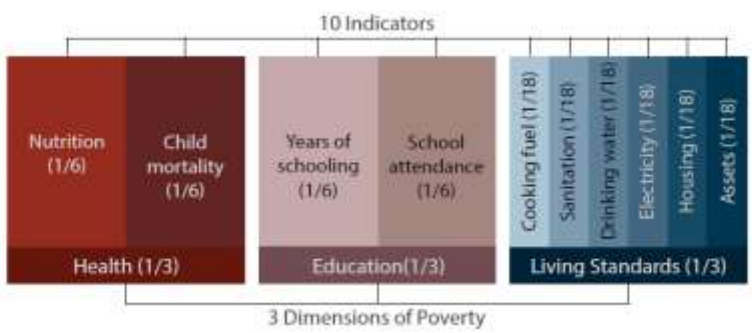


Figure 12 The Structure of the Global MPI[21]

Data presented in the 2017 Economic and Social Survey of Jamaica (ESSJ) indicate that rural poverty is significantly higher than the national and urban levels.

Although poverty fell after a 2013 high, the latest data (2015) suggest that it is on the rise again (**Error! Reference source not found.**).The relationship between environmental state, population size and various disparities is complex. Environmental degradation is more likely to occur where resources are scarce and strong inequalities and disparities exist, creating marginalized and vulnerable groups.

[19] Taking into account the Quintile and Palma ratios and the Gini coefficient.

[20] Data published at https://ophi.org.uk/multidimensional-poverty-index/databank/country-level/ using data from the JSLC, 2014

[21] Reproduced from *The Oxford Poverty & Human Development Initiative Jamaica Country Briefing* (2018). https://ophi.org.uk/wp-content/uploads/CB_JAM-3.pdf (Retrieved December 18 2018) - MPI index calculated using data from the Jamaica Survey of Living Conditions 2014.

For Jamaica, poverty and environmental quality are inter-related in many ways. Dimensions of this characterize the nexus between poverty and environment, and include:

- **Vulnerability**: The poor tend to live in marginal environments that are more hazard prone, lacking in formal municipal services such as sewage treatment, clean running water, solid waste collection, drainage infrastructure, and pest control, for example for mosquito control. Consequently, there are high risks in these areas related to public health and disasters. Target 1.5 of the National Poverty Policy and National Poverty Reduction Programme aims, by 2030, to "*build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters*".

- **Natural Resource Dependency**: The poor tend to have insufficient access to clean cooking fuels (butane or electricity).Reliance on solid fuels for cooking (e.g. charcoal and wood) may result in deforestation and watershed degradation, and may also indirectly affect aquifer recharge, erosion, flooding and other hazards. Many of the poor tend to work in primary industries (agriculture, forestry, hunting, fishing, mining/quarrying) and tourism, which rely more heavily on natural resources than other sectors. These sectors collectively accounted for 25% of the labour force in 2017 (STATIN 2018).

- **Unsustainability**: Livelihood practices engaged in by rural poor (especially small farmers and fishers) may not be sustainable (PIOJ 2007). These include, for example deforestation for farm plots, yam sticks or crafts, or use of unsustainable fish pots. Lack of engagement in sustainable practices is likely to be tied to:

    - low levels of land tenure (and therefore a lack of environmental stewardship or social responsibility for reducing ecological footprints);
    - lack of education and awareness of the implications of these practices and the linkages to hazard risk, and
    - trade-offs being made in respect of resource allocation for basic needs (food, shelter, clothing water, health) against provisions for environmental impact mitigation.

2.4 Conclusions

The population data analyzed in this section are largely based on estimated trends, using the 2011 Census data; the trends analyses undertaken by STATIN are considered to be reliable and reasonably accurate. Since 2013 Jamaica's population has grown very slowly, and the rate of natural increase now stands to be overtaken by the rate of emigration, with more persons leaving Jamaica than the net natural increase occurring, for the first time in 2017.

More than half of the population of Jamaica now live in urban places (particularly in the Kingston Metropolitan Area and St. Catherine), most of which are located in proximity to the coast or rivers. They thus present environmental pressure on aquatic ecosystems (particularly nearshore systems) and watersheds and generate a demand for energy. While Jamaica is making reasonable progress towards gender equality and poverty reduction, rural poverty is high. This has implications for vulnerability to natural hazards, dependencies and consumption patterns, in relation to natural resources, and general sustainability of livelihood practices.

3. Food Production

Scorecard 3: Food Production (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
EXPORT CROP PRODUCTION	With the exception of bananas and coffee, *indicator* export crop production in the review period showed slow growth (citrus and coconuts) or decline (sugar and cocoa).	MODERATE	2	2
FOOD CROP PRODUCTION	Overall growth of 10% (compared to population growth for same period of 0.4%). Yam production shows highest absolute growth, which indicates high potential impact due to yam stick sustainability issues.	HIGH	2	2
% FISHERIES & AQUACULTURE STOCK MANAGED WITHIN BIOLOGICALLY SUSTAINABLE LEVELS	Most absolute production and growth associated with artisanal nearshore fisheries. Fisheries Division indicated that **40% of stock is managed at a biologically sustainable level.**	MODERATE TO HIGH	2	2
LAND USE INTENSITY	Declining sugar plantation (monocultural) land cover and increases in forest cover. Potential increases in aquaculture and beach impacts (Fisheries).	MODERATE	2	1
CHEMICAL LOADS	Very high-level increases in fertilizer and pesticide use reported (42%)	HIGH	2	1
SNMI	SSNI - Sustainable Nitrogen Management Index (1.1).	HIGH	2	2

Photo: Drip irrigation system in Jamaica, NEPA. Used with permission.

3.2 Environmental Linkages

The production of food is regarded as a fundamental human need, which both affects and is affected by other drivers such as population growth, economic growth, water demand, climate change and the occurrence of natural hazards. Interactions between drivers and pressures can result in increasing levels of environmental stress. Food production creates direct environmental pressures that use up natural resources (such as fertile soil, land, water). This creates further stresses through the need for supporting infrastructure and management of the waste streams associated with its various processes.

The country's agricultural sector can be roughly divided into two major classes: plantation and small-scale farming. General environmental impacts associated with each of these vary in nature, scale and intensity, and are outlined in the relevant sections of this chapter. Industrialized plantation agriculture in Jamaica is not regarded as a driver under the DPSIR framework, as it does not directly fulfil the basic human need for food supply. The crops grown on monocultural plantations are generally exported in raw form or as processed products (secondary industries like rum). These include sugar cane, citrus, bananas, coffee, cocoa and coconuts. Growth in these export industries tends to be market driven and strongly influenced by extreme weather.

According to the Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF, 2017), between 2013 and 2016 the sector experienced marginal decline, attributed to Hurricane Sandy and severe drought conditions. These traditional export crops tend to have greater adaptive capacity (from more established management and investment structures) and therefore have a greater ability to recover from extreme weather and short- to medium-term market fluctuations. However, commercial small farmers, with lower adaptive capacity, also contribute to total annual production in these export crops; cocoa and coffee in particular are grown mainly by small farmers.

Domestic crop and animal production (poultry, meat, eggs, dairy) , as well as fisheries and aquaculture are more directly aligned with food security and supply issues for the domestic population and can be collectively considered a key driver under the DPSIR framework. Production of domestic food supplies ranges from medium-scale industry (such as poultry and aquaculture operations) to subsistence level market gardening. The environmental effects of these smaller, less industrialized farms tend to be related to agricultural practices such as clearance of hillsides (slash and burn practices, encroachment into forested lands; over-cultivation), and a less efficient use of inputs such as water, fertilizers and pesticides.

Like industrialized plantations, domestic food supply was also affected by extreme weather conditions between 2013 and 2015.The 2015/2016 MICAF annual report highlighted that drought and bush fires impacted vegetable and tuber crop production in the south-central parishes (St. Elizabeth, Manchester and Clarendon) in 2015.

Operational constraints, such as the lack of access to capital, supporting infrastructure and land tenure, severely limits the adaptive capacity and resilience of the small farming communities to effectively deal with adverse environmental conditions such as flooding, soil erosion, drought, hurricanes, heat waves and bush fires. Another key difference between domestic food producers and the export crop plantations is that the more formal nature of operations as well as the constraints mentioned above, make them less likely to implement environmentally sustainable practices or measures that mitigate environmental impact or reduce disaster risk which come at some cost.

Domestic fisheries are an important part of the food supply chain, and supplement the traditional imported processed fish (salted cod, mackerel, preserved sardines and herrings). The industry comprises capture fisheries (inland, nearshore and offshore marine) as well as aquaculture operations, which mainly comprise farming of various tilapia varieties, and some farming of freshwater prawns (*Macobrachium rosenbergii)* and white shrimp (*Penaeous vannamei)*. Ornamental fish are also cultured. Marine finfish fisheries are by far the most commercially important, and create environmental pressures on marine ecosystems.[22]

3.3 Indicator Trends and Patterns

Environmental key performance indicators (KPIs) are generally proxy indicators which assume that the magnitude of environmental impact increases with the size or intensity of operations in the sector. These include economic and production (quantity) indicators. In examining these statistics, it should be noted that environmental effects are cumulative, and do not necessarily equally reflect all food production enterprises.

3.3.1 Economic Indicators

Economic indicators provide a general idea of the likely level of environmental impact, and are discussed here mainly to provide context. Value-added statistics are available for agriculture, forestry and fishing, expressed as the percentage contribution of the Gross Domestic Product (GDP). GDP growth in this group has been slow, amounting to less than half of a percent between 2014 and 2017, with a total contribution of 6.45% of total GDP[23] in 2017. The fisheries sector contributed 0.32% of the national GDP, and accounted for 4.39% of the total GDP contribution for agriculture, forestry and fishing.

Despite the relatively small earnings in the sector, employment in agriculture (as a percentage of total employment) is relatively more important, increasing from 18.25% in 2013 to 18.62% of total employment in 2017[1]. The total number of persons employed in agriculture and fisheries is estimated in 2017 as 195,800[24], with females accounting for less than 25% of the total number of persons employed in the sector (STATIN 2017).

For the fisheries sub-sector, the proportion of women involved is considerably less (~6%) over the review period. In contrast to the STATIN 2017 estimate, the Rural Agricultural Development Authority (RADA)[25] reports that there are presently (2018) 204,946 farmers registered in Jamaica. The National Register of fishers and fishing vessels indicates that, at the end of the period under review (2014 to 2017), there were 24,491 registered fishers. This figure accounts for just under 12% of the estimated total number of persons reported by STATIN as being employed in the sector. Estimates, based on formal registration with either RADA or the Fisheries Division, are likely to underestimate the actual numbers involved in these activities, as some industry participants may choose to remain informal for various reasons. Because of the uncertainty about the actual numbers of persons involved (registered or unregistered) in the sector, it is difficult to use employment as an indicator of change.

The seven southern parishes (St. Elizabeth, Manchester, Clarendon, St. Catherine, Kingston, St. Andrew and St. Thomas) account for ~60% of all RADA-registered farmers, with Kingston and St. Andrew accounting for only 4.2%. Among the remaining seven parishes (northern and western), St. Ann has the most registered farmers (10.6%). A similar pattern emerges for the fisheries sub-sector, with southern parishes and offshore fishing banks accounting for ~61% of registered fisheries, and Manchester contributing less than 2% of the registered fishers. Among the northern and western parishes, Westmoreland has the highest number of registered fishers (12%).

[22] http://nepa.gov.jm/student/resource-material/pdf/Coral_Reef_of_Jamaica_2007.pdfRetrieved October 10 2018
[23] https://data.worldbank.org/country/jamaicaRetrieved October 10 2018
[24] http://statinja.gov.jm/Demo_SocialStats/PopulationStats.aspxRetrieved October 10 2018
[25] https://rada.gov.jm/Retrieved January 22 2019

3.3.2 Production Trends

Export Crops: This type of cultivation produces its own set of environmental impacts related to the prevalence of monoculture, intensive use of water, fertilizer and pesticide, and the generation of large amounts of trash (including plastic bags in the case of bananas), wastewater, and greenhouse gas (GHG) emissions associated with exports. In the case of coffee, it is likely that increasing temperatures may lead to pressure to expand into higher elevation i.e. cooler forested areas. Agricultural commodities' production trends give a very general indication of the scale of environmental impacts, assuming that environmental impact increases with production. Table 8 below summarizes the trend in production of select indicator export crops (based on information from Commodity Boards) between 2014 and 2017.

Table 8 Export Crop Production Trends (2014-2017)

Export Crop	Quantity processed		% change
	2014	2017	
Bananas	51,581 tonnes (PIOJ, 2018a)	64,815 Mt(FAO[26])	25%
Coffee (delivered to factories)[25]	6,450 tonnes	7,462tonnes	15%
Total Citrus (PIOJ, 2018a)	71,194 tonnes	72, 990tonnes	3%
Coconuts[27]	97 million	95 million	2%
Sugar cane (delivered to factories)[25]	1.714 million tonnes	1.127 million tonnes	-34%
Cocoa (delivered to factories)[25]	1,040 tonnes	348tonnes(Cocoa Ind. Board)	-77%

Of the six selected indicator crop commodities, two major historic export crops (sugar cane and cocoa) showed significant declines in the review period, while two others showed very marginal change (citrus and coconuts). Stronger production growth was noted for bananas and coffee. Coconut production capacity was expanded through upgrades of existing nurseries and the establishment of a new nursery in Hanover (PIOJ 2018a).

Increased banana production is attributed to the Banana Export Expansion Programme (BEEP), under which considerable investment from the European Union facilitated recovery of the banana industry. This included the introduction of infrastructure, nurseries, new tissue cultures, fertilizer and pesticides, and new disease resistant varieties to offset the impact of natural hazards such as Hurricane Gustav in 2008, disease and declining yields per hectare that impacted banana production in the early 2000s. Banana is typically grown in the prime agricultural areas, on both industrial plantations and small farms in St. James, St. Mary, Portland, St. Thomas, St. Catherine and Clarendon. The St. Mary Banana Estate produced more than half of all bananas grown in Jamaica in 2015.[28]

[26] https://knoema.com/atlas/Jamaica/topics/Agriculture/Crops-Production-Quantity-tonnes/Bananas-production Retrieved January 22 2019

[27] http://statinja.gov.jm/BusinessStatistics.aspx Retrieved January 22 2019

[28] http://www.thebananaboard.org/images/pdf/annualreport2015.pdf Retrieved October 05 2018

Figure 13 Banana Farm (Source: NEPA)

The major fall in cocoa production in this period is likely due to the higher incidence of fungal disease[29] impacting orchard, according to the Cocoa Industry Board.

Sugar cane cultivation, unlike with many other crops, is a major air polluter, as traditional harvesting methods require that fields be burnt. Declining acreage and new harvesting methods are expected to reduce environmental impact associated with sugar cultivation and processing. For example, MICAF (2017) reported that 120 ha[30] of sugar cane is now harvested using the Green Cane Harvesting Method which does not require burning.

Domestic Food Production: Domestic food production includes the cultivation of vegetables, condiments, fruits, legumes, cereals (mainly corn), and tubers (yams, potatoes among others). These crops are primarily produced by small farmers to supply local markets. Between 2014 and 2017, total domestic food production grew by an estimated 10%.

Crops that are grown in annual quantities greater than 10,000 metric tons (shown in Table 9) are likely to have more significant cumulative environmental impact than crops produced in smaller quantities (e.g. Figure 15). Of 18 key domestic crops, only three showed decline in production (carrots, potatoes and scallion). Crops with the highest growth in production include pineapple (+41%) (Figure 14) and pak-choi (+36%). Many of these key crops have high water demand and require intensive use of fertilizer and pesticides to maintain or increase yields.

[29] Frosty Pod Rot disease

[30] Ha refers to a hectare which is a unit of measurement for an area, specifically representing 10,000 square metres.

Figure 14 Pineapple Farm (Source: NEPA)

In absolute terms, total production of yams amounted to 144,319 tonnes in 2017, with most of this attributed to yellow yam production (over 105,653 metric tons) .Production of yam is not just for the domestic market; currently, less than 10% of the yams are exported; [31] however there is potential for growth in export volume. Yam cultivation grew by ~6.7% between 2014 and 2017, which signals high potential for environmental impact. The environmental impact of yam production has long been recognized as a major issue (Beckford and Barker 2003), as yam plants require stakes that are often sourced from threatened forests. Additionally, a high percentage of yams are grown on hillsides, and harvesting disrupts the soil in such a way as to exacerbate erosion. Yams also require inputs of pesticides and fertilizers. It is very likely that increases in yam production to meet the local and export markets would result in increased environmental impact, unless sustainable approaches and mitigation measures are implemented concurrently.

Table 9 Domestic Food Production (2014-2017; Source: STATIN[32]) for crops produced in quantities over 10,000 Mt/year. Red indicates a decline in production over the review period.

Crop	Quantity Produced(Mt)		% Change in Production(2014-2017)
	2014	2017	
Yam	135304	144,319	6.7%
Pumpkin	46763	50,494	8.0%
Cassava, coco, dasheen	40882	46,229	13.1%
Plantain	39348	46,093	17.1%
Sweet potato	39412	41,996	6.6%
Cabbage	31993	35,818	12.0%
Tomato	25238	27,545	9.1%
Pineapple	18374	25,848	40.7%
Carrot	24080	21,997	-8.7%
Cucumber	15512	18,387	18.5%
Sweet pepper	15445	18,282	18.4%
Pak-choi	13228	17,978	35.9%
Irish potato	19577	17,148	-12.4%
Callaloo	14472	16,338	12.9%
Watermelon	13618	15,289	12.3%
Hot pepper	14101	14,520	3.0%
Lettuce	11299	13,313	17.8%
Escallion	12436	10,713	-13.9%

[31] http://www.jamaicatradeandinvest.org/sites/default/files/SandorPike_Yam_15Nov2016.pdf Retrieved October 22 2018

[32] http://statinja.gov.jm/BusinessStatistics.aspx Retrieved October 19 2018

Figure 15 Small Farm Plots in St. Elizabeth (Source: NEPA)

Meat, Eggs and Dairy: Available data for meat, eggs and dairy production are given in Table 10. Poultry production increased by ~16%, while egg production increased by almost 50% between 2014 and 2017. Pork production grew 20% between 2014 and 2016, and was reported to be at an all-time high in 2016 (MICAF 2017). Beef production increased by ~25% between 2014 and 2016, and goat/sheep meat production increased by 30% for the same period. In general, Jamaica's meat production has shown consistent growth in the review period (NB: no data available for 2017 pork, beef, goat/sheep production)

Table 10 Meat, Dairy and Egg Estimated Production (2014-2017)

Item	2014	2015	2016	2017	Sources
Eggs (Million Eggs)	122	150	174	181	STATIN
Poultry (Metric Tons)	110,313	112,612	125,992	128,290	STATIN/ MOA website;
Pork (Metric Tons)*	6,821	6,454	8,214	*n/d*	MICAF 2017
Beef (Metric Tons)*	5,163	6,300	6,426	*n/d*	MICAF 2017
Goats/Sheep (Metric Tons)*	770	747	1,000	*n/d*	MOA website; MICAF 2017
Milk (Million Litres)	11.7	*n/d*	12.1	*n/d*	MICAF 2017
*dress weight[33]					

Both poultry and pig farming have considerable potential for environmental impact, due to the waste that is produced, which can cause nutrient and bacteria loading of receiving waters. In addition to these run-offs, livestock operations (particularly cattle farming) can produce large quantities of methane emissions which contribute to climate change. In general, methane emissions are a function of feed mix and tend to be higher when higher quality feeds or pastures are used (which is a function of rainfall). No data are available for estimated methane emissions.

Fisheries: Marine finfish production accounted for ~87% of total fisheries production in 2017, which was about the same proportion in 2014 (Fisheries Division data). Overall, fisheries production increased by 34% between 2014 and 2017 (Figure 16). Although significant growth was noted in lobster (industrial) and tilapia (freshwater aquaculture) production (Table 11), much of the growth of the sub-sector is attributed to the expansion of the marine finfish sector, which accounted for 86% of the total growth in fisheries production between 2014 and 2017. Jamaica`s marine finfish fisheries are traditionally mainly

[33] http://www.moa.gov.jm/AgriData/index.php Retrieved October 19 2018

artisanal (Aiken & Kong, 2000), as a result, growth in this sector is assumed to reflect growth in the artisanal fisheries sector.

Table 11 Fisheries Production (2014-2017; source: Fisheries Division)

	Quantity Produced in(metric tonnes)		% change in production (2014-2017)
Fishery	2014	2017	
Marine Finfish	10456	13,939	+33%
Conch	500	500	0
Lobster	300	484	+61%
Tilapia (aquaculture)	698	1,085	+55%
TOTAL	**11,954**	**16,008**	**34%**

The island's nearshore artisanal finfish and lobster fisheries are potentially environmentally deleterious (Hawkins and Roberts 2004; Jones 2017), as they are associated with overfishing and harvesting of females or juveniles (impacting the sustainability of target populations), habitat degradation (associated with spear fishing or compressors and anchors), and use of fish-pots/traps deployed on the ocean floor. The industry is further affected by the vulnerability of nearshore ecosystems to extreme weather, ocean acidification, land-based sources of pollution, invasive alien species (e.g. lionfish), decline of the sea urchin population, coral bleaching and coral diseases, among other factors.

Growth in tilapia production also has the potential to generate pressure on VECs. The main impact of aquaculture is associated with water and electricity demand and wastewater (nutrient loads). Environmental impact of lobster fishing tends to be associated with the use of lobster traps, which can be deleterious to marine biodiversity, as other non-target species may also be caught.

The greatest potential for environmental impact in the fisheries sub-sector is associated with the marine finfish sector, which continues to grow to supply domestic markets (including tourism demand). The Fisheries Division has indicated (2018, written communication) that all fisheries are managed using an ecosystem-based approach (EbA), and that approximately 40% of the stock is managed within biologically sustainable levels.

Figure 16 Fishermen (Photo: Brandon Hay)

Timber Extraction: Timber is harvested from forest plantations/estates through the granting of a timber cutting licence that is based on the estimated saleable volume, and not from natural forests. Timber generally comprises Caribbean Pine and Jamaican hardwoods (e.g. mahogany, cedar, mahoe), with the former accounting for more than two thirds of the harvested timber in 2017 (68%). Between 2016 and 2017 the quantity of harvested timber tripled (Table 12). A positive trend observed is that the ratio of hardwood to Caribbean pine being harvested is declining. Caribbean Pine is generally more sustainable as it is faster-growing than hardwoods.

Table 12 Timber Production in Jamaica (Source: ESSJ Reports: PIOJ 2014b, PIOJ 2015, PIOJ 2016b and PIOJ 2017b)

Year	Total Timber harvested		Hardwood/Pine harvested	Registration of saw mill licences approved/received
	(m^3)	Metric Tonne Equiv		
2013	347	208	1.10	
2014	141	85	0.69	# approved not reported (18 applications received)
2015	580	348	0.74	# approved not reported (69 applications received)
2016	481	289	0.61	30 approved (55 applications received)
2017	1528	917	0.32	85 approved

While it is likely that formally reported timber extraction is sustainably managed, these reported statistics are likely to represent only a fraction of the total amount of timber that is being harvested in Jamaica. For example, the National Forest Management and Conservation Plan (Forestry Department, 2017, p 18) indicated that there is unsustainable extraction of timber from mangrove forests for construction, yam sticks, artisanal fish pots, small-scale farming, charcoal production and for use as firewood.

Bamboo is an extremely fast-growing wood that is being harvested in Jamaica (not included in statistics above). While it is not classified as forest cover in this country, it has the potential to reduce reliance on forest species for many of the uses described above. Its main environmental impact is on native forest biodiversity; it also increases fire risk during dry periods. It is estimated that there are over 70,000 ha of bamboo growing island-wide, most of which is classified as "mixed fields" where the bamboo is growing with other plants (Forestry Department estimate, NEPA 2017b).

3.3.3 Cereal Yield

SDG 2 (Zero Hunger) includes the goal of sustainable agriculture in its title: *"End hunger, achieve food security and improved nutrition and promote sustainable agriculture".* In the 2018 SDG score sheet, Jamaica's score for SDG 2 was brought down by a declining "Cereal Yield (t/ha)" score. Cereal yield[34] is measured as tonnes per hectare of harvested land (Sachs *et al.* 2018). Based on FAO data, the country's cereal yield has declined by almost 10% since 2013, with its lowest value in 50 years recorded 2016 (to 1090.1 t/ha).

As a tropical country, Jamaica does not grow wheat nor does it produce flour. However, flour is imported to meet the demand for wheat flour products such as bread and other baked products which are staples in Jamaica. Yam and other tubers are non-cereal traditional staples that form a key part of

[34] Reported from FAO estimates by the World Bank at: https://data.worldbank.org/indicator/AG.YLD.CREL.KG?locations=JM (Retrieved October 19 2018). The indicator includes production data on cereals and relates to crops harvested for dry grain only. The data exclude crops harvested for hay or for food, feed, or silage ,and those used for grazing.

the Jamaican diet. For these reasons production of cereals (represented by yield per acre) is not considered a reliable indicator of food security and nutrition.

3.3.4 The Sustainable Nitrogen Management Index (SNMI)

The Sustainable Nitrogen Management Index (SNMI)[35]- SDG indicator of sustainability of agricultural systems) is based on two crop efficiency indicators: Nitrogen Use Efficiency (NUE) and land use efficiency (crop yield), and is calculated using country-level data. The SNMI score published for 2018 (Sachs et al. 2018) was 1.1, which is considered very low, and indicative of poor progress towards sustainable agriculture. A low NUE score can result from high nitrogen pollution levels.

Jamaica's score of 1.1, depicted in the darker yellow band (Figure 18), usually indicates high levels of nutrient use with lower crop yields.

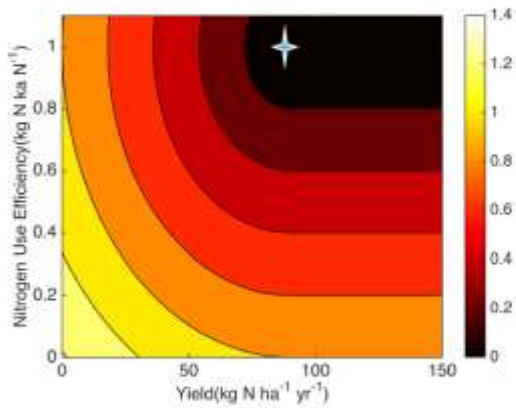


Figure 17 SNMI (Source: reproduced from Zhang and Davidson 2016)

3.3.5 Land Use

Aside from chemical inputs, agricultural land use can be a reliable indicator of environmental impact, as expansion of agriculture tends to encroach on forested lands. Forest replacement with agricultural land use directly impacts biodiversity and the forest ecosystem, and can also result in downstream impact on aquatic and marine ecosystems such as increased sediment, nutrient and pesticide loads. The total land area of Jamaica is estimated by the National Land Agency as 10,968.8 km^2. MICA reported that 3,880 km^2 (35.4%) of Jamaica's total land area could be classified as arable lands.

The crop using the largest area is traditionally sugar cane, which has been on the decline for many years: MICAF estimates acreage of reaped sugar cane lands in 2017 at 66.8% of 2013 levels (195 km^2 in 2017 compared to 292 km^2 in 2013).Even at these relatively low levels (compared to previous years) cane cultivation still occupies more than 50% of all arable land in Jamaica. As sugar cane lands are taken out of active production, much of it lies as 'ruinate' plantations, some of which have been converted into residential land uses, while others remain under 'natural' disturbed vegetation cover.

The 2014 estimate of forest cover[36] indicates that the total forested area in Jamaica had increased from 2009 level of 337.5km^2 to 438.8 km^2, a 30% increase in five years. In the wider Caribbean, recent gains in secondary forest cover have been attributed to historically declining sugar cane lands,[37] which may be the case in Jamaica.

Aquaculture land take in Jamaica was approximately 10 km^{2}in 2011.[38] Since 2011, tilapia production has increased, but no up to date data are available on the land area used. Aquaculture operations could potentially impact coastal wetlands and nearshore benthic ecosystems, depending on their specific

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[35] Zhang and Davidson 2015 Sustainable Nitrogen Management Index (SNMI) Methodology http://www.umces.edu/sites/default/files/profiles/files/Ranking%20Method_submit_to_SDSN_SNMI_20160705_0.pdfRetrieved October 01 2018

[36]http://statinja.gov.jm/Environmentdata.aspxRetrieved October 01 2018

[37] FAO, 2014 Forests and climate change working paper 13 – Forests and climate change in the Caribbean p. 8 (in reference to general regional trends) http://www.fao.org/3/a-i4220e.pdfRetrieved February 01 2019

[38]http://www.fao.org/fishery/countrysector/naso_jamaica/enRetrieved February 01 2019

locations and compliance with wastewater treatment regulations and effluent standards. MICAF[39]indicates that the main production areas are located on the plains of Clarendon and St. Catherine, with other smaller operations in other parishes.

The Fisheries Division of the Ministry of Industry and Commerce, Agriculture and Fisheries (MICAF) reports that there are currently 187 officially designated fishing beaches, from which artisanal fishers operate. The parishes with the largest number of landings are Portland (22 beaches), Westmoreland (21 beaches) and St. Thomas (17 beaches).These operations are associated with the landing of small vessels which are described by MICAF as "*open canoes ranging in size of 4 to 9 m, constructed from wood or reinforced fibreglass and powered by either outboard motors or oars".[40]*. Potential adverse environmental impact associated with beach landings include nearshore pollution from organic waste (from fish processing), fuelling, and boat repairs.

3.3.6 Chemical Inputs

Chemical inputs used in agriculture are more direct indicators of the likely environmental effects of food production. In general, these are cumulative non-point sources of pollution that can have far-reaching and persistent environmental effects. Agricultural run-off can be loaded with sediment (if soil erosion is occurring), nutrients (from fertilizers and organic waste), pesticides (wide-ranging chemicals), and bacteria (from livestock and aquaculture).

Fertilizer imports can be used as a proxy indicator of possible nutrient load (in respect of nitrates and phosphates). The World Bank[41] reports that fertilizer consumption in Jamaica (reported as kg/ha arable land: 7860 metric tons) decreased from 73.4 kg/ha in 2014 to 38.1 in 2015 kg/ha; however, this source also reported a marked increase between 2015 and 2016 to 57.2 kg/ha. According to World Bank statistics, Jamaica's fertilizer consumption has been generally decreasing since the last SOE review period. However, MICAF (2018) indicated that imports of fertilizers increased by ~42% between 2015 and 2017 with a total of 18,608 tons of fertilizer imported in 2017.

Pesticide imports are also a useful indicator of the environmental impact of agriculture. MICAF (2018) indicated that pesticide imports increased by ~42% with a total of 4,221 tons of pesticides imported in 2017. The Pesticide Control Authority (PCA) controls the importation and use of pesticides in Jamaica, and provides a list of managed and restricted pesticides, as well as a database of approved pesticides and their associated uses.

3.4 Conclusions

Agriculture, forestry and fishing account for a very small portion of total GDP (6.45%), although they have a relatively large footprint, with a third of the total land area being classified as arable land. In terms of indicator export crops, banana and coconut cultivation showed major growth in the period, the former mainly due to national policies designed to grow the industry. Domestic food production, and banana cultivation, to some extent) is undertaken by small farmers, utilizing relatively small farm plots, which are often located on sloped land prone to soil erosion. Production of most major domestic food crops (defined by the annual production of more than 10,000 metric tons) grew over the review period, with yam having the highest yield. Increasing small farming outputs are likely to be reflected in greater cumulative environmental impact, as this kind of farming is largely characterized by unsustainable

[39] (2018, written communication)

[40] (MICAF 2018, written communication)

[41] https://data.worldbank.org/indicator/AG.CON.FERT.ZS?locations=JMRetrieved February 01 2019

practices (Selvaraju et al 2013). Jamaica continues to have a relatively low score, in terms of the Sustainable Nitrogen Management Index (SNMI) which is generally indicative of unsustainable agricultural practices. This is also reflected in escalating fertilizer and pesticide imports, which are needed to generate higher levels of crop yields, as soils lose fertility and experience other challenges such as pests, diseases and natural hazards.

The indicators currently available to assess the environmental impact of Jamaica's food production are inadequate to determine internationally accepted (SDG) KPIs. Additionally, it is recommended that the country work towards improving its data capture on livestock quantities and feed, as well as updating its spatial databases to identify the proportion of land used in various forms of agriculture.

Indicator gaps are shown in Table 13.

Table 13 Indicator Gaps

SDG Indicator	Methodology Concept Note
2.4.1 Proportion of agricultural land under productive and sustainable agriculture	FAO indicates that key themes under consideration include economic (labour productivity, land productivity and farm income), environmental (soil, water use and quality, GHG emissions) and social (work conditions, household poverty and household/farm resilience)http://www.fao.org/3/a-br903e.pdf
5.a.1. (a) Percentage of people with ownership or secure rights over agricultural land (out of total agricultural population), by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure	This is intended to measure gender equality in respect of agriculture. http://www.fao.org/3/I8808EN/i8808en.pdf
14.7.1 Sustainable fisheries as percentage of the GDP.	Tier III (methodology being worked on) – no concept paper available. http://www.fao.org/sustainable-development-goals/indicators/1471/en/

4. Water Supply

Scorecard 4: Water Supply (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
WATER ALLOCATION AND LEVEL OF WATER STRESS	Water allocation has increased for all three major users (domestic use, agriculture and industrial sector). Total water allocation in 2017 is 65% of the total exploitable water. This indicates a situation of high stress. Water stress increased from 0.51 in 2013 to 0.65 in 2017.	HIGH	2	2
TOTAL WATER SUPPLY PER CAPITA	Water production has increased (8%) and the amount of water supplied per capita in 2017 is slightly higher than in 2014.	MODERATE	1	1
ABSTRACTION	There has been a steady increase (licences granted have increased by 77.53%) in the number of water abstraction applications.	HIGH	1	2

Photo: Woman carrying bucket of water, Clarendon, Jamaica. UNESCO, 2014, is licensed under CC BY 2.0

4.2 Environmental Linkages

Fresh water, in sufficient quantity and quality, is a critical requirement for human life and sustainable development (UN 2018). Water resources are also necessary to maintain healthy water-related ecosystems which, in turn, provide essential services to human communities, including irrigation, flood protection and habitats for biodiversity and natural purification, among other uses.

Water demand is mainly driven by demographics, economic growth and food production through irrigated agriculture. Climate change and variability affect the timing, quantity and intensity of rainfall which, in turn, affect river discharges (rates and quantities, stream loads and erosion) as well as groundwater resources i.e. water table level, aquifer recharge and resource availability. The Second National Communication of Jamaica to the United Nations Framework Convention on Climate Change (UNFCCC) anticipated that, by 2015, there would be deficits in water supply to areas of important economic activity (Cashman 2014). More recently, Taylor and Clarke (2018) predicted that, if temperatures increased to the +2°C scenario (2DS), there may be a shift to a drier region with a greater occurrence of droughts. Jamaica is prone to periodic droughts which have been linked to the occurrence of El Niño.[42]

The extent to which water resources are exploited and utilized has several repercussions in the environment. General overexploitation of freshwater resources can lead to the depletion of surface and groundwater resources and negative impacts on water-related ecosystems and biodiversity. The effects of water abstraction[43] on both natural and human systems are likely to be further compounded by drought conditions or land use that affects groundwater recharge.

Drought conditions that started in 2014 had serious effect on Jamaica during the review period (Rahbar et al 2016 and Neuville 2015). According to Neuville (2015), the 2014 drought resulted in severe use restrictions and lock-offs being implemented by the NWC. Excessive groundwater abstraction in coastal aquifers is also likely to compound the effects of sea-level rise (SLR) increasing the risk of saline intrusion. Saline intrusion can result in diminished freshwater resources for natural and human systems, and can also have major repercussions for agriculture and coastal habitats.

- Water production and distribution can be relatively energy-intensive, with the associated greenhouse gas emissions, especially if the municipal infrastructure is inefficient or leaky, or if there are significant leaks at the end-user level.
- Treatment of freshwater prior to distribution in Jamaica is done primarily through chlorination. Chlorinated water that is used for domestic purposes such as watering of lawns or laundry is obviously more expensive than untreated water, in view of chemical and energy inputs, and it also presents a risk to aquatic habitats when the wastewater is discharged, if chlorine concentrations are high. Freshwater availability is further compromised by the deterioration of water quality or source contamination. Decreasing water quality is a problem in some basins, notably Kingston, due to improper sewage disposal, agricultural chemicals, mining, and other contributing factors. [44]

Jamaica is reliant on rainfall for its water resources. It feeds rivers and recharges aquifers (see Chapter 14). Especially critical to the island's water supply are its aquifers with 85% of water coming from groundwater resources (Cashman 2014). On average, Jamaica's internal renewable water resources are

[42] http://rcc.cimh.edu.bb/files/2015/11/CaribbeanDroughtBulletin_November_Vol2_Issue6.pdfRetrieved October 01 2018
[43] Water abstraction is the process of taking water from a source, either temporarily or permanently.

[44] AQUASTAT 2015

10,823 million cubic metres per year (m^3/year), as a long-term average[45]. Surface water resources are characterized by a marked seasonal variability in flow, especially in the southern watersheds, which are especially variable, and have comparatively low base flows. Almost 40% of the internal renewable water resources are considered exploitable or reliable; this is defined as water that can be withdrawn over a long period of time without affecting aquifers or causing groundwater contamination by sea water intrusion[46]. Situations leading to overexploitation or the degradation of water resources in a given area significantly affect human health, social well-being and the opportunities for economic development.

As competition among water users increases, there is potential for conflicts. Ultimately, if the supply of clean and abundant freshwater resources is compromised by over-use or inefficiencies, climate change, watershed degradation or contamination, it becomes increasingly challenging to ensure delivery of safe drinking water to the population.

4.3 Indicator Trends and Patterns

4.3.1 Level of water stress

The level of water stress provides an estimation of the pressures that human activities have on freshwater resources. Water stress occurs when the demand for water exceeds the available amount during a certain period, or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.)[47]

A high level of water stress has both environmental and socio-economic consequences. Water-related ecosystems under too much pressure degrade, and conflicts around water use are likely to happen in communities and basins where water resources are limited. Water stress is one of the indicators (SDG 6.4.2) identified by the UN to inform about the Sustainable Development Goal 6: *Clean water and sanitation* (UN Water 2018).

Water stress is usually calculated as the ratio between total freshwater withdrawn by all major sectors and the total renewable freshwater resources. The total renewable freshwater resources are the fraction of water available for human use after discounting environmental flow requirements i.e., the amount of water needed to maintain the ecological functions of water ecosystems.

Based on Jamaica's long-term average precipitation (i.e. 2,051 mm/year), the internal renewable water resources are estimated to be 10,823 million m^3/year [48]. From this amount, less than 40% is considered exploitable without impairing the aquifers or causing sea water intrusion[49]. The Water Resources Development Master Plan (1990) provides an assessment of the country's water resources. It establishes 3,929.7 million m^3/year as the total annual quantity of exploitable water. The 2015 Draft National Water Resources Master Plan established the total exploitable potential for the island as 3,865million m^3/year.

[45] Ibid

[46] Ibid

[47] European Environment Agency, an Agency of the European Union

[48] AQUASTAT 2015

[49] Ibid

In consideration of the annual data on water allocation for the three major sectors, i.e. agriculture, industry and domestic or residential use, and the total exploitable potential or TEP (resulting from deducing the environmental water requirements – EWR – to the total amount of exploitable water – TEW) the level of water stress as estimated for 2013-2017 is illustrated in Table 14. Based on information provided by WRA, the deduction of non-consumptive uses would leave the total water volume allocated as approximately 43% of the total exploitable potential for 2017.

If the level of water stress exceeds 1, the basin is classified as "environmentally water scarce", which means that the amount of water left is less than the EWR (Smakhtin et al 2004) (See Table 15). Lower values of water stress indicate progressively lower water resources exploitation and lower risk of scarcity. According to the classification of water stress levels by Smakhtin et al (2004), and based on total withdrawals), Jamaica's water resources would be in a situation of high stress or 'highly exploited'. The level of water stress or the percentage of total water allocated over the exploitable potential increased throughout the period 2014-2017; from 0.51 in 2013 to 0.65 in 2017.

Table 14 Evolution of water allocation and level of water stress (Source: WRA)

Annual water resources available and allocated (million m^3)	2013(1)	2014	2015	2016	2017	%Change (2014-2017)
Total exploitable potential (TEP)(2)	3,865.00	3,865.00	3,865.00	3,865.00	3,865.00	
Water allocated for agriculture (irrigation)	405.32	496.3	452.64	479.14	568.1	14.47%
Water allocated for industrial use	1,151.63	1,065.43	1,073.22	1,064.05	1,399.65	31.37%
Water allocated for domestic use	364.93	438.86	354.26	337.3	531.05	21.01%
Total water allocated	1,952.61	2,000.59	1,880.12	1,880.49	2,498.80	**24.90%**
Level of water stress	**0.51**	**0.52**	**0.49**	**0.49**	**0.65(3)**	**24.90%**

(1) Data reported in the 2013 SOE included water allocated for commercial use and tourism
(2) Total exploitable water as estimated in the 2015 Water Resources Development Master Plan
(3) This figure includes withdrawals for non-consumptive water use

Table 15 Levels of water stress (Source: Smakhtin et al 2004)

Water Stress Indicator (WSI)	Stress level
WSI > 1	Overexploited
0.6 ≤ WSI < 1	Heavily exploited
0.3 ≤ WSI < 0.6	Moderately exploited
WSI < 0.3	Slightly exploited

Per sector, the highest increase of 31% in water allocation has been for the industrial sector. Relative to the total amount of water allocated, the percentage that each sector represents has remained fairly constant (Figure 18). Industry uses slightly more than half of the total water allocation, while agricultural and domestic demands are approximately 25% and 20%, respectively.

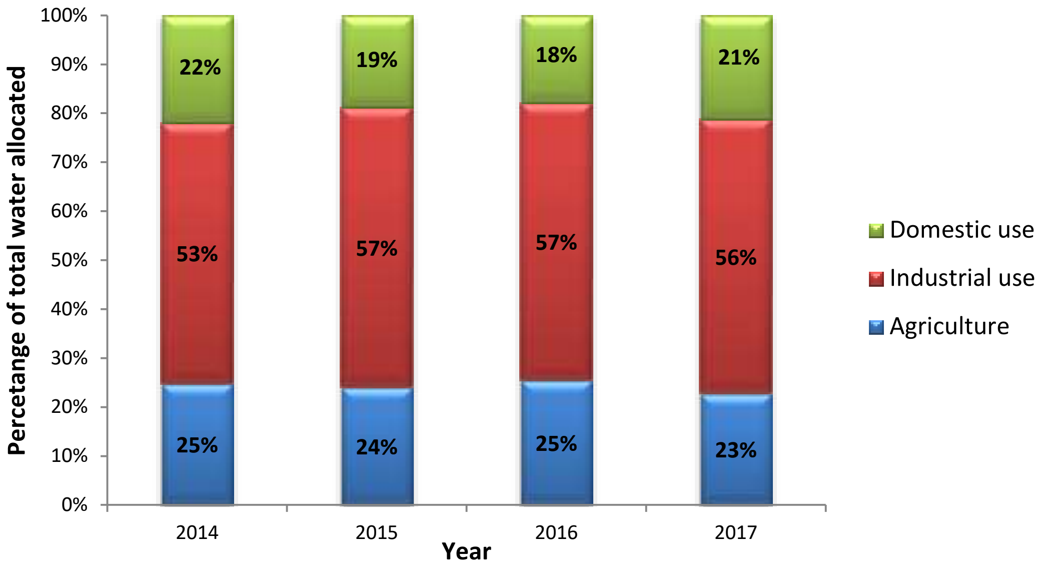

Figure 18 Distribution of total water allocated per sector for the 2014-2017 period (Source: WRA)

Figures of total water allocated per sector annually refer to the country level, and are not spatially disaggregated. Water demand is higher in the southern areas of the country where most of the population and irrigation systems are concentrated. By way of example, the Kingston hydrological basin has a recurrent water shortage problem and surface water is imported from the Yallahs River of the Blue Mountain south basin to meet the domestic demands of the Kingston Metropolitan Area[50].

Water consumption data available for Petrojam[51], the main oil refinery in Jamaica, is an illustrative example of increasing industrial sector water demands. Water delivery to Petrojam in 2014 was 1,390 m^3/year. This demand more than doubled by 2015 to 3,743 m^3/year, and increased to 5,775m^3/year in 2017, more than four times its demand in 2014.

With respect to water demand in the agricultural sector, the overall 14% increase has been accompanied by a commensurate 14% increase in total land under irrigation, with land area served by the National Irrigation Commission (NIC) increasing from 14,786 ha in 2014 to 16,829 ha in 2017.The NIC is the public entity in charge of irrigation systems. NIC's infrastructure is primarily located in the southern basins, location of the Rio Cobre and Rio Minho basins. Their demand for water to supply agricultural needs accounts for 71% and 89%, respectively, of the total demand [52].

Jamaica's irrigation infrastructure (Table 16) consists of a network of pipes, wells, and pump stations that supply water to 14 irrigation schemes. The total number of agricultural water users in 2017 was 2,830. The values in bold have changed since the 2013 SOE and the previous value is indicated in parentheses. In general, irrigation infrastructure has expanded; there are three new irrigation schemes and the length of the network of pipes has increased by 41%.

[50] AQUASTAT 2015

[51] (Petrojam 2018,written communication)

[52] AQUASTAT 2015

Table 16 Changes in irrigation infrastructure (2014-2017; Source: National Irrigation Commission (NIC)

Name of irrigation scheme	Pump stations	Wells	Canals	Pipes(km)
Rio Cobre	18	22	**66** (26)	**55.84** (31.01)
St. Dorothy	8	7	**18** (28)	12.14
Yallahs	3	3	0	15.21
Mid Clarendon	32	32	**137** (153)	36.10
Duff House/New Forest	**3** (2)	4	0	26.00
Hounslow	5	5	0	41.40
Beacon Little Park	3	3	0	27.83
Seven Rivers	0	0	0	2.96
Colbeck	1	1	0	5.13
Braco	1	-	0	8.60
Plantain Garden	**1**	0	0	**8.23**
Amity Hall	**1**	0	0	
Spring Plain/Ebony Park	**1**	**1**		**41.99**
Yallahs IBD	**00**	**0**	0	
Total	**78** (73)	**78** (77)	**221** (207)	**273.87** (194.24)
%Change (2013-2017)	**6.8%**	**1.3%**	**6.8%**	**41.0%**

4.3.2 Total Water Supplied Per Capita

The definition of per capita water use is gross annual water production by a utility divided by the number of people in the service area. Data for water production and population from STATIN show that, although the population of Jamaica increased by less than 0.5% in the review period, the amount of water supplied increased by 8% in the same period. Water use intensity increased from 91 m^3/capita/year in 2013 to more than 98 m^3/capita/year in 2017. These data likely underestimate per capita water consumption intensity as this reflects supply from the National Water Commission (NWC) and does not take into account water from other sources. Most of the water used in Jamaica is supplied by the NWC, which currently supplies 190 million gallons (~719,228 million m^3) of potable water per day to 400,000 registered accounts that represent a population of approximately 2.7 million people.

However, in rural areas, the responsibilities for water supply are shared between the NWC and the Municipal Corporations. It is estimated that 23% of the rural population rely on rainwater harvesting via roof collection[53]. The NWC and the Municipal Corporations manage 353 public rainwater harvesting catchment tanks.

4.3.3 Water Abstractions

Abstractions, for different uses, exert the most significant pressure on the quantity of freshwater resources. The number of applications and of licences granted increased by 113 % and 78%, respectively, in the 2014-2017 period (Table 17).

Table 17Number of water abstraction applications and licences through 2014-2017

Number of applications and granted licences for water abstraction	2014	2015	2016	2017	%Change (2014-2017)
Applications for licence	93	123	63	198	112.90%
Licences granted	89	78	51	158	77.53%

[53] AQUASTAT 2015

If we consider the number of water abstraction applications by hydrological basin (Figure 19), there is a concentration of demand in the southern basins of Rio Cobre and Rio Minho, mainly for irrigation purposes. Water applications in the basins of Dry Harbour and Kingston increased throughout the 2014-2016 period, most likely because of the increase in tourism in Dry Harbour basin and general population growth in the Kingston Metropolitan Area.

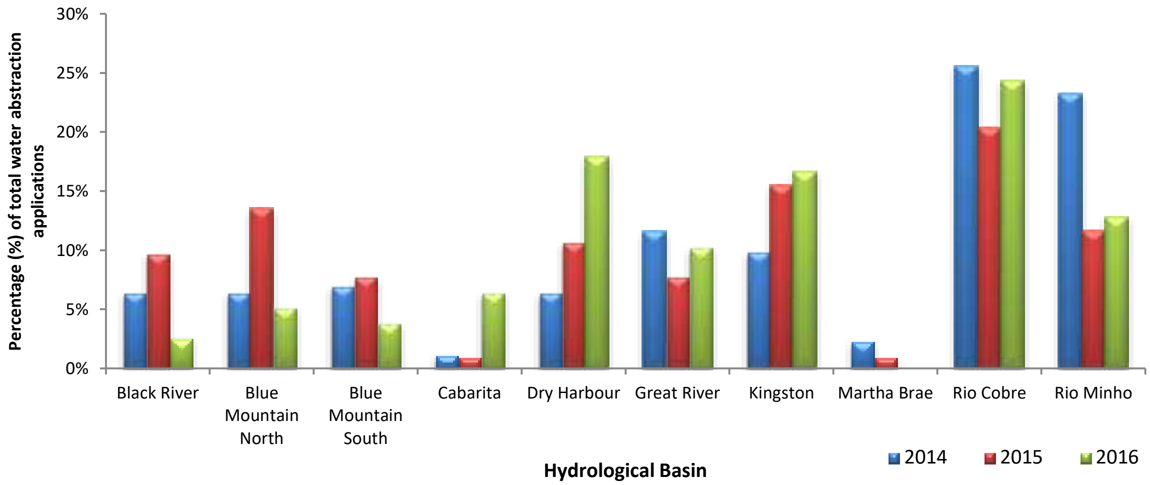

Figure 19 Water abstraction applications per hydrological basin (Source: WRA)

In terms of source of water (Figure 20), most applications were for the exploitation of groundwater resources (i.e., wells), although there appeared to be a trend for a higher use of surface water resources (rivers, springs, lakes, etc).

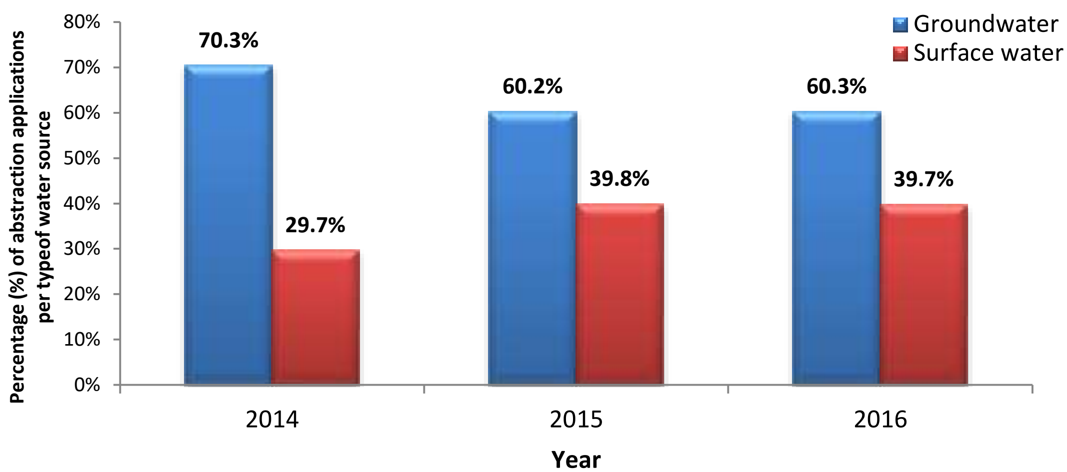

Figure 20 Water abstraction applications per type of water source (Source: WRA, written communication)

4.4 Conclusions

Current levels of water allocation indicate a 'heavily exploited' state, if we consider the fraction of water allocated over the total exploitable potential. The amount of water allocated increased steadily for all sectors through the 2014-2017 period, especially for the industrial sector (31% increase).Water production also increased (+8%) in the same period and the amount of water supplied per capita in 2017 was slightly higher than in 2014. This trend of increasing water demand is also reflected in the number of water abstraction applications processed and approved, which increased by 113 % and 78%, respectively. Most of these applications came from the southern basins of Rio Cobre and Rio Minho and were related to the development of irrigated agriculture in this region. The Kingston and Dry Harbour basins also experienced a steady increase in water demand.

5. Climate Change & Variability

Scorecard 5: Climate Change & Variability (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
NATIONAL GHG EMISSIONS PER CAPITA	Per capita national carbon dioxide emissions from burning of fossil fuels and cement production decreased by 8.5% between 2013 and 2014. Jamaica was the 7th highest per capita emitter among CARICOM members in 2013 and 2014.	MODERATE	2	1
DEPARTURES FROM CLIMATE MEANS: TEMPERATURE AND RAINFALL	National annual average temperatures during this reporting period were consistently above the climate mean. The 2014-2017 temperature departure was 0.6˚C above the climate mean. National average rainfall for the 2014-2017 reporting period was 6% below the climate mean. Rainfall amounts were highly variable from year to year and by parish. 11/13 parishes received rainfall below the 30-year mean in 2014; 13/13 in 2015; 8/13 in 2016; and 3/13 in 2017. Lower than average rainfall across the island contributed to instances of extreme, severe and normal drought conditions in 2014, 2015 and 2016. Drought conditions in 2015 were particularly acute. Lower than average rainfall adversely affected agriculture & aquaculture, food prices, water and energy supplies.	HIGH	2	2

5.2 Environmental Linkages

The state of the Earth's climate influences Jamaica's environment. The Earth's climate system includes the atmosphere, land surface, snow and ice, oceans and other bodies of water, living things and the interactions among them (Solomon et al. 2007) (see definitions in Box 3). These interactions regulate flows of energy and carbon (among other compounds) on Earth, and result in sporadic and constantly changing phenomena (e.g., El Niño Southern Oscillation described on the following page). External drivers also influence the state of the climate system over time and include the creation and destruction of the Earth's crust, volcanic eruptions, changes in the sun's energy output, changes in the planet's path and tilt toward the sun, and changes in the composition of the atmosphere.

The rise in greenhouse gas emissions (GHGs) from human activities and resulting levels of GHGs in the atmosphere are warming the Earth's climate. The industrial activities that we depend on have increased levels of atmospheric carbon dioxide (CO_2) – the GHG that stays longest in the atmosphere- from 280 parts per million (ppm) to 400 ppm in the last 150 years.[54] Levels of CO_2 in the atmosphere recorded in 2018 stood at 410 ppm. The rate of growth in human-caused GHG emissions sped up since the 21st century, relative to 30 years prior (1970 to 2000) (IPCC 2014). Sources of GHGs differ. For example, the burning of fossil fuels, cement production and deforestation releases CO_2. Rice and livestock agriculture, biomass burning and landfills release methane (CH_4). Burning of fossil fuels and using agricultural fertilizers release nitrous oxide (N_2O).

Globally, emissions from energy supply, industry sectors, transport and buildings account for the growth in the annual rate of GHG emission in the 21st century, with emissions growth from land use change and forestry staying, more or less, stable since 2000. Population and economic growth are the main drivers underlying increases in CO_2 from the burning of fossil fuels, although the former's contributions were more significant between 2000 and 2010. Globally, average temperatures have risen by 0.85°C since the late 19th century (Stocker et al. 2013).

So far, the 21st century includes 17 of the 18 warmest years on record (Stocker et al. 2013). Scientists conclude that the rising global temperatures since the mid-20th century are extremely likely due to human activities (IPCC 2014). Due to the build-up of GHGs in the atmosphere and lags in the climate system's response, global warming and related physical and biological changes will continue, and possibly accelerate for decades, if not centuries.

[54] https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/Retrieved September 18 2018

Weather: Condition (rain, humidity, temperature) experienced at a specific time and place.

Climate: It is usually defined as "average weather" and described in terms of the average and extreme values of such variables as temperature, rain and wind speed over a period of time, ranging from months to millions of years. The typical period is 30 years, which is referred to as the "climate normal". "Climate averages", "climate means" and "climate normals" are interchangeable terms.

Climate change: A shift in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change is due to natural variability (e.g., volcanic eruptions and changes in solar output) or to human activities through sustained changes in the composition of the atmosphere or land use.

Climate variability: Variations in the climate on time scales of a few years to decades. El Niño is an example of climate variability during which large-scale interactions between the ocean and atmosphere lead to periodic warming of sea surface temperatures across the central and east-central Equatorial Pacific. El Niño and the Southern Oscillation, also known as ENSO is a periodic fluctuation in sea surface temperature and the air pressure of the overlying atmosphere (Southern Oscillation) across the equatorial Pacific Ocean. The Southern Oscillation describes a variation in sea level barometric pressure. The force exerted by the atmosphere at sea level (zero meters elevation) as measured by a barometer.) as measured by a barometer. between observation stations at Darwin, Australia and Tahiti. Normally, lower pressure over Darwin and higher pressure over Tahiti encourages a circulation of air from east to west, drawing warm surface water westward and bringing precipitation to Australia and the western Pacific. When the pressure difference weakens, which is strongly coincidental with El Niño conditions, parts of the western Pacific, such as Australia experience severe drought, while across the ocean, heavy precipitation can bring flooding to the west coast of equatorial South America.[55]

Greenhouse effect: The 50km blanket covering the Earth's surface, although chiefly composed of oxygen and nitrogen, also includes trace gases known as greenhouse gases (i.e., water vapour, carbon dioxide, methane, nitrous oxide and ozone). The presence of these gases regulates the balance of energy from the sun that warms the Earth's surface. The greenhouse effect is a natural process, and without it the Earth would be 30°C colder, on average. However, human activities since the industrial revolution, such as the burning of fossil fuels for energy, have significantly increased the concentration of greenhouse gases (GHGs) in the atmosphere, which is amplifying the natural greenhouse effect and causing global warming.

Mitigation: Interventions to limit the speed and scale of climate change by reducing sources of GHG emissions and enhancing GHG sinks. "No regrets" measures have objectives beyond tackling the cause of climate change (e.g., energy security and industrial eco-efficiency). A "no regrets" climate policy endorses emission reductions of CO2 and methane that make sense in their own right, i.e. are economical. It relies on personal decision-making.[56]

Adaptation: Adjustment to actual or expected climate and its effects, with the objective of moderating or avoiding harm or exploiting beneficial opportunities.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

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[55] National Centers for Environmental Information

[56] "Rather than adopt costly regulatory measures that serve to suppress energy use and economic growth, policy makers should seek to eliminate government interventions in the marketplace that obstruct emission reductions and discourage the adoption of lower emission technologies. Such an approach is a 'no regrets' strategy…."
– Jonathan Adler, "Greenhouse Policy without Regrets: A Free Market Approach to the Uncertain Risk of Climate Change" (2000).

Box 3 Climate Definitions

The threats from warming of the global climate are cross-cutting, affecting all environments, sectors and human communities. Observed and projected changes in climate conditions include shifts in seasonal rainfall patterns, more heavy downpours and flooding, more frequent and / or intense drought, more frequent and intense heat waves, more intense storms and storm surges, rising sea levels, and a warmer and more acidic ocean (Stocker et al. 2013; IPCC 2014; Magrin et al. 2014; Seneviratne et al. 2012).

As a small island developing state affected by climate variability and highly vulnerable to natural hazards that include severe weather, the increasingly damaging consequences of climate-related impacts for Jamaica's natural resources, economy and social well-being are already evident (PIOJ 2018a).Climate change, compounded by poverty, development in high-risk areas and environmental degradation, has the potential to exacerbate food insecurity, water stress, natural disasters, human health risks and harm the productivity of economic sectors reliant on a stable climate (GOJ 2015).

Contributing to global cuts in emissions by pursuing "no regrets" GHG mitigation and managing the negative impacts of climate change are among the greatest environmental challenges facing Jamaica today. Central to the country's 2015 National Climate Change Policy Framework is a commitment to building a *"country with enhanced resilience and capacity to adapt to the impacts and to mitigate the causes in a coordinated, effective and sustainable manner (GOJ 2015)".* As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and party to the Paris Agreement[57], Jamaica, along with 174 other countries, has signed on to the goals of holding the increase in global average temperatures to well below 2°C over pre-industrial levels (PIOJ 2018a) and to increasing the ability to adapt to climate change and foster climate resilience and low carbon development (UNFCCC 2015).

Jamaica's energy and agricultural sectors are the country's main sources of GHG emissions. Figure 21 shows annual GHG emissions reported in Jamaica's recent Biennial Update Report to the UNFCCC for 2006 to 2012 (MEGJC 2018). Emissions from the energy sector comprise, on average, about 50 percent of the annual inventory, with sources including public electricity and heat production, refinery flaring, bauxite mining, transport and commercial / residential combustion. Agricultural emissions comprised, on average, about 40 per cent of the annual inventory. These emissions, primarily released as methane and nitrous oxide, stem from manure and its management, digestive processes of ruminants, field burning, fertilizer use, leaching from soils, among other on-farm activities. For the most part, the sources of emissions varied little during the inventory period. The most significant change in year–to-year emissions between 2006 and 2012 derived from contraction in mining / bauxite production, itself driven by a drop in global commodity prices (MEGJC 2018).

[57] The Paris Agreement is an agreement signed in 2016 within the United Nations Framework Convention on Climate Change (UNFCCC), dealing with greenhouse-gas-emissions mitigation, adaptation, and finance. The Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

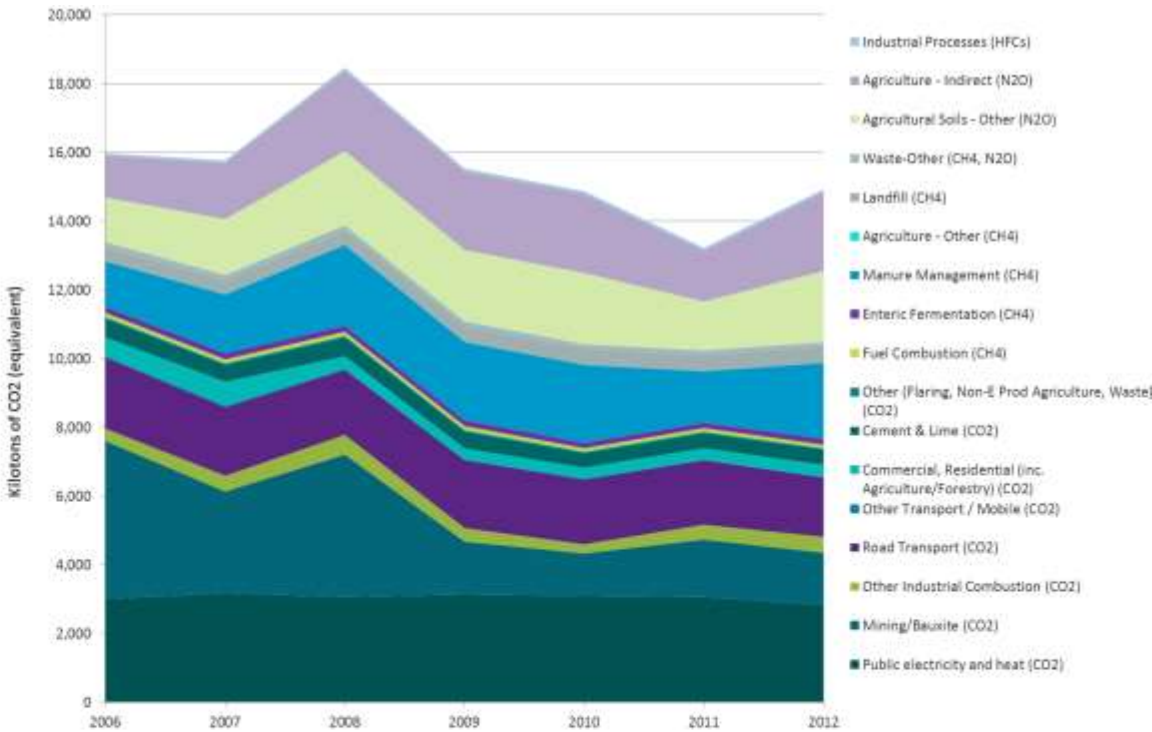

Figure 21 Greenhouse gas emissions from 2006 to 2012 quantified in Jamaica's national inventory. Emissions from various sources and gases are presented in kilotons of carbon dioxide (Source: reproduced from MEGJC 2018)

Jamaica's tropical marine climate, with little monthly variation in air temperature, marked wet and dry seasons and peak hurricane activity in August, is changing (CSGM 2017). In addition to establishing baseline climate patterns, the 2015 State of the Jamaican Climate Report analyses historical data for a number of climate variables and provides conclusive evidence of long-term trends and seasonal variations due to climate change, in combination with natural climate variability. For example, average annual temperatures in Jamaica increased by 0.16˚C per decade between 1950 and 2014 (CSGM 2017). Other examples of trends detected are documented in Table 18.

Table 18 Examples of historical climate trends for Jamaica (Source: CSGM 2017)

Climate variable	Observed change	Observation period
Air temperature	↑ minimum, maximum and average annual temperatures Rate of increase in minimum temperatures (~0.27˚C/decade) greater than maximum temperatures (~0.06˚C/decade)	1950-2014
	↑number of nights warmer than 20˚C, except in easternmost part of the country (as measured in Duckenfield, St. Thomas station)	1992-2011
Rainfall	↑intensity and occurrence of extreme rainfall events ↓in dry spells in north and west; ↑ in dry spells in south and interior	1940-2010
	Significant year-to-year variability due to influence of El Niño / La Niña events[58]	1880-2010
	Strong decadal swings between dry and wet periods	Since the 1950s
Sea levels	↑ in 1.66 mm/year, as measured at Port Royal	17.8 years
Hurricanes	↑ in intensity, frequency and duration of Atlantic hurricanes	Since 1995
	↑number of category four and five hurricanes South coast most exposed to hurricane passage and its impact	1950-2015

5.3 Indicator Trends and Patterns

Key performance indicators (KPIs) for climate used in this SOE report capture both Jamaica's contribution to global climate change and the direct effects of global climate change felt in the island. These KPIs are as follows:

- Total national greenhouse gas emissions per capita
- Departures from climate norms for temperature and rainfall

5.3.1 Total National Greenhouse Gases per Capita

Total National levels of greenhouse gas emissions is a standard measure used to assess a country's contribution to global human-caused GHGs and therefore, global climate change. Parties to the UNFCCC must submit national GHG inventories periodically,[59] including in national communication and biennial update reports. Presenting GHG emissions per capita facilitates comparisons across countries, recognizing that total emissions tell a partial story of a country's development pathway.

Measures of national GHGs can include a range of emissions sources or sinks (i.e., human activities) and pollutants; inventories are reflective of the structure of economies, data availability and analytical capabilities. Jamaica's GHG emissions inventory quantifies emissions of CO_2 (carbon dioxide), methane, nitrous oxide and hydro fluorocarbons, as well as emissions of indirect GHGs (MEGJC 2018a). However, GHG emissions data are only available for 2006 to 2012. For the purposes of this report, the focus is on annual CO_2 emissions from the burning of fossil fuels and cement manufacturing, supplementing national data with datasets from the Carbon Dioxide Information Analysis Centre (CDIAC) of the Oak Ridge National Laboratory in the United States (Boden et al. 2017). Using this combination of data

[58] During El Niño, surface water in the central and eastern equatorial Pacific Ocean is unusually warm. La Niña is characterized by the opposite process: the trade winds strengthen, and warm water and rainstorms are pushed to the far western equatorial Pacific over Indonesia. This results in cooler surface water in the equatorial Pacific Ocean, dry conditions in Pacific coastal South America.

[59] https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/ghg-data-unfccc Retrieved September 18 2018

sources permits both reporting on Jamaica's performance beyond 2012 and drawing regional comparisons based on standardized data sets. Despite the complementary data, reporting for the full 2014-2017 SOE period is not possible.

Total national carbon dioxide emissions per capita are annual CO_2 emissions from the burning of fossil fuels and manufacturing of cement divided by the total population. Using demographic data from the Statistical Institute of Jamaica, CO_2 emissions data from Jamaica's inventory and from a global data set, Table 19 presents indicator results for the period 2011 to 2014. Confidence in these results is moderate. Jamaican emissions data were compared with emissions data for Jamaica in the global data set for 2006 to 2012, and values were within ±4%. Similar comparisons between the two data sets for population data show a difference in values of -5%, with World Bank population figures for Jamaica consistently higher than figures from the Statistical Institute of Jamaica.

Table 19 Trends in national carbon dioxide emissions for Jamaica.

Total national CO_2 emissions	2011*	2012*	2013	2014	% change (2013-2014)
CO_2emissions [(1)] (ktons / year)	7,871	7,387	8,093	7,422	-8.3%
Total population[(2)] (inhabitants)	2,704,133	2,711,476	2,717,862	2,723,246	0.21%
Total national CO_2 emissions per capita (t/person and year)	2.91	2.72	2.98	2.73	**-8.5%**

*MEGJC (2018) and Carbon Dioxide Information Analysis Center (CDIAC; Boden et al 2017);
(1) CO2 emissions from energy and cement manufacturing, with data sources including
(Statistical Institute of Jamaica.

National per capita CO_2 emissions decreased by about 8% between SOE reporting periods but this result should be interpreted with caution, since the comparison is between two years (2013 and 2014) and CO_2 emissions in Jamaica are sensitive to year-to-year fluctuations. Mining and quarrying, bauxite / alumina sales either remained constant or increased slightly (<2%) between 2013 and 2014; in contrast, fossil fuel imports and electricity generation decreased between 2013 and 2014 and can partly explain the drop in emissions (PIOJ 2015).

Jamaica is in the middle of the pack, relative to other CARICOM member states; it is the seventh highest emitter of the 14 Caribbean nations.

Table 20 displays Jamaica's carbon dioxide emissions for 2013 and 2014 (absolute and per capita), alongside data for 13 CARICOM members and regional averages. In absolute terms, Jamaica's emissions are almost double the CARICOM average. However, accounting for population sizes reduces Jamaica's footprint to about half the CARICOM average.

Results in

Table 20 also suggest limitations in drawing out differences across the two SOE reporting periods. The rank order of per capita emitters did not change significantly between 2013 and 2014; only three countries changed position. This suggests regional (or global) drivers and pressures at work in shaping emissions profiles year to year, as opposed to unilateral action by countries.

Table 20 Per capita carbon dioxide emissions for members of the Caribbean Community (CARICOM) and ranking from highest (1) to lowest (14) per-capita emitters in 2013 and 2014.

	Total national CO_2 emissions (ktons)*		Emissions per capita per capita (2013-2014)**		% change in Emissions	Emissions Rank
	2013	2014	2013	2014		
Jamaica	**8,093**	**7,422**	**2.98**	**2.73**	**-8.5%**	**7, 7**
Antigua and Barbuda	524	532	5.36	5.38	0.3%	3, 3
Bahamas, The	2,802	2,417	7.43	6.32	-15%	2, 2
Barbados	1,448	1,272	5.13	4.49	-12%	4, 4
Belize	513	495	1.49	1.41	-5.6%	13, 13
Dominica	132	136	1.82	1.86	2.2%	12, 12
Grenada	304	242	2.87	2.28	-21%	8, 10
Guyana	1,936	2,010	2.55	2.63	3.1%	9, 8
Haiti	2,406	2,860	0.23	0.27	17%	14, 14
St. Kitts and Nevis	224	231	4.21	4.30	2.2%	5, 5
St. Lucia	407	407	2.32	2.31	-0.4%	10, 9
St. Vincent and the Grenadines	209	209	1.91	1.91	0.0%	11, 11
Suriname	1,918	1,991	3.53	3.63	2.8%	6, 6
Trinidad and Tobago	46,542	46,274	34.5	34.2	-1.0%	1,1
CARICOM average	4,818	4,750	5.45	**5.26**	**-3.5%**	

* CO2 emissions from energy and cement manufacturing (ktons) from the Carbon Dioxide Information Analysis Centre (CDIAC);
**Population data for Jamaica from STATIN, all other population data are from the World Bank Indicators series (SP.POP.TOTL).

5.3.2 Departures from Climate Means

Climate means derive from averaging observed values for climate variables for a given location and time period. Climate means are useful to characterize a region or a country's climate and inform all manner of development decisions, including infrastructure design, farming, energy and water use. Climate means are also used for communication with the public, as comparing daily, monthly or seasonal values of climate variables, such as rainfall amounts, to a location's climate mean conveys information about how unusual those values are. Both the direction and magnitude of departure from climate means are of interest. This report focuses on indicators of departures from climate means with respect to temperature and rainfall.

Globally, temperature averages (land and ocean) continued to increase between 2014 and 2017 and set new records. Average global temperatures in 2014, 2015, 2016 and 2017 were 0.69°C, 0.90°C, 0.94°C and 0.84°C, higher than the 20th century average.[60] All four years are among the top 10 warmest on record.[61] In contrast, annual average precipitation is hugely variable across regions. During the reporting period, global average precipitation, as measured on land-based stations, stayed close to the 1961-1990 reference value. [62].

Temperature Change in Jamaica

The national average temperature for the year 2017 was 0.3°C above the climate mean, as averaged from six weather stations (Table 21).

[60] NOAA State of Global Climate, as reported in PIOJ'sEconomic and Social Survey – Jamaica 2013, 2014, 2015, 2016, 2017
[61]https://www.climatecentral.org/gallery/graphics/the-10-hottest-global-years-on-recordRetrieved December 18 2018
[62] NOAA 2015

Table 21 Annual national and sub-national average temperature departures (˚C), based on average monthly temperature data from the Meteorological Service of Jamaica; climate means are from CSGM (2017)

Weather station	Years averaged	Climate mean (˚C)	2014 departure (˚C)	2015 departure (˚C)	2016 departure (˚C)	2017 departure (˚C)	4-year (2014-2017) (˚C)
Norman Manley Airport (Kingston)	1992-2015	28.3	0.2	0.3	0.2	-0.2	0.1
Sangster Airport (St. James)	1992-2015	27.6	0.5	0.7	0.6	0.3	0.5
Worthy Park (St. Catherine)	1973-2015	23.7	0.9	1.2	1.2	0.7	1.0
Bodles (St. Catherine)	1987-2015	26.6	0.4	0.9	0.9	0.3	0.6
Frome (West Moreland)	1996-2016	26.7	0.3	1.9	0.8	0.4	0.9
Passley Gardens (Portland)	2000-2015	26.3	0.9	1.2	0.5	0.1	0.7
Jamaica Average		**26.5**	**0.5**	**1.0**	**0.7**	**0.3**	**0.6**

Annual average temperatures during this reporting period were consistently above the climate mean. Influenced by a strong El Niño occurrence, the warmest year was 2015, at 1.0°C above the climate mean. The year 2016 also saw the influence of El Niño conditions. At individual weather stations, almost all annual averages were higher than the climate mean at each location. The annual average temperature calculated from weather records at Norman Manley International Airport for 2017 was 0.2°C below the reference value.

Figure 22 shows monthly temperature departures from maximum and minimum reference values at six weather stations, averaged across the four reporting years. With few exceptions, maximum and minimum monthly temperatures across Jamaica for the reporting period were higher than reference values. Departure patterns differed sub-nationally. Minimum temperature departures were more consistently higher than maximum temperature departures at Passley Gardens, Bodles and Norman Manley Airport than at the other stations. The magnitude of departure was lowest at Norman Manley and highest at Worthy Park. Of the six weather stations, Norman Manley was at the lowest altitude (2.7m) and Worthy Park at the highest (374m).

Strong seasonal patterns are not evident when averaging across four years; year-to-year and spatial variation is substantial. Nevertheless, national and sub-national, annual and monthly departures in air temperatures are consistent with the longer-term warming observed in Jamaica. [63]

Precipitation Change in Jamaica.

The national average rainfall for the 2014-2017 reporting period was 6% below the climate mean (Table 22). Annual rainfall averaged over the reporting period was below the 30-year climate mean for eight parishes and above for five parishes. St. Mary, St. Thomas and Hanover registered the driest conditions in proportion to reference values and St. Ann and Portland the wettest.

[63] CSGM 2017.

Table 22 National and sub-national average rainfall departures (%) for the four-year reporting period, based on average monthly rainfall data and climate means from the Meteorological Service of Jamaica. Colour coding denotes years that were wetter (green) and drier (brown) than the particular location's climate mean

Parish	30-year climate mean (1971-2000) (mm)	4-year average departure (%)
Hanover (H)	2,378	-17%
Westmoreland (W)	2,079	-14%
Manchester (M)	1,649	-6%
St. Elizabeth (St. E)	1,819	-13%
Clarendon (C)	1,152	-14%
St. Catherine (St. C)	1,277	7%
Trelawny (T)	1,275	6%
St. James (St. J)	1,549	4%
St. Ann (St. A)	1,325	20%
St. Mary (St. M)	1,818	-22%
Portland (P)	3,439	11%
St. Thomas (St. T)	1,842	-20%
Kingston & St. Andrew (K& St. A)	1,450	-14%
Jamaica	1,773	-6%

Long-term, annual and monthly rainfall patterns in Jamaica and the weather systems that drive them arise from a combination of island-specific traits (topography, shape) and atmosphere-ocean interactions at regional scales and beyond. Based on patterns of variability, scientists have identified four rainfall zones in Jamaica: coasts, interior, western and north-eastern[64] . These rainfall zones do not always conform neatly to parish boundaries. For example, parts of St. Elizabeth belong to the coast, western and interior rainfall zones, respectively. Still, by comparing monthly climate means of the four rainfall zones[65] with average departures from reference values over the 2014-2017 period by parish (Figure 23and Figure 24) some overall observations can be drawn.

Months with the lowest rainfall according to the climate mean were drier during the reporting period for all parishes except St. James. Monthly rainfall in St. Mary and Kingston and St. Andrew during the reporting period was consistently lower than these locations' climate means. In contrast, monthly rainfall in St. Ann was higher than the climate mean in 10 of 12 months. Westmoreland and Hanover, both in rainfall zone three (western), exhibited similar patterns of departure from monthly means. At least eight months were drier than the climate mean, including months producing the highest rainfall (September, October) and lowest (January).In Portland, which falls into rainfall zone two (north-eastern), the wettest month (November), according to the climate mean, received above normal rain during the 2014-2017 period.

[64] CSGM 2017

[65] See Figure 9 in CSGM (2017).

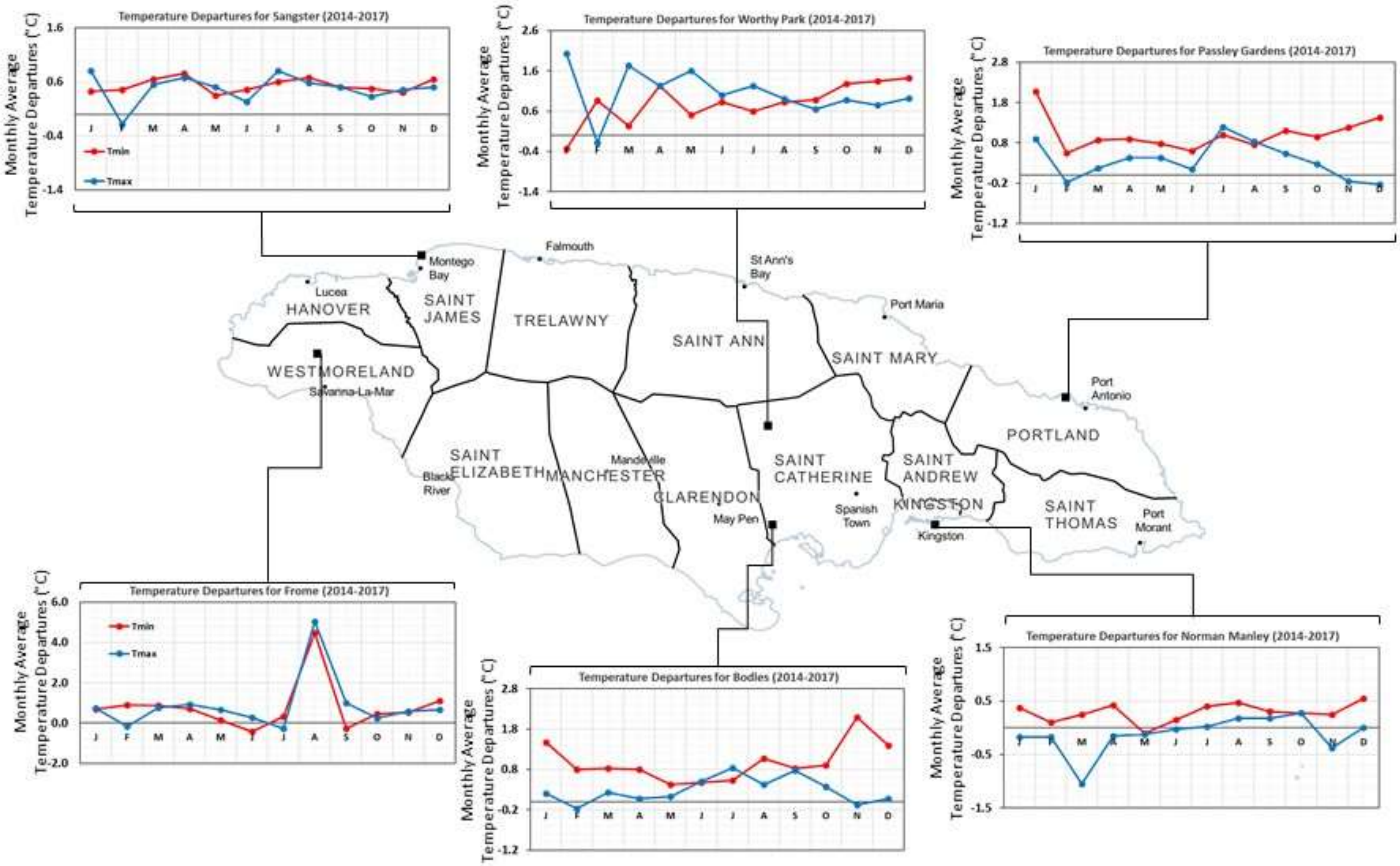

Figure 22 Maximum (Tmax, red) and minimum (Tmin, blue) monthly temperature departures (˚C) for six weather stations across Jamaica over 2014-2017, based on average monthly temperature data from the Meteorological Service of Jamaica; climate means are from CSGM (2017)

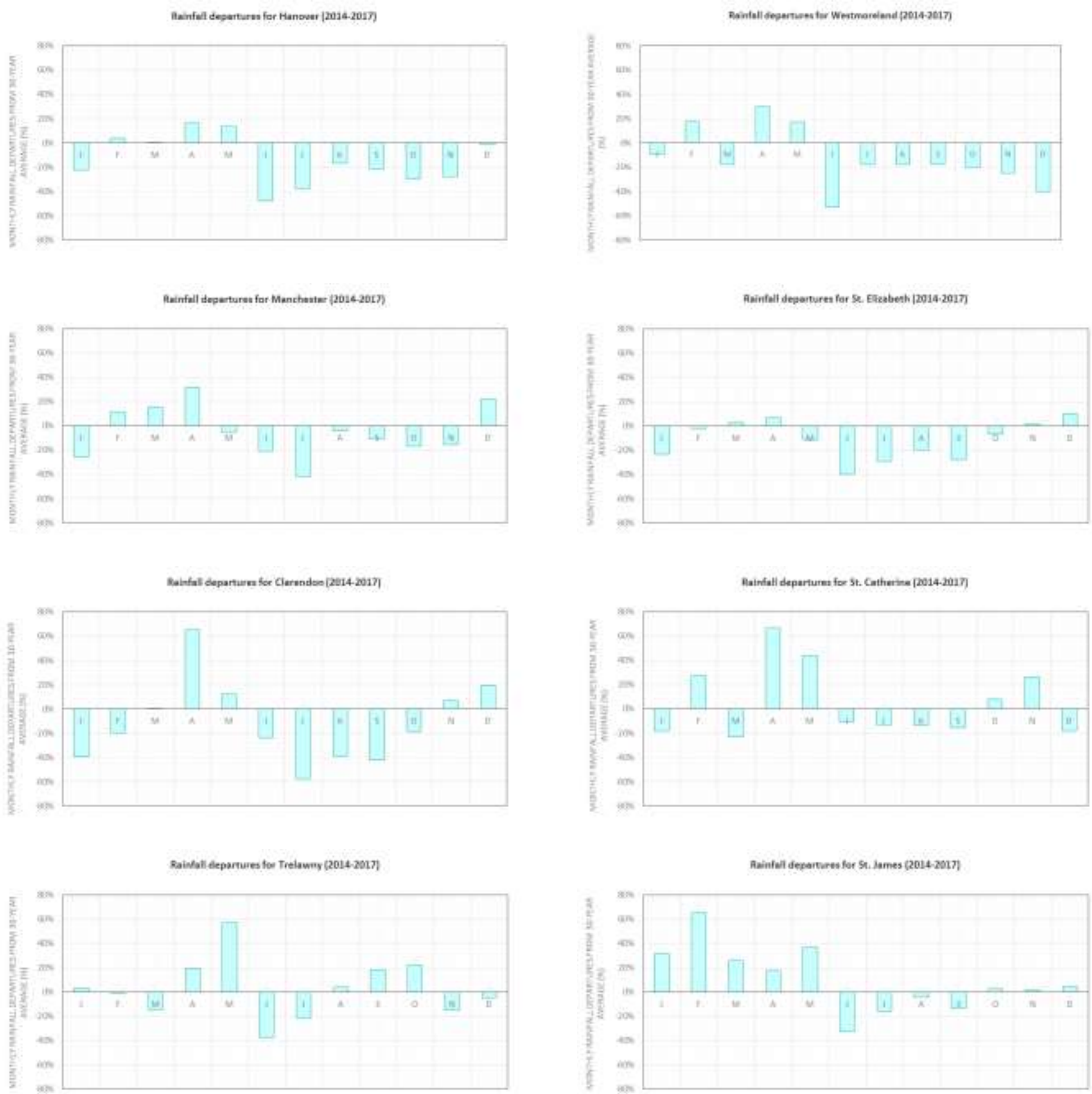

Figure 23Monthly rainfall departures (%) for the 2014-2017 reporting period for Hanover, Westmoreland, Manchester, St. Elizabeth, Clarendon, St. Catherine, Trelawny and St. James parishes. Calculations are based on monthly rainfall data per year and climate means (1971-2000) from the Meteorological Service of Jamaica. Positive percentage values mean rainfall was above the reference and negative percentage values mean rainfall was below the reference.

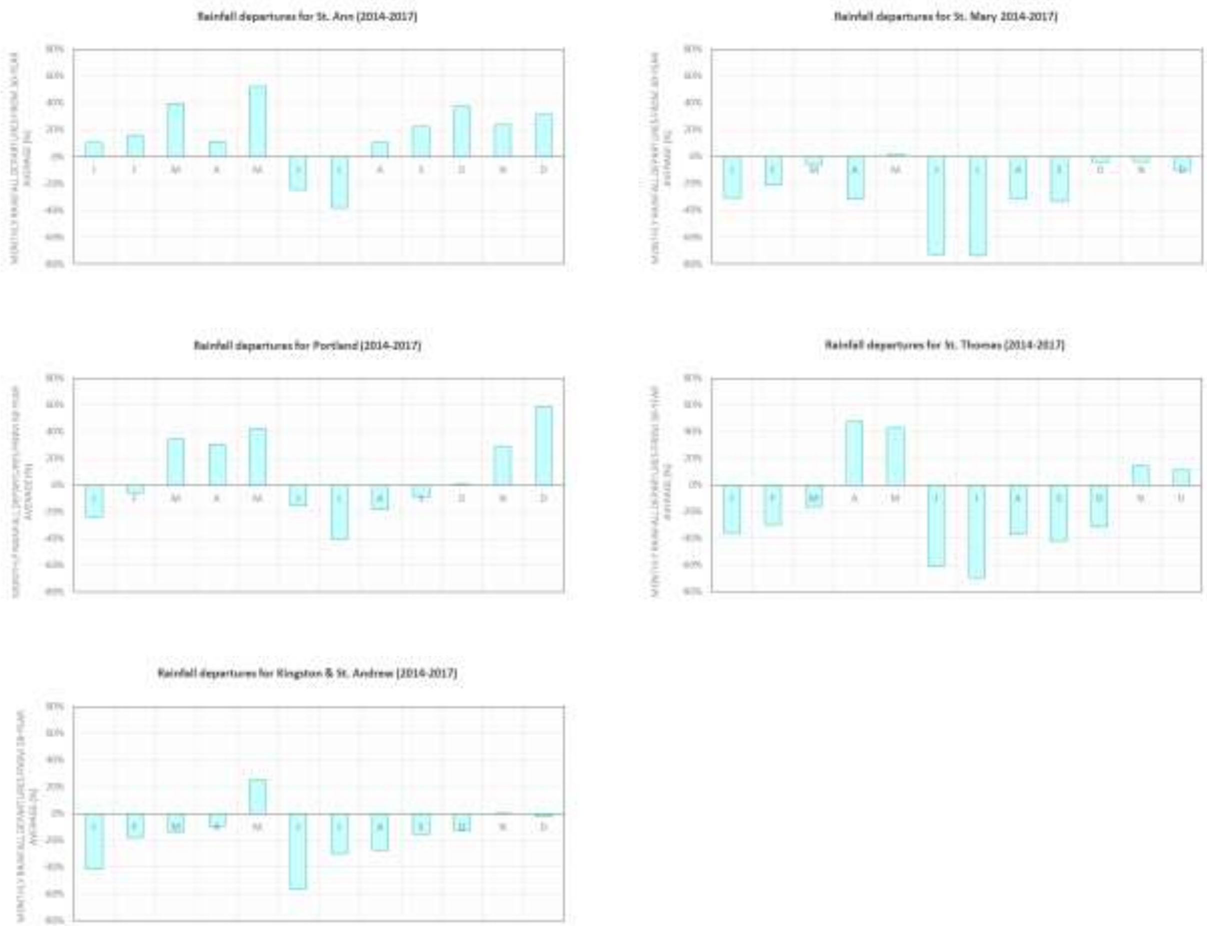

Figure 24 Monthly rainfall departures (%) for the 2014-2017 reporting period for St. Ann, St. Mary, Portland, St. Thomas and Kingston/St. Andrew. Calculations are based on monthly rainfall data per year and climate means (1971-2000) from the Meteorological Service of Jamaica. Positive percentage values mean rainfall was above the reference and negative percentage values mean rainfall was below the reference.

Rainfall during this reporting period exhibited significant year-to-year variation, as did the underlying weather systems driving rainfall. Table 23 shows annual rainfall departures per parish for 2014, 2015, 2016 and 2017.

The year 2014 brought more rainfall than 2013[66], but dry conditions prevailed overall, and 11 of 13 parishes received rainfall below the 30-year mean, with Clarendon and St. Thomas being the hardest hit. In 2015, the presence of El Niño brought lower rainfall than was expected from the low-pressure weather systems (troughs) that occurred that year[67]. Rainfall was lower than the 30-year mean in all parishes, and markedly so in Clarendon, St. Thomas and St. Mary. Troughs were the main influence on rainfall in 2016. These low-pressure systems, as well as the passage of Hurricane Matthew in 2016, caused localized flooding and landslides (see Chapter 6) (PIOJ 2017a). Rainfall amounts were higher in 2016 than in 2015, but eight of the 13 parishes still received less than the 30-year mean rainfall (Table 23). A range of weather systems affected the island in 2017, including troughs, cold fronts and tropical

[66] PIOJ 2015

[67] PIOJ 2016b

waves.[68] As a result, rainfall amounts were higher than the 30-year mean for 10 of the 13parishes. Clarendon, St. Catherine and St. Ann had significantly wetter conditions than the 30-year mean (73%, 65% and 49% higher, respectively). Dry conditions prevailed in Hanover, Westmoreland and St. Mary; annual rainfall amounts in these three parishes were below the 30-year mean in 2014, 2015, 2016 and 2017.

Table 23 National and sub-national average rainfall departures (%) per year, based on average monthly rainfall data and climate means from the Meteorological Service of Jamaica. Colour coding denotes years that were wetter (green) and drier (brown) than the particular location's climate mean.

Parish	30-year climate mean (1971-2000) (mm)	Departure (%)			
		2014	2015	2016	2017
Hanover (H)	2,378	-11%	-20%	-23%	-16%
Westmoreland (W)	2,079	-4%	-17%	-24%	-9%
Manchester (M)	1,649	-19%	-26%	-8%	30%
St. Elizabeth (St. E)	1,819	-14%	-26%	-19%	8%
Clarendon (C)	1,152	-52%	-60%	-16%	73%
St. Catherine (St. C)	1,277	-10%	-29%	0%	65%
Trelawny (T)	1,275	1%	-11%	9%	26%
St. James (St. J)	1,549	10%	-18%	7%	19%
St. Ann (St. A)	1,325	-4%	-9%	44%	49%
St. Mary (St. M)	1,818	-23%	-43%	-9%	-13%
Portland (P)	3,439	-8%	-18%	29%	41%
St. Thomas (St. T)	1,842	-43%	-47%	-25%	36%
Kingston and St. Andrew (K& St. A)	1,450	-18%	-32%	-11%	6%
Jamaica	**1,773**	**-14%**	**-26%**	**-3%**	**21%**

Lower than average rainfall across the island resulted in instances of extreme, severe and normal drought conditions in 2014, 2015 and 2016. Figure 25 shows the number of extreme, severe and normal drought activity registered during the reporting period per parish. The frequency of drought was greatest in 2015 (56 extreme, severe and normal droughts in a year) and 2014 (40 extreme, severe and normal droughts in a year). Moisture conditions improved in 2016 (23 extreme, severe and normal droughts in a year) and, by 2017, even fewer drought conditions were experienced (nine normal and severe droughts in a year). Clarendon, St. Mary and St. Thomas were the worst affected parishes over the reporting period. Overall, drought conditions from 2014-2017 led to reduced stream flows in the Rio Minho, Rio Cobre and Blue Mountain basins, which had an impact on domestic water supplies and electricity generation, reduced agricultural output and increased prices of domestically-produced vegetables and tubers, and had a negative impact on aquaculture pond operations [69].

[68] Significant Weather Systems Affecting Jamaica (1953-2018), provided by Meteorological Service of Jamaica

[69] PIOJ 2015, 2016, 2017

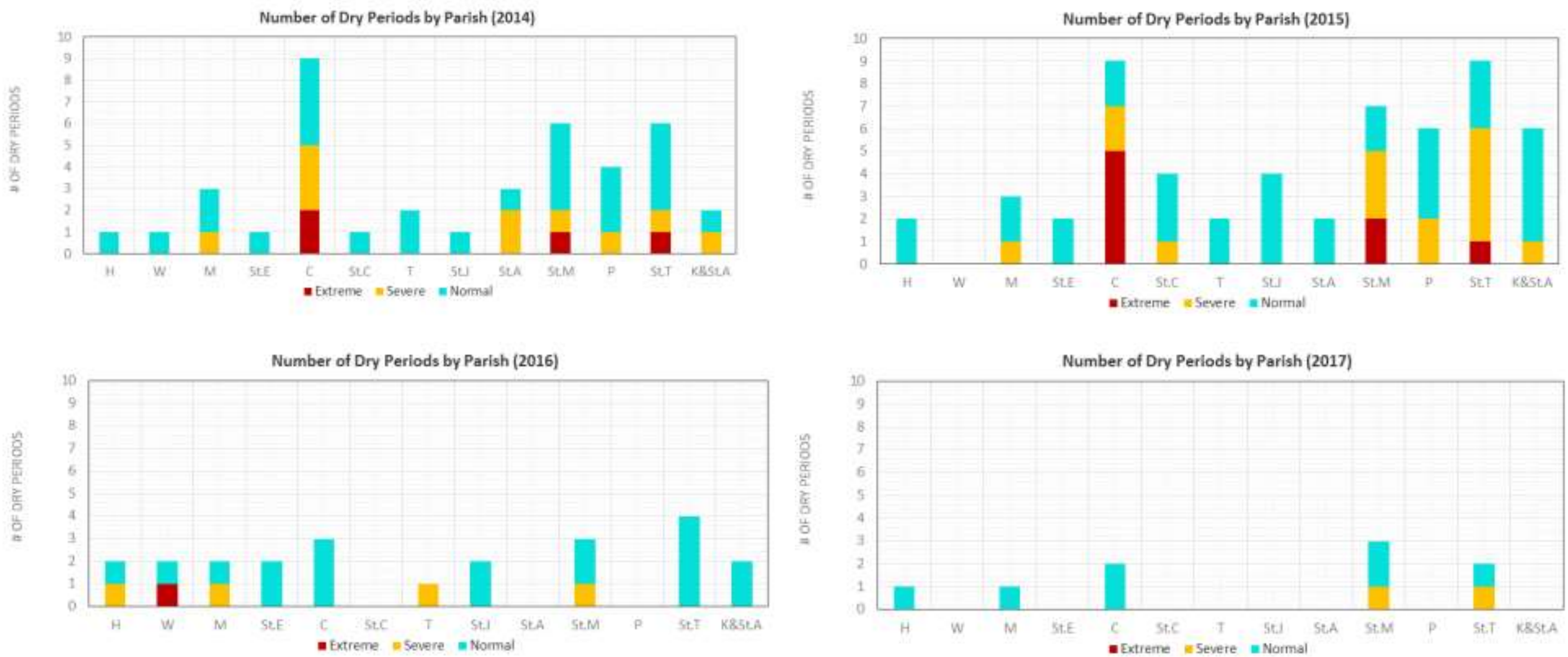

Figure 25 Count of dry periods per parish in 2014, 2015, 2016 and 2017, as measured by calculations of bi-monthly drought indices that take into account departures from 30-year means (1971-2000). Extreme, severe and normal drought periods are shaded in red, orange and blue, respectively.

5.4 Conclusions

Global emissions of greenhouse gases (GHGs) from human activities are altering the global climate system, with profound ramifications for the environment, societies and economies. Action at all levels is necessary to cut GHG emissions and limit global average temperatures to well below 2°C above pre-industrial levels, and to adapt to the impact of climate change already underway. The case for global action is clear. The long-run economic savings alone from global compliance with the Paris Climate Agreement and the 2˚C target stand at approximately US$17.5 billion per year compared to business-as-usual emissions (Kompas et al. 2018).

Contributing to global cuts in emissions by pursuing "no regrets" GHG mitigation and managing the negative impact of climate change are among the greatest environmental challenges facing Jamaica today. This is central to the country's 2015 National Climate Change Policy Framework in support of attaining Vision 2030-Jamaica. The 2017 State of the Environment Report includes two key performance indicators, with respect to Jamaica's contribution to global climate change and direct effects of global climate change felt in the country. These indicators are per capita carbon dioxide (CO_2) emissions from the burning of fossil fuels, cement production, and departures from climate means for temperature and rainfall.

Analysis of indicators reveals a decrease in per capita CO_2 for Jamaica between 2013 and 2014, and a carbon footprint ranging from 2.72 to 2.98 tons CO_2 / per person between 2011 and 2014. When measured against carbon footprints per person within the Caribbean, Jamaica falls in the middle. With regard to climate departures, indicator analysis suggests a continued trend in warmer and drier conditions for the island. The 2014-2017 departure in air temperature was 0.6˚C above the climate mean.

National average rainfall for the 2014-2017 reporting period was 6% below the climate mean, although rainfall amounts were highly variable from year to year and by parish. Lower than average rainfall across the island contributed to instances of extreme, severe and normal drought conditions during this reporting period, adversely affecting agriculture and aquaculture, food prices, water and energy supplies.

Since 2013, the Government of Jamaica has increased the profile of climate change issues. Efforts to boost the island's institutional capacity to step up climate action included establishment of a Climate Change Division at the Ministerial level, the creation of the Climate Change Focal Point Network, and approval of the Climate Change Policy Framework. Important international milestones were also reached. These included: preparation and submission of Jamaica's Intended Nationally Determined Contribution, spelling out the country's GHG reduction target among other policy goals; signing of the Paris Accord, and compilation of an updated GHG emissions inventory for 2006 and 2012, which appeared in the Biennial Update Report to the UN Framework Convention on Climate Change (UNFCCC). By 2017 Jamaica had made significant progress toward the completion of its Third National Communication to the UNFCCC, submitting it in January 2018.

6. Natural and Human-Induced Hazards

Scorecard 6: Natural and Human-Induced Hazards (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
#, TYPE, LOCATION OF MAJOR HAZARD EVENTS AND DISASTERS IN COUNTRY	<u>Earthquakes:</u> 5% of local earthquakes felt by Jamaicans (15 of 309). Most occurred in south-eastern parishes <u>Drought:</u> 128 localized droughts reported with a peak in 2015 (56) mostly impacting southern and eastern parishes. <u>Storms/Floods:</u> 2016 peak mostly impacting eastern parishes (St Mary, Portland, St Thomas and KSA). Flooding in 2017 impacted Clarendon, St Ann and St Catherine. <u>Landslides:</u> highest susceptibility in eastern parishes and along scarps. <u>Fires:</u> generally lower in 2016 and 2017. Highest incidence in KSA, St Catherine, St James, and Manchester. Two fires at Riverton City Dump. <u>Environmental incidents:</u> mainly air pollution (fires) – down from 2013. Improper sewage discharges increased.	MODERATE	1	
# DEATHS, MISSING, AFFECTED PERSONS BY DISASTER PER 100,000 PEOPLE	Peak in 2014. Generally, very low – one death (2017) and indicative of high coping capacity. • 2014 Drought Manchester and St Elizabeth 3,354 affected per 100,000 people (agriculture). • 2015 River City Dump fire 121 affected per 100,000 people. • 2016 Hurricane Matthew 132 affected per 100,000 people. • 2017 heavy rainfall and floods 102 affected per 100,000 people. • Increasing numbers affected by fires.	HIGH	1	1
DIRECT DISASTER ECONOMIC LOSS IN RELATION TO GDP	$5 billion (JMD) compared to previous reporting period ($30 billion JMD). 3.96 billion – 2017 floods.	LOW TO MODERATE	2	2

Photo: Landslide in Jamaica, NEPA. Used with permission.

6.2 Environmental Linkages

Hazards are related to the environment in four ways. Hazards and other key terms used in this chapter are defined in Box 4 below.

Affected (persons): People requiring immediate assistance during an emergency, in the form of basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impact, property damage, social and economic disruption or environmental degradation. Hazards are predominantly caused by natural processes or phenomena, although hazards that are human-induced or technological also occur (e.g., industrial pollution). Several hazards are socio-natural, resulting from a combination of natural and human-caused factors, including environmental degradation and climate change.

Disaster, emergency: A natural or human-induced event that causes intense negative impacts on people, goods and services, and/ or the environment, and that exceeds the affected community's internal capacity to respond. A disaster occurs when a hazardous event intersects with conditions of exposure, vulnerability and capacity. The terms emergency and disaster can be interchangeable, although emergency can specifically refer to situations where hazardous events do not lead to serious disruptions of the functioning of a community or society.

Jamaica's Disaster Risk Management Act (2015) defines disaster as "the occurrence or threat of an event, whether caused by act of God or otherwise, which a) results or threatens to result in loss or damage to property, damage to environment, or death or injury to persons on a scale which requires emergency intervention by the state; and b) may result from fires, accidents, acts of terrorism, hurricane, pollution, disease, earthquake, drought and flood, or widespread dislocation of essential services."

Section 20 in Jamaica's Constitution clarifies the conditions for proclaiming a state of public emergency as a result of an "earthquake, hurricane, flood, fire, outbreak of pestilence, outbreak of infectious disease or other calamity". The state of emergency can remain in effect for 14 days and extended by up to three months, contingent upon a majority of Parliamentary approval.

Disaster risk: The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, community in a specific period of time, determined as a function of the likelihood of hazard exposure and magnitude of impact.

Disaster risk management: Implementation of strategies and actions to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses.

Exposure: The case of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

Box 4 Definitions of key terms

The first way in which hazards are related to the environment is that the natural environment is the source of so-called natural hazards, comprising geophysical, meteorological, hydrological and climatological hazards. Natural hazards can be characterized by magnitude or intensity, frequency of occurrence, speed of onset, duration and area of extent. On a global level, hundreds of natural hazard events causing significant losses occur every year. This does not account for natural hazard events that occur frequently but do not register insurable losses, and therefore are not tracked systematically. The "environment as a hazard" has been a rich topic for discussion and scholarship for over 50 years (Kates 1976), increasingly recognizing the complex interplay between the environment and societal choices, behaviours and capacities.

Second, geography, geology and the use of space (land, coastlines) are environmental factors that shape trends in disaster impacts (Cardona et al 2012). Low-lying islands, coastal zones, mountain regions, dry lands, and Small Island Developing States (SIDS) are among the natural systems or geographies in which hazard events can concentrate. By virtue of Jamaica's geography, geology and location, the country is prone to several hazards, including floods, earthquakes, landslides and droughts[70]. Nevertheless, settlement patterns and development trajectories mediate the extent to which a hazard event results in a disaster or emergency. Occupation of hazardous areas such as flood plains and seismically-active areas exposes people and assets to flooding and earthquakes. This can also undermine ecological processes and flows of ecosystem services, such as protection from erosion. Poor households are particularly vulnerable to natural hazard risk, as their capacity to confront recurring events is diminished over time. In some cases they settle in at-risk areas such as gullies, flood plains and areas along major fault lines, where land is inexpensive[71]. Natural hazard risk profiles in cities and rural areas differ, but neither environment is more vulnerable or resilient to natural hazard risk, as a rule (Cardona et al 2012).

Third, environmental and natural resource degradation is an important driver of disaster risk and vulnerability for resource-dependent communities (Nantel et al 2014; UNISDR 2015). For example, the loss of forest cover, especially on slopes and along rivers, causes soil erosion and landslides, which are major contributors to flash and riverine flooding (see Figure 27 and Box 5). In cities, the increase of impermeable surfaces, inadequate drainage and solid waste disposal contribute to flash flooding following intense rainfall. Human-induced hazards, such as industrial pollution, toxic waste release, arson and chemical spills can also cause environmental disasters.

In addition, global climate change is affecting disaster risk, by changing the frequency, intensity or duration of some events and influencing exposure and vulnerability. Patterns and occurrence of extreme events around the globe are changing (Figure 28). Future projections of rare events and attribution of an individual event to climate change is an evolving science. Nevertheless, changes in the frequency and severity of extremes are associated with climate change and are generally expected to continue (IPCC 2012; Herring et al 2018).

Hydrological and meteorological hazards directly affected by climate change include rapid-onset events such as riverine flooding, wildfires, extreme heat, landslides, as well as coastal inundation, storm surge, and erosion associated with coastal storm events. Other hazards affected by climate change that have a slower onset include drought and sea-level rise. Hazard events interact with non-climatic factors to exacerbate consequences: for instance, slow onset sea level rise can increase the severity of the impact of storm surges or tsunamis; prolonged and repeated drought conditions in areas where rain-fed subsistence farming predominates leads to greater instances of food insecurity.

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[70] ODPEM 2008

[71] PIOJ 2014a

Figure 26 Inundated farmland in Bog Hole, Clarendon parish, during the May 2017 rains (photo credit: NEPA)

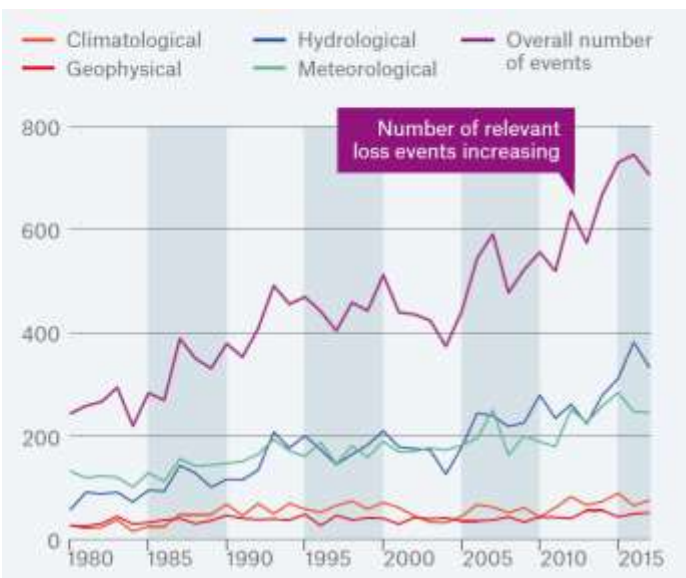

Figure 28 Number of loss events from 1980 to 2017 from around the globe (Source: Reproduced from Munich Re 2018)

The **Upper Rio Minho Watershed** (URMW) in the parish of Clarendon is characterized by steep slopes and valleys, with a dense stream network incised into the rocks of clastic-carbonate successions underlain by volcanic rocks. Soils developed on the volcanic bedrock tend to be relatively fertile, although thin and prone to erosion. Landslides and soil erosion are controlled by slope, seismic activity and rainfall. However, human factors exacerbate these hazards:

- Deforestation: tree cutting for fuel, charcoal and yam sticks, slash and burn clear cutting, as well as bushfires;
- Poor farming practices: over-cultivation and over-grazing: intense small-scale mixed farming on the steep slopes of the upper catchment has made the watershed one of the most degraded on the island;
- Poor road construction and inadequate drainage;
- Quarrying.

The degraded state of the URMW is apparent by the following trends and conditions:

- Increased sediment loads following storms, leading to choking of drains, intakes and river beds as well as scouring and physical damage to river banks/beds, bridges and roadways;
- Flash flooding in response to storm events, resulting in large volumes of surface run-off becoming available to transport sediment/debris as well as pollutants (e.g., solid waste, sewage),which devastate fields and built-up areas. This contributes to less infiltration and aquifer recharge.

These conditions persist, despite the existence of a number of protected areas in the URMW, including seven forest reserves (Stepheny, John's Vale, Peckham, Douces, Peace River, Kellits-Camperdown, Bull Head, and Pennants), and one protected area , a Protected National Heritage in the Kellits area (Mason River Protected Area/ Mason River Field Station).The latter site is also a designated Wetland of International Importance (Ramsar Site) known as Mason River Protected Area, Bird Sanctuary and Ramsar Site.

Box 5 Degradation of the Upper Rio Minho Watershed and Hazard Risk

6.3 Indicator Trends and Patterns

Key performance indicators (KPIs) capture both trends in occurrence of hazards and disasters as well as consequences of these events. KPIs for natural and human-induced hazards used in this SOE report are as follows.

- Occurrence of hazard events and disasters;
- Direct economic loss;
- Persons affected by disaster

These indicators support Goal 4 of Vision 2030 Jamaica, which recognizes the importance of reducing hazard risk through National Outcome #14 (Hazard Risk Reduction and Adaptation to Climate Change).

6.3.1 Occurrence of Hazard Events and Disasters

Exposure of people and assets to hazard risk is an indicator that is commonly used for comparative assessment of vulnerability within and across countries; tracking the occurrence of events is an input to this. Operating since the 1970s, the Centre for Research on the Epidemiology of Disasters (CRED) maintains an international disaster database (EM-DAT). EM-DAT adds to their dataset on disasters from natural and human-induced/technological hazards if events meet certain criteria, including 10 or more people dead, 100 or more people affected, and declaration of an emergency or appeal for assistance.

Globally, the number of disasters linked to natural hazards has increased since the 1900s, according to EM-DAT records. An increase in the number of floods and storms is driving this upward trend. Similarly, the number of disasters caused by technological hazards around the world rose significantly between 1980 and the mid-2000s and has since shown a downward trend. Since the mid-1980s, transportation accidents – road, air, rail and water – have been the dominant source of disasters. Between 2014 and 2018, transportation disasters accounted for about 70 % of all recorded human-induced disasters. EM-DAT records show an increasing trend in disaster events in Jamaica as well. Figure 29 summarizes the number of disaster events linked to climatological, meteorological, hydrological and geophysical hazards by decade, since the 1950s.

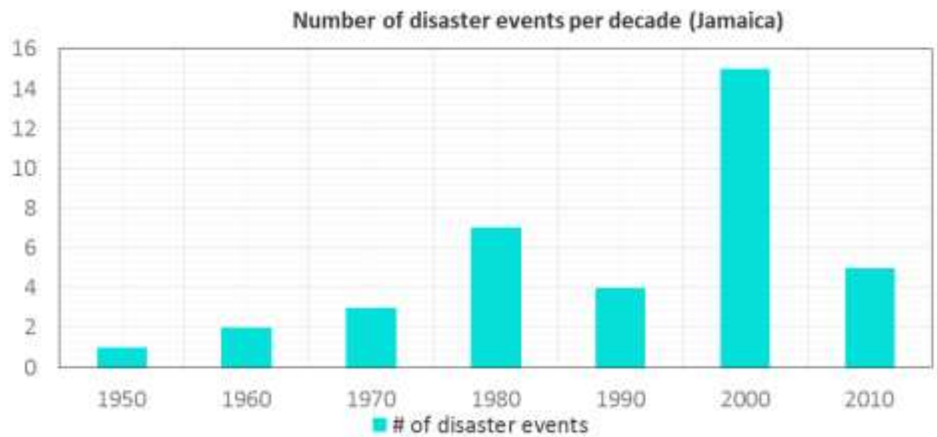

Figure 27 Number of disasters in Jamaica, linked to (a) natural hazards (climatological, meteorological, hydrological and geophysical) from 1950 to 2017 (Source: EM-DATN.D.)

According to the World Bank-funded Global Facility for Disaster Reduction and Recovery (GFDRR), Jamaica ranks among the top three most exposed countries in the world to multiple natural hazards. GFDRR estimates that over 96 %of the island's GDP and a majority of its population are at risk from two or more hazard types. Jamaica's high exposure is due to its location in the Atlantic Hurricane Belt, the orientation of its low-lying coastal areas, its mountainous topography and the presence of major fault zones within its territory.

The occurrence of hazard events and disasters is simply the number of events recorded in a year by type of hazard. In Jamaica, several agencies collect information on natural and human-induced hazards at a national level. Chief among them are the Office of Disaster Preparedness and Emergency Management (ODPEM), the Jamaican Fire Brigade, the Earthquake Unit at The University of the West Indies – Mona Campus, the National Environment and Planning Agency (NEPA), the Mines and Geology Division of the Ministry of Transport and Mining and the Meteorological Service of Jamaica. This document uses data provided by all of these Ministries, departments and agencies to report on the occurrence of hazard events for the 2014-2017 SOE reporting period. Information on disaster events comes from ODPEM, supplemented by a review of the global EM-DAT database.

Earthquakes: Figure 28 summarizes earthquake activity in 2013 and in the 2014-2017 reporting period. A total of 309 local events occurred during this period, with an average of 77 tremors per year. Five percent of these were felt. These seismic events registered magnitudes on the Richter scale of between 3 and 3.7. About half of all recorded local events were located in three areas: The Blue Mountain Block (32%), the Rio Minho-Crawle River Fault Zone (10%) and the Wagwater Trough North area (9%). In 2013, during the previous reporting period, more seismic tremors occurred than in the 2014 to 2017 period combined. The number of events recorded for 2013 and their source were, nevertheless, comparable to the activity registered during 2014-2017.

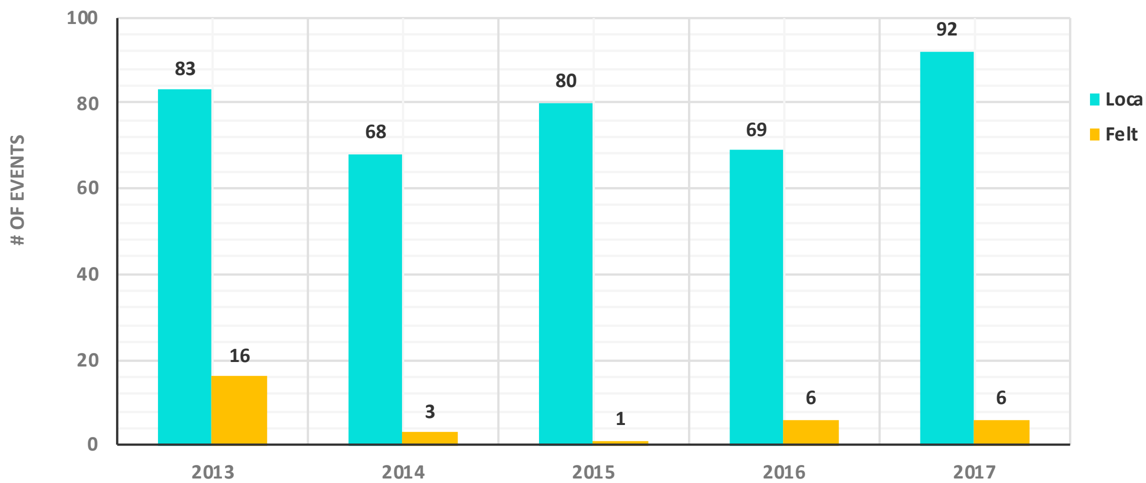

Figure 28 Number of local earthquakes reported and proportion felt in Jamaica 2013-2017 (Source: Earthquake Unit, UWI Mona)

Earthquake activity during this reporting period was not disastrous. Overlaying data on the spatial distribution of seismic activity (both frequency and magnitude) and the location of critical infrastructure is a simple way of providing information on the potential exposure of these assets to earthquake risk and impact from infrastructure loss and damage. Figure 29 highlights the exposure of mining infrastructure, manufacturing and wastewater treatment facilities to earthquake activity that occurred in 2014-2017.

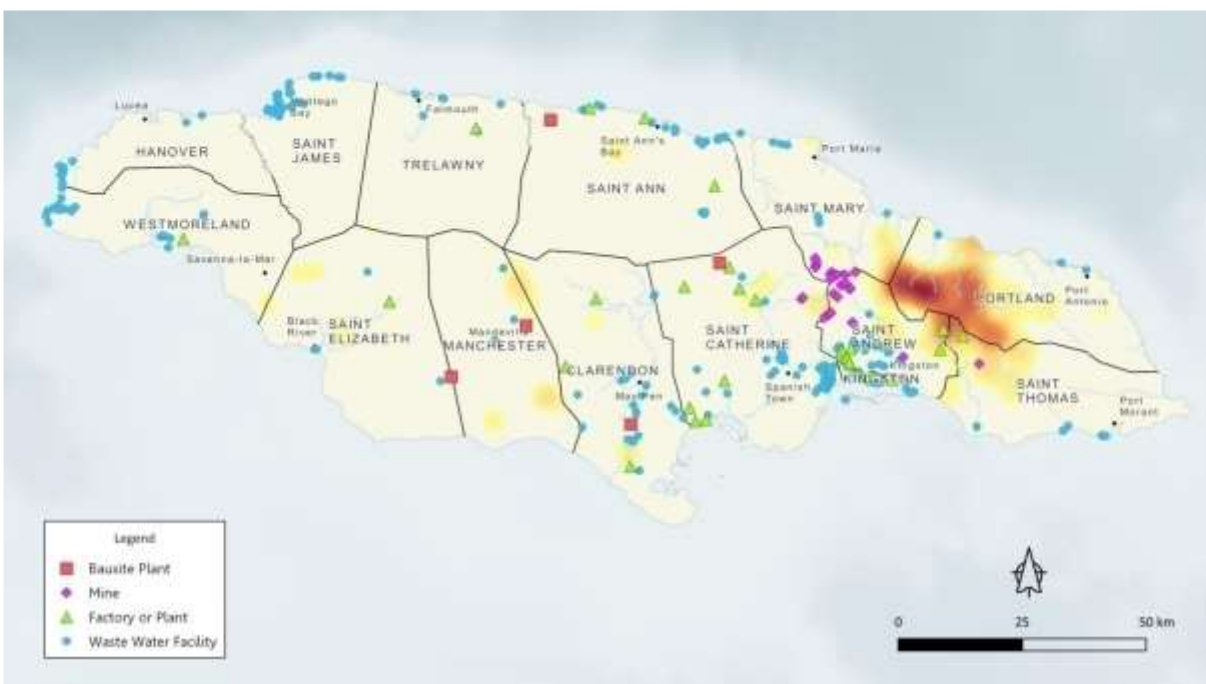

Figure 29 Map of Jamaica showing the spatial distribution of frequency and magnitude of earthquake activity between 2014 and 2017. (Source: Earthquake Unit, UWI)

Droughts: Lower than average rainfall across the island during the period under review resulted in 128 instances of localized extreme, severe and normal drought conditions.Table 24 provides an account of the number of extreme, severe and normal drought events for 2013 and for the 2014-2017 reporting period.

Table 24 Number of drought events (extreme, severe and normal) per parish in 2013, 2014, 2015, 2016 and 2017, as measured by calculations of bi-monthly drought indices that take into account departures from 30-year means (1971-2000; Source: Meteorological Service of Jamaica)

Parish	2013	2014	2015	2016	2017	2014-2017 total	2014-2017 average
Hanover (H)	1	1	2	2	1	6	2
Westmoreland (W)	0	1	0	2	0	3	1
Manchester (M)	1	3	3	2	1	9	2
St. Elizabeth (St. E)	9	1	2	2	0	5	1
Clarendon (C)	4	9	9	3	2	23	6
St. Catherine (St. C)	3	1	4	0	0	5	1
Trelawny (T)	2	2	2	1	0	5	1
St. James (St. J)	2	1	4	2	0	7	2
St. Ann (St. A)	4	3	2	0	0	5	1
St. Mary (St. M)	2	6	7	3	3	19	5
Portland (P)	2	4	6	0	0	10	3
St. Thomas (St. T)	3	6	9	4	2	21	5
Kingston & St. Andrew (KSA)	4	2	6	2	0	10	3
Jamaica	**37**	**40**	**56**	**23**	**9**	**128**	**32**

Much like in 2011 to 2013, localized drought events occurred with the highest level of frequency in the southern and eastern parts of the country (Clarendon, St. Mary and St. Thomas, specifically). Western parishes, (Hanover, Westmoreland, St. James and Trelawny) were least exposed to drought conditions. Although the Meteorological Office did not declare national drought status during the current SOE reporting period, both the EM-DAT and PIOJ's Economic and Social Survey Jamaica drew attention to drought conditions in 2014 and 2015.

Storms and floods: Several weather systems, including surface to upper-level troughs, cold fronts and the passage of one Atlantic hurricane, resulted in heavy and / or prolonged rains and 18 reports of flooding across the island during this reporting period. Figure 30 summarizes the number of floods by parish and by year.

Floods were reported with least frequency in Hanover and Westmoreland. In contrast, floods were reported with greatest frequency in Portland and St. Mary. Four types of floods are common in Jamaica:

- Flash floods occur when excess rainfall combines with inadequate or blocked drainage;
- Riverine or overland floods occur when a river breaches its banks and overflows into the surrounding areas;
- Tidal floods occur when heavy rains and high tides combine, or through seismic action on the sea bed;
- Ponding is simply the build-up of rainwater in depressions on the land surface.

During this reporting period, flash flooding and riverine flooding were most common.

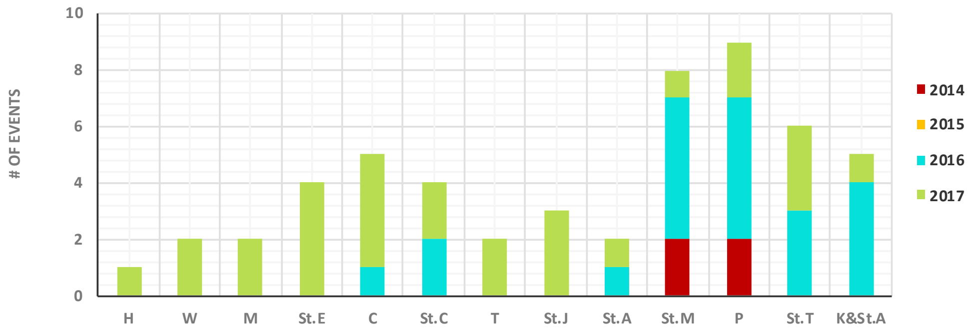

Figure 30 Number of reported flood events in Jamaica between 2014 and 2017 by parish (Source: Meteorological Service of Jamaica, ODPEM and PIOJ)

Five major hydro-meteorological hazards occurred during this reporting period, including the passage of one **major** hurricane (see Table 25). Hurricane Matthew, rated at category 5, affected the island between October 2 and 5, 2016. It did not make landfall in Jamaica, but the outer cloud bands caused heavy rain and flooding in 26 communities across eastern parishes, resulting in the activation of the National Emergency Operations Centre by ODPEM. Jamaica was also affected by one hurricane during the previous reporting period (2010-2013).

Flood activity in 2017 was noteworthy. Significant rainfall occurred between April and June of that year, but the disastrous event of that season took place between May 13 and 18 (Table 25). A trough produced moderate to heavy rainfall across the island, resulting in major flooding and landslides in 13 parishes. Some areas received up to a month's volume of rainfall over the five day period. [72] Overall, 66 communities were affected and approximately 300 families from Clarendon, St. Ann and St. Catherine were marooned.

Table 25 Major hydro-meteorological hazard events reported in Jamaica between 2014 and 2017 (Sources: Meteorological Service of Jamaica, Office of Disaster Preparedness and Emergency Management)

Year	Date	Event	Parishes affected
2014	6.3.2	No major events	6.3.3
2015	6.3.4	No major events	6.3.5
2016	October 2-5	Hurricane Matthew	KSA, St. Catherine, Clarendon
	October 25-27	October floods	St. Mary, Portland and St. Thomas
	December 11	Runaway Bay floods	St. Mary, Portland and St. Ann,
2017	April 16	Prolonged precipitation	St. Elizabeth
	April 20		St. Elizabeth
	April 21-22		Clarendon, St. Thomas, St. Elizabeth, Westmoreland
	May 13-18		Clarendon, St. Thomas, St. Ann, St. Mary, Portland, KSA, St. Catherine, Manchester, St. Elizabeth, Trelawny, Westmoreland, Hanover, St. James
	June 16-17		St. Elizabeth, Manchester, Clarendon, St. Catherine
	November 19-24	Montego Bay floods	Portland, St. James

[72] PIOJ 2017a.

A trough over the Central Caribbean caused heavy rainfall in November, with the highest incidence of rainfall and related flooding registered on November 22. Approximately 80 % of the 30-year mean rainfall (1971–2000) for the month of November fell within 4.5 hours. Several communities in St. James were affected, with Montego Bay being the hardest hit.[73]

Landslides: Landslides (mudslides and rock slides) are common in Jamaica and frequently co-occur with other hazards. They tend to happen in steep, hilly areas where loads (e.g., engineered structures) are added to the rock mass or when soils and/or rocks become saturated by rainfall, causing land movement. Seismic activity can also trigger these hazards, including in underwater environments. Slope, bedrock and soil characteristics, land cover, proximity to roads, streams and faults are all factors that shape susceptibility to landslides. Taking these factors into account, the Pacific Disaster Centre has published a map depicting varying levels of susceptibility to landslides across Jamaica's territory (Figure 31). According to information in this map, landslide susceptibility is highest in the eastern part of the island, specifically in the parishes of Kingston,St. Andrew, Portland and St. Thomas.

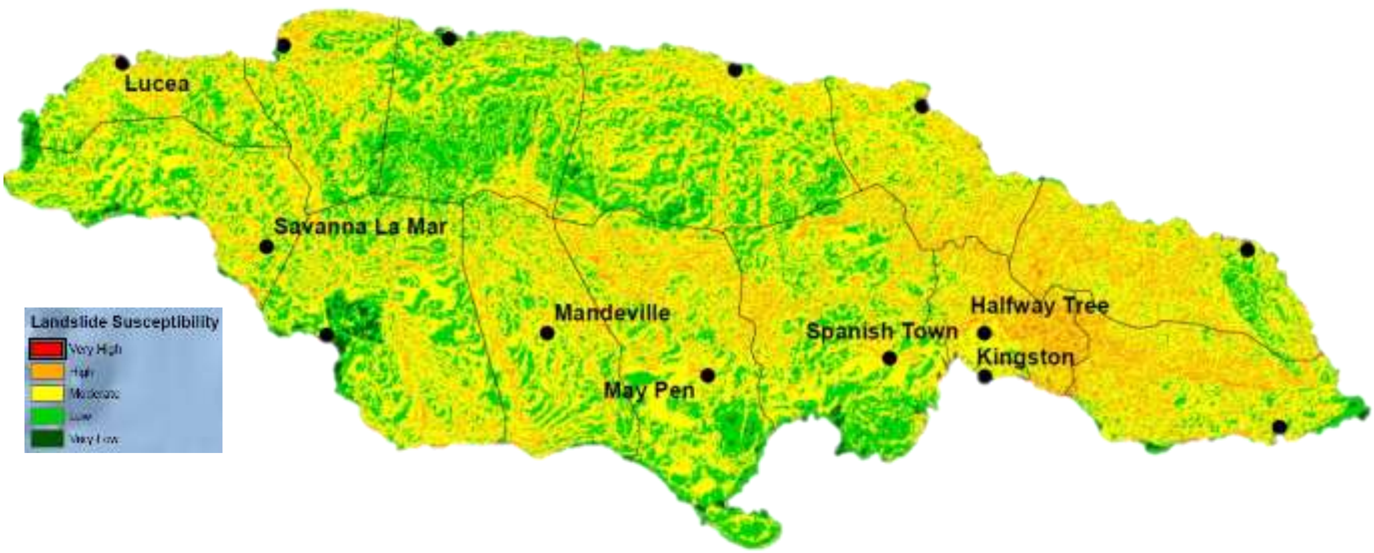

Figure 31 Landslide susceptibility of Jamaica (Reproduced from Pacific Disaster Centre 2016)

Figure 32 shows the breakdown (by parish and year) of landslides that were reported. Landslides occurred with greatest frequency in the eastern part of the island, particularly in Portland, St. Mary and St. Thomas (Figure 35); Landslides in these areas are generally associated with heavy rains and susceptible geological conditions. Most of the reported landslides affecting other parishes were reported in 2017.

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[73] (OPDEM, personal communication)

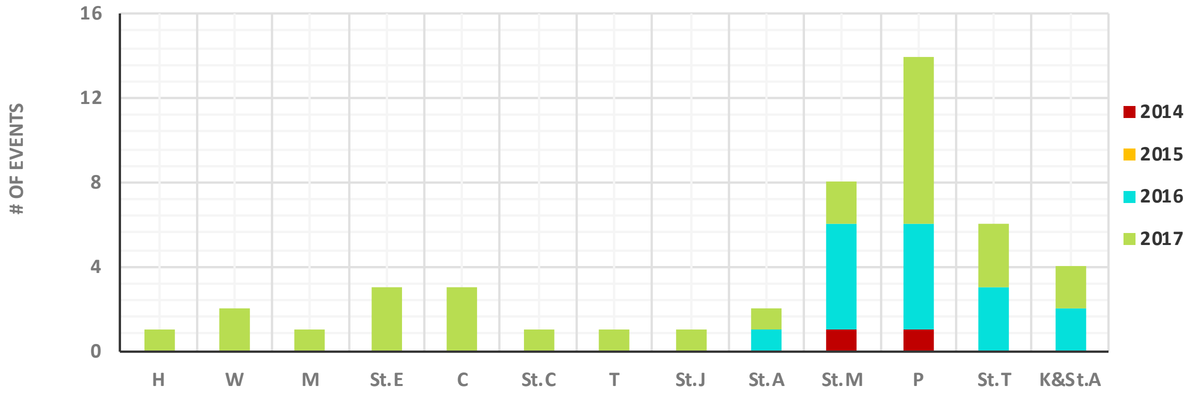

Figure 32 Number of reported landslides in Jamaica between 2014 and 2017 by parish (Source: Meteorological Service of Jamaica, ODPEM and PIOJ)

Figure 33 Landslide In Portland (Source: NEPA)

Fires: The number of genuine fire calls received and acted upon by the Jamaica Fire Brigade is a proxy for the number of fires in Jamaica.Table 26 lists the yearly number of genuine fire calls per parish and nationally, for 2013 and for the current reporting period. It includes human-induced fires and wildfires. Nationally, the number of genuine fire calls amounted to 11,359 in 2017, which was 4% fewer than in 2014. Trends in numbers of fires appear to vary across parishes.

The number of fires shows an increase in the parishes of Hanover, Westmoreland and St. Elizabeth. Relatedly, annual rainfall amounts in these parishes were below the 30-year average. For other parishes, the number of fires in this reporting period either hovered around comparable values or decreased. Another metric useful in comparing across parishes, which vary in their population density, is to calculate the number of fires per 100,000 inhabitants. Based on this metric, Kingston and St. Andrew and St. Catherine ranked first and second, respectively.

Table 26 Number of genuine fire calls, by parish, from 2013 - 2017. Genuine fire calls are a proxy for number of fires, wildfires and human-induced fires. (Source: Jamaica Fire Brigade and Statistical Institute of Jamaica)

Parish	2013	2014	2015	2016	2017	% change (2014-2017)	# fires / 100,000 inhabitants (2017)
Hanover (H)	262	187	264	306	517	176%	0.005
Westmoreland (W)	543	393	512	690	582	48%	0.006
Manchester (M)	876	947	1,055	816	995	5%	0.010
St. Elizabeth (St. E)	656	722	648	725	809	12%	0.008
Clarendon (C)	1,094	1,012	507	590	833	-18%	0.008
St. Catherine (St. C)	2,697	2,065	2,147	1,721	1,945	-6%	0.019
Trelawny (T)	311	342	359	378	293	-14%	0.003
St. James (St. J)	992	857	1,039	1,132	1,175	37%	0.012
St. Ann (St. A)	704	1,199	1,045	835	726	-39%	0.007
St. Mary (St. M)	336	507	522	305	254	-50%	0.003
Portland (P)	241	356	340	206	191	-46%	0.002
St. Thomas (St. T)	646	599	728	428	420	-30%	0.004
Kingston & St. Andrew (KSA)	2,476	2,662	2,545	2,825	2,619	-2%	0.026
Jamaica	**11,834**	**11,848**	**11,711**	**10,957**	**11,359**	**-4%**	**0.009**

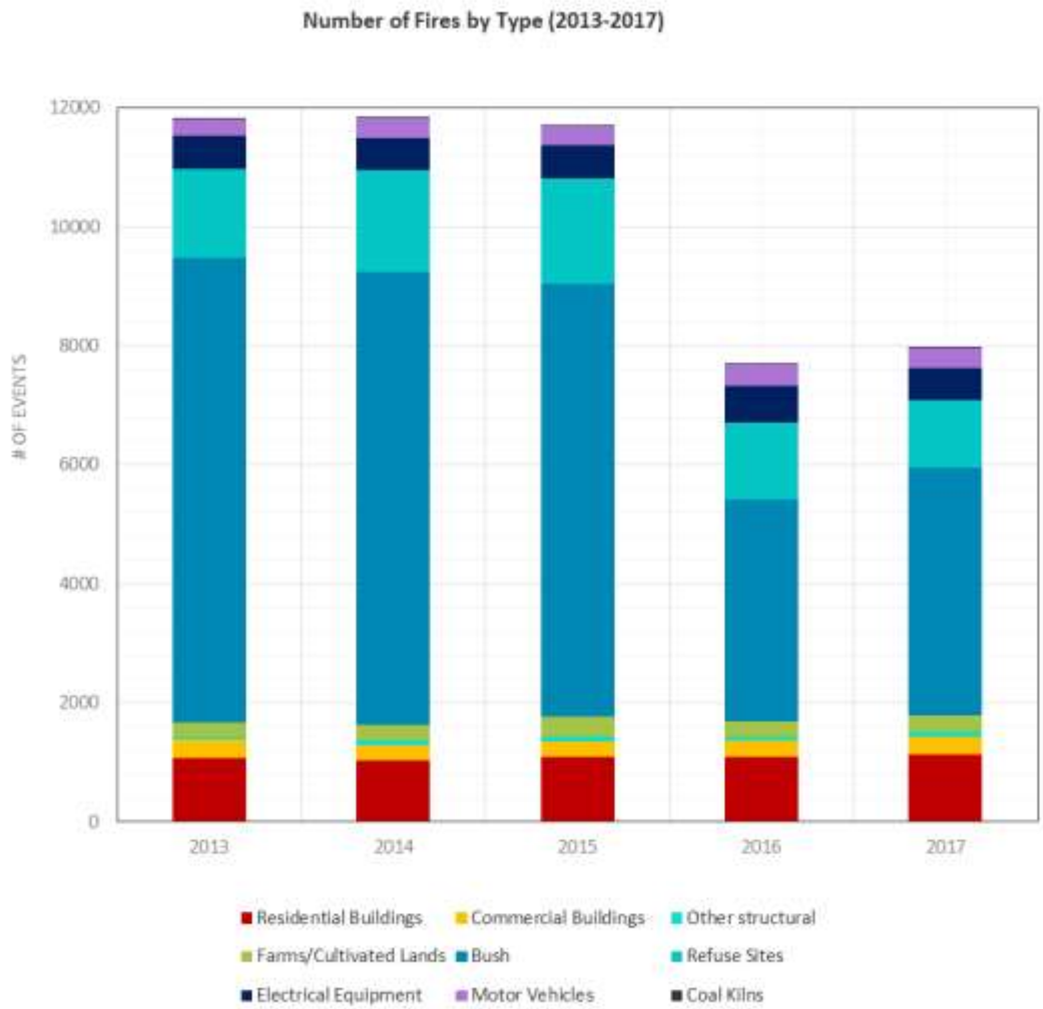

Figure 34Number of fires in Jamaica in 2013 and during the 2014 to 2017 reporting period, by type (Source: PIOJ 2018a)[74]

Forest fires or bush fires were the most common type in 2013 and during the reporting period (Figure 34). On average, forest fires comprised approximately half of all fires. The number of fires in forests and refuse sites decreased by 45% and 33% respectively between 2014 and 2017. The decrease in forest fires corresponds to the increase in annual rainfall volumes[75]. Fires in residential and commercial buildings and with motor vehicles increased between 2014 and 2017.

Two fire-related disasters occurred during this reporting period, both in the drought stricken year of 2015. The first was at the major municipal dump located at Riverton City in the Kingston Metropolitan Area, which burned over a two-week period in March 2015 (Figure 35). Arsonists initiated the blaze, which began as a surface fire and spread into three areas. Fanned by south-easterly winds, smog affected significant portions of the populations of Kingston, St. Andrew and St. Catherine, exceeding air quality standards for particulate matter and sulphur dioxide[76].

[74]Note: there is a discrepancy in the total number of fires in 2016 and 2017 that needs to be reconciled. Totals by fire type and by genuine fire call do not match up for 2016 and 2017

[75] PIOJ 2018a

[76] PIOJ 2016a

May 2015 saw a widespread bush fire in the hills of St. Andrew, which started on May 2 and continued burning for a week, with flames sustained by drought conditions on the island. Poor agricultural practices (slash and burn) and illegal burning of domestic waste were cited as causes.

Figure 35 Riverton City Dump Fire, March 2015 (Source: NEPA)

Environmental incidents: Some fires are human-caused hazards, but the category of "environmental incidents" is most reflective of human-caused or technological hazards. Table displays the number of environmental incidents in 2013 and in the 2014-2017 SOE reporting period, by type of incident. Overall, this reporting period saw a decline in the occurrence of environmental incidents. This is in contrast to the past reporting period, which reported an upward trend of hazard occurrences between 2010 and 2013. Air pollution continued to be the main environmental incident, as measured in number of events. Fires were the main contributors to air pollution and were primarily linked to arson, illegal burning of domestic waste and poor agricultural practices. Improper sewage discharge was another important factor, as measured in number of events. These incidents increased four-fold during this reporting period. As was the case in the previous reporting period, incidents related to underperforming sewage treatment plants, many under the management of the National Water Commission.

Table 27Number of human-caused hazards (technological hazards) in Jamaica in 2013 and during the 2014 and 2017 (Source: NEPA and Statistical Institute of Jamaica).

Type of incident	2013	2014	2015	2016	2017	% change (2014-2017)
Air Pollution	36	37	30	21	21	-43%
Fish Kill	5	7	5	5	6	-14%
Oil Spills	16	13	17	18	13	0%
Sewage Discharge	8	2	9	8	10	400%
Sewage Odour	8	7	5	2	2	-71%
Other Spills	9	10	16	2	1	-90%
Unspecified	0	4	0	0	1	-75%
Water Pollution	0	1	0	0	1	0%
Trade Effluent Discharge	0	0	3	3	1	n/a
Improper waste disposal	0	0	2	1	1	n/a
Total	**82**	**81**	**87**	**60**	**57**	-30%

Jamaicans are unevenly exposed to human-caused hazards. Figure 36 shows the annual number of environmental incidents for 2015-2017, by parish. Note that the number of incidents does not add up to those listed inTable 27, because of inconsistencies in data presentation. For example, the NEPA data set with the "number of environmental incidents within Jamaican waters" does not include air pollution events. In any case, it is evident that environmental incidents occurred in greatest numbers in areas of high population density (Kingston and St. Andrew) and in some southern parishes, where large industries such as bauxite and sugar are present. Clarendon and St. Catherine saw a year-over-year drop in the number of environmental incidents reported. Manchester and Portland were the only two parishes with no reported environmental incidents between 2015 and 2017.

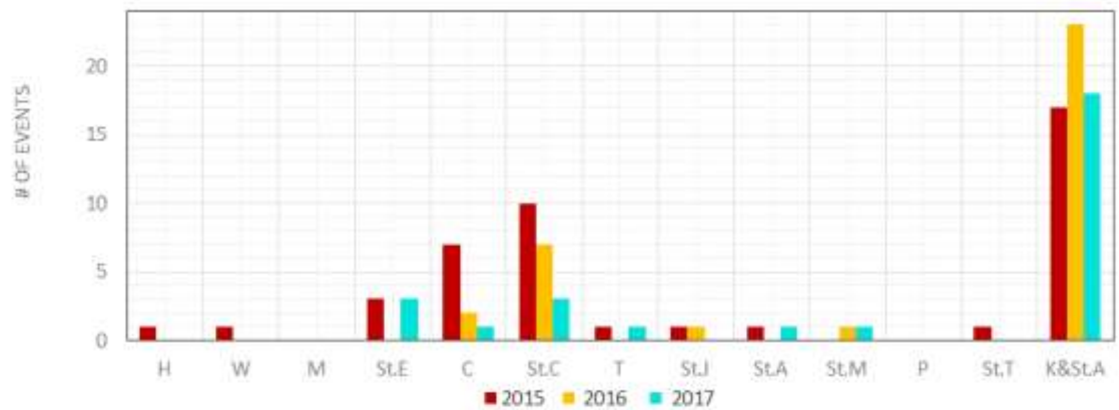

Figure 36 Number of environmental incidents for 2015-2017, by parish (Source: authors' coding of NEPA environmental incident database)

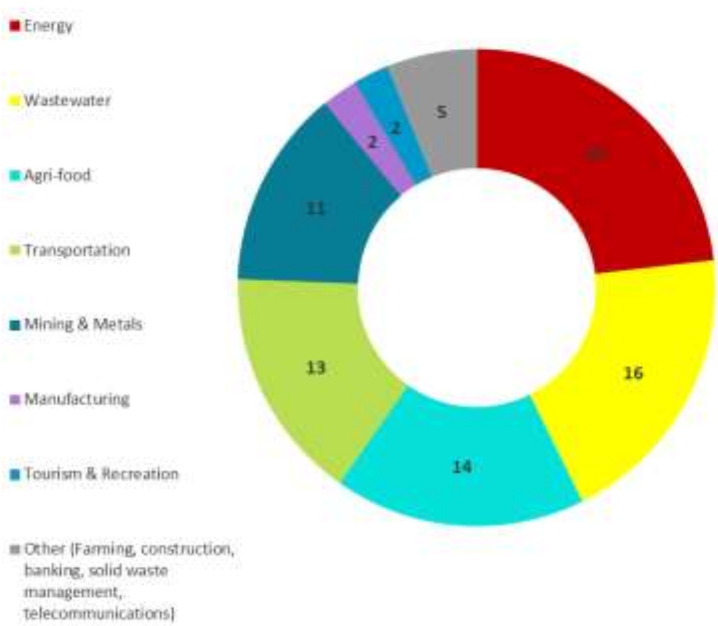

Figure 37 Number of environmental incidents over three years (2015-2017), by industry / sector responsible. It excludes the 23 reported incidents that were caused by unspecified or unknown industries / sectors (Source: authors' coding of NEPA environmental incident database)

During this reporting period the principal offenders of environmental incidents were from the energy, wastewater, agri-food, transportation and mining and metals sectors. Figure 37 shows the sectoral breakdown of environmental incidents in Jamaica over three years (2015-2017). The energy sector (petroleum refinery, fuel retailing and electricity generation) was responsible for just over a third of oil spills. The wastewater sector was overwhelmingly responsible for incidents of sewage discharge. Spills (e.g., molasses) and trade effluent discharge are the types of environmental incidents most reported for the agri-food sector (sugar refinery, distillery). The transportation sector, which includes marine transport, was responsible for about a fifth of oil spills. The mining and metals sector also caused oil spills and trade effluent discharges. Three entities were responsible for these environmental incidents.

6.3.6 Deaths and Affected Persons by Disaster

SDG Target 11.5. indicates that, by 2030, there should be a significant reduction in the number of deaths and number of people affected, as well as a reduction in the direct economic losses relative to the GDP caused by disasters per 100,000 inhabitants. The target also specifically mentions that there should be a focus on protecting the poor and people in vulnerable situations.

The number of people killed and directly affected by disasters is a standard measure to identify and describe trends in a human population's sensitivity to disasters. The global disaster database EM-DAT tracks the number of people killed or otherwise affected by disasters linked to natural and technological hazards. This number increased in the late 1980s, and has since stayed within a range marked by periodic spikes in affected people due to droughts. Globally, floods are the types of disasters from natural hazards most demanding of emergency response, in terms of the number of people affected yearly.

Droughts in the early 1980s caused deaths in the hundreds of thousands. Since 2000 earthquakes have caused more deaths than other natural hazards. Far fewer people are affected or killed as a result of technological disasters than from disasters linked to natural hazards. For example, in 2014 approximately 140 million people were affected by drought, floods, storms and earthquakes worldwide, and of this number about 20,000 died. In that same year 300, 000 people were affected by industrial and other human-induced incidents, and 4,000 people died from transport accidents. Overall, when it comes to technological disasters, industrial incidents affect more people and transport accidents result in most deaths.

The Sendai Framework for Disaster Risk Reduction 2015-2030 [77] includes "*number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population*" as a template for countries to report. The SDG indicator framework incorporates this metric as well (indicator 11.5.1) as a way to monitor progress toward the United Nations 2030 goal to *"significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations (UN Stats N.D.)."*

Estimates of the number of deaths and people affected by disasters per 100,000 inhabitants in Jamaica originate from multiple sources. Despite a recommendation to this effect in the 2013 SOE report, Jamaica lacks a centralized publicly-accessible digital database on indicators relating to hazards and disasters. The completeness and consistency of statistics available from Jamaican agencies are variable, with records from the Jamaican Fire Brigade a possible exception. Post-disaster loss and damage assessments, a valuable source of disaster impact data, are carried out for only some major events. The quality of information for Jamaica in the EM-DAT database is difficult to assess, although we have found inconsistencies in reports of the number of affected persons, with EM-DAT figures up to two orders of magnitude greater than figures available from Jamaican sources. The source of discrepancies is unclear; one possibility is differences in the application of classification criteria. The following paragraphs present indicator results, based on the best available information.

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Between 2014 and 2017 about 100,000 Jamaicans were affected by major natural and technological hazard events, with reports of one fatality from prolonged rains in May 2017 (Table 28). Affected people refer to those requiring immediate attention to fulfil basic needs, including shelter, food, water, sanitation and medical attention.

Table 28 Major natural and technological hazard events reported in Jamaica between 2014 and 2017 and their human impact (Sources: Meteorological Service Jamaica, Office of Disaster Preparedness and Emergency Management. Planning Institute of Jamaica and EM-DAT). Blank cells indicate no reports of deaths or people affected.

Year	Event	Deaths	People affected	Source	Comment
2014	Manchester and St. Elizabeth drought		91,545	EM-DAT	Impact on agriculture. Number of people affected potentially overstated.
2015	East Rural St. Andrew bush fire			ODPEM	Residences and business were destroyed. Disaggregated impact information unavailable.
	Drought in southern parishes			PIOJ	Impact on agriculture and aquaculture. Disaggregated impact information unavailable.
	Riverton City Dump fire		3,314	PIOJ	50% of the population living within the parishes of Kingston, St. Andrew and St. Catherine were in the sphere of influence. Children and persons with pre-existing conditions, such as asthma, comprised the greater proportion of those seeking help.
2016	Hurricane Matthew		3,600	PIOJ	EM-DAT reports 125,000 people affected. 26 communities in eastern parishes exposed to floods and landslides.
	October floods			PIOJ	Pencar and May Rivers broke their banks; White, Yallahs and Negro Rivers overflowed.
	Runaway Bay floods			ODPEM	Event reported but no impact information available.
2017	Prolonged precipitation	1	2,408	PIOJ & ODPEM	EM-DAT reports 5,000 people affected; 66 communities reported flooding and 40 communities reported landslides.
	Montego Bay floods		392	PIOJ	27 communities in the vicinity of Montego Bay's town centre affected by flooding.

During the period under review, the number of people affected per 100,000 inhabitants was greatest in 2014 and lowest in 2017 (Table 29). Except for 2014, these values are relatively low and indicate low exposure to high-magnitude / duration of major hazard events and capacity to cope with the events that did occur. In terms of fatalities, Jamaica's average over a 20-year period (1998-2017) is 0.161 deaths / 100,000 inhabitants, due to severe weather and climate events alone (i.e., geological hazards and technological hazards excluded) (Eckstein et al. 2018).

Table 29 Number of directly affected persons attributed to disasters per 100,000 inhabitants in Jamaica between 2014 and 2017 (Sources: Meteorological Service Jamaica, Office of Disaster Preparedness and Emergency Management. Planning Institute of Jamaica and EM-DAT). Blank cells indicate no reports of deaths or people affected

Hazard	People affected / 100,000 inhabitants			
	2014	2015	2016	2017
Drought	3,361	-	-	-
Fire	-	121.5	-	-
Storm	-	-	131.9	88.2
Flood	-	-	-	14.4
Total	**3,361**	**121.5**	**131.9**	**102.6**

The Jamaica Fire Brigade records and maintains information on the human cost of fires in consistent formats. Table 30 presents this information in both absolute and relative numbers. Overall, both the number of deaths and people affected by fires showed an increase during the 2014-2017 reporting period. In 2017, fires caused the death of 25 Jamaicans and injured and rendered homeless 2,465 people across the island. Children comprised about a third of people made homeless by fires; child fatalities, as a proportion of the total, decreased over the reporting period.

Table 30 Number of fatalities and directly affected persons attributed to fires in Jamaica in 2013 and between 2014 and 2017. Values in parentheses are the number of incidents per 100,000 inhabitants (Source: Jamaica Fire Brigade, PIOJ)

Metric	2013	2014	2015	2016	2017	% change (2014-2017)
	Number of Incidents (*rate per 100,000*)					
Deaths from fires	19 (*0.0002*)	21 (*0.0002*)	22 (*0.0002*)	38 (*0.0004*)	25 (*0.0003*)	19%
People affected by fires (hurt, rendered homeless)	1,900 (*0.0190*)	2,144 (*0.0214*)	2,223 (*0.0222*)	2,194 (*0.0219*)	2,465 (*0.0247*)	15%

6.3.7 Direct Disaster Economic Loss in Relation to Gross Domestic Product (GDP)

Economic damage and loss due to disasters is a standard measure used to identify and describe trends in a national or regional economy's sensitivity to disasters. Economic damage and loss statistics also inform policy decisions on the type and extent of coverage through disaster risk financing. The global disaster database EM-DAT keeps records of total economic damage attributable to disasters from natural and technological hazards. Globally, total economic damage from disasters of both origins (natural and technological hazard) is on the rise. Annual economic damage linked to natural hazards has exceeded US$100 trillion 12 times in the past two decades, and only once in the prior two decades.[78] Economic damage from storms is increasingly significant. Global economic damage from technological disasters is an order of magnitude lower than from natural hazards. Costly events are also infrequent and exclusively due to industrial incidents.

The Sendai Framework for Disaster Risk Reduction 2015-2030 [79] includes "*direct economic loss due to hazardous events in relation to global gross domestic product*" as a metric to track progress toward the

[78] This is true even when annual figures are scaled to US$ 2016 values.

[79] The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines clear targets and four priorities for action to prevent new and reduce existing disaster risks: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation

global reduction in economic losses from disasters. The SDG indicator framework incorporates this metric as well, (indicator 11.5.2) as a way to monitor progress toward the 2030 goal to *"significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations (UN Stats N.D.)."* Indicator guidance pertaining to the Sendai Framework gives countries the option of accounting for "direct economic loss due to environment degraded by hazardous events".[80]

Jamaica's approach to disaster loss and damage assessments distinguishes three sectors: productive, social and the environment, and encourages treating the environment as a natural asset, since disasters can affect the flow of environmental goods and services[81]. The SDG indicator references damage to critical infrastructure and disruptions to basic services, so natural assets and services flowing from them can be part of the indicator estimation.

Estimates of direct disaster-connected economic loss in relation to GDP are shown in Table 31 and Figure 38. Loss and damage information draws from the Office of Disaster Preparedness and Emergency Management and the Planning Institute of Jamaica (more information on loss is presented in Box 6). Gross domestic product data comes from the Statistical Institute of Jamaica (GDP by expenditure at current prices). During the 2014-2017 reporting period, direct economic loss and damage from major events amounted to ~$J5 billion or 0.07% of GDP. This amount is significantly lower than the direct loss and damage incurred in the previous reporting period, which totalled J $30 billion. The prolonged rains of 2017 were the costliest event. Economic costs include infrastructure damage and losses to the social and productive (agriculture, forestry and fisheries) sectors. Environmental damage, when discussed, receives qualitative treatment such that direct loss and damage estimates do not account for changes in stocks and flows of environmental goods and services. Figure 38 shows that the economic loss and damage from disasters during this reporting period remained well below the 2020 target line established in 2007 in the aftermath of the second costliest disaster since the 21st century.

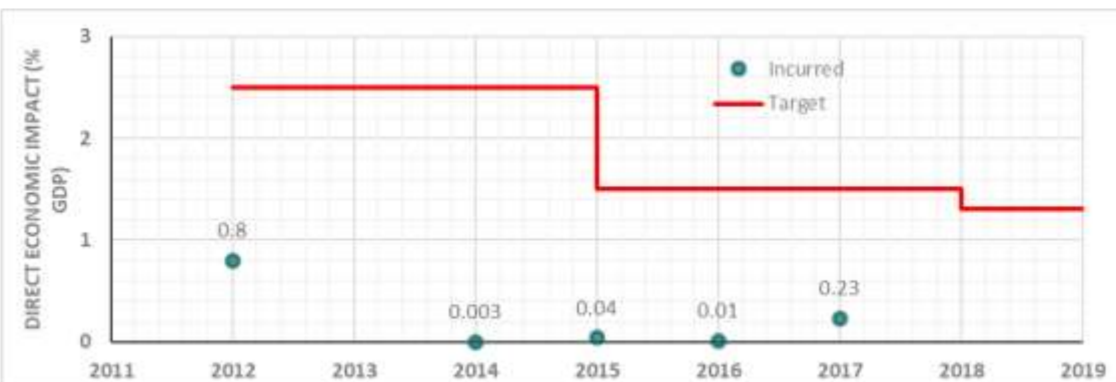


Figure 38 Economic impact of disasters in Jamaica, relative to annual GDP, and compared to the 2030 target (Sources: ODPEM, the Planning Institute of Jamaica and the Statistical Institute of Jamaica)

and reconstruction. The Sendai Framework for Disaster Risk Reduction 2015-2030 outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks: (i) Understanding disaster risk; (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to https://www.unisdr.org/we/inform/publications/4329

[80] https://www.unisdr.org/files/47136_workingtextonindicators.pdf Retrieved September 18 2018

[81] PIOJ 2012

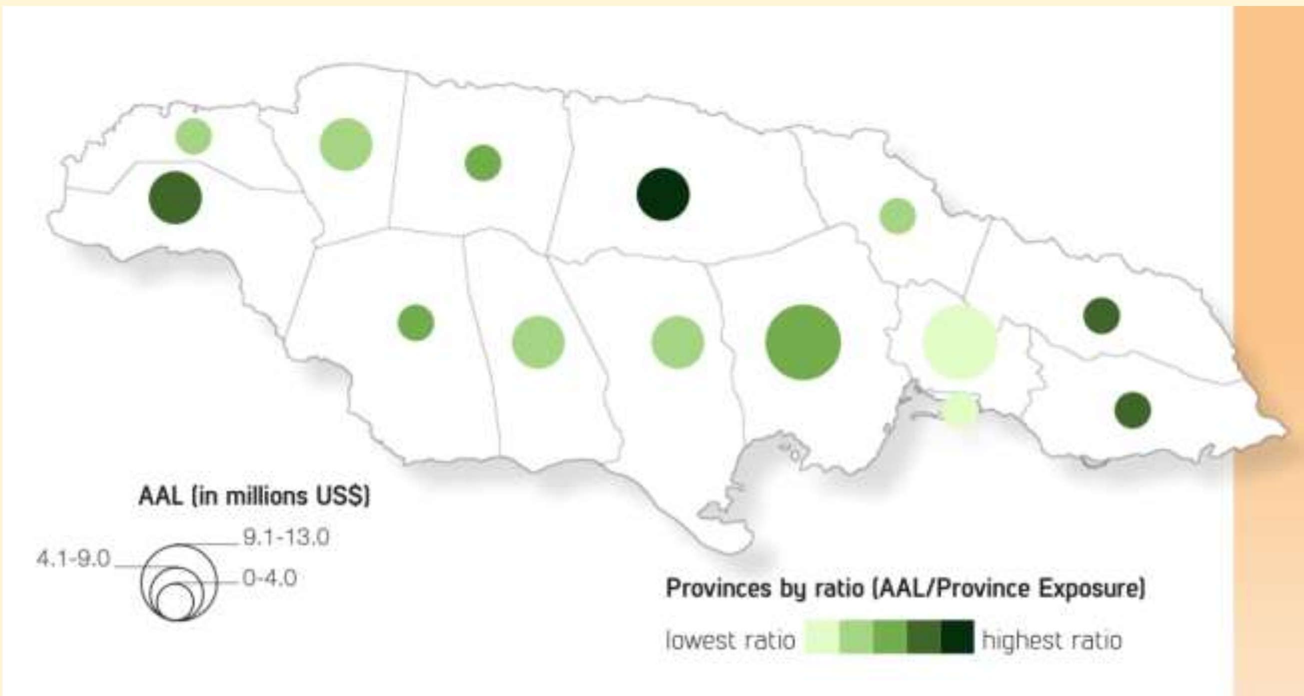
Table 31 Reported direct economic loss and damage linked to major natural and technological hazard events in Jamaica between 2014 and 2017, in absolute figures and relative to annual GDP (Sources: ODPEM, the Planning Institute of Jamaica and the Statistical Institute of Jamaica)

Year	Event	Est. Direct Loss &Damage ($JM)	Impact (% of GDP)	Source	Comments
2014	National drought	45	0.003%	PIOJ	715 ha of crop and pasture land lost. Manchester and St. Elizabeth were the worst affected.
2015	East Rural St. Andrew bush fire	203	0.04%	ODPEM	
	Drought in southern parishes	-		PIOJ	0.2% reduction in agricultural production.
	Riverton City Dump fire	413		PIOJ	Includes losses (port, business), damage and emergency expenditures. Environmental damage not quantified or monetized, although air pollution affected human health.
2016	Hurricane Matthew	145	0.01%	PIOJ	Includes one day of lost production and damage to infrastructure.
	October floods	-		PIOJ	
	Runaway Bay floods	-		PIOJ	
2017	Prolonged precipitation	3,963	0.23%	PIOJ	Includes loss and damage to infrastructure, productive and social sectors. Environmental damage in Clarendon, St. Catherine, St. Thomas and St. Mary included: increased debris and silt deposited in the mouth of major waterway, crocodile habitat disrupted, increased erosion and landslides in hilly areas.
	Montego Bay floods	492		ODPEM	
Total	**All events**	**4,877**	**0.07%**		

Average Annual Loss (AAL) is a common risk metric used in disaster risk studies. It represents the expected economic loss per year to property, caused by hazard events, averaged over many years. Using AAL can be beneficial because it:

- Provides a uniform measure;
- Is comparable across hazard and infrastructure / asset types;
- Relates directly to financial implications of financial exposure;
- Suits data-poor contexts; and
- Involves a calculation that is conceptually simple (i.e., summing expected damage to infrastructure measured in $ across hazard scenarios).

A World Bank study (2017) used AAL to compare economic risk from hurricanes and earthquakes in Jamaica. Their estimates indicate that hurricane risk is more significant than earthquake risk, with AAL from hurricanes pegged at US$67.3 million (0.5% of gross domestic product, GDP) and at US$36 million (0.3% GDP) from earthquakes. Focused on hurricane risk, the study estimated the difference in AAL by parish, both in absolute and relative terms and found that the economic risk was greatest in St. Catherine (in absolute numbers) and St. Ann (highest ratio of AAL to exposure).



The map (reproduced from The World Bank 2017)shows estimated hurricane risk by parish, as measured in Average Annual Loss (AAL) in US$ million. Absolute risk is depicted by the size of circles, where the larger the circle the higher the AAL the parish could incur over the long term. Relative risk is depicted by the shade of green of the circles, where the darker the shade the higher the ratio of AAL/parish exposure

Box 6 What is Average Annual Loss?

6.4 Conclusions

Vulnerability to hazards and selection of appropriate solutions to reduce vulnerability is the result of a complex interplay between the environment and societal choices, behaviours and capacities. By virtue of Jamaica's geography, geology and location, the country is prone to several hazards, including floods, earthquakes, landslides and droughts. Exposure and vulnerability to these hazards may heighten in the future, as global climate change is causing shifts in the frequency, intensity or duration of some events. Unplanned and disorderly development and resulting land and environmental degradation, settlements in hazard-prone areas the increase of impermeable surfaces and inadequate drainage and solid waste disposal in cities are important social challenges that continue to shape Jamaica's vulnerability.

Several hazardous events of relatively low intensity occurred during this reporting period. The human and economic costs associated with hazards and disasters were lower, compared to SOE reporting period 2010-2013.

- A total of 309 local earthquakes occurred, 5% of which were felt by people in Jamaica, registering a magnitude on the Richter scale between 3 and 3.7.
- Lower than average rainfall across the island resulted in 128 total instances of localized extreme, severe and normal drought conditions. No national drought was declared.
- 18 reported instances of flooding occurred across the island. Five major hydro-meteorological hazards were registered, including the passage of a hurricane.
- Several weather systems and related rainfall contributed to the occurrence of landslides in 17 instances across the island. This number may be an underestimate.
- The number of genuine fire calls amounted to 11,359 in 2017, which was 4% fewer than in 2014. Two fire-related disasters occurred, both in the dry year of 2015.
- The number of environmental incidents (also called technological hazards or human-induced hazards) declined over this reporting period. Air pollution continued to be the main environmental incident, as measured in number of events. The energy, wastewater, agri-food, transportation and mining and metals sectors were the principal offenders of environmental incidents.
- About 100,000 Jamaicans were affected by major natural and technological hazard events, with reports of one fatality from the prolonged rains in May 2017. The number of people affected per 100,000 inhabitants was greatest in 2014 and lowest in 2017 (Table 29).
- Direct economic loss and damage from major events amounted to ~$J 5 billion or 0.07% of GDP. This amount is significantly lower than the direct disaster loss and damage incurred in the previous reporting period, which totalled J$30 billion.

The Government of Jamaica recognizes the importance of reducing climate-related and other disaster risks under Goal 4 of Vision 2030 Jamaica and is strengthening institutional frameworks and operational capacities to deliver gains in disaster risk reduction.

PRESSURES

As outlined in Table 2, environmental pressures are how drivers of environmental change directly influence the changes that are seen in the VECs and associated ecosystem services. Pressures are human activities that arise as we fulfil and exceed the basic needs represented by the drivers. Pressures result in exploitation and consumption of natural resources (including land use) and the generation of waste streams and, because pressures occur at smaller spatio-temporal scales than drivers, they have potential for effective management in the medium to short term by national and sub-national team members.

The main environmental pressures that have been selected for Jamaica's 2017 SOE report are:

- Human Settlements
- Fuel Energy and Fuel Supply
- Raw Materials Extraction (Primary Industries II)
- Manufacturing (Secondary Industries)
- Transportation
- Tourism, Recreation and Sports

For each of these, the SOE Report:

1. Outlines the linkages between the pressure and VECs, identifying environmentally deleterious activities, associated land use change and natural resource consumption, as well as waste streams associated with the sector;
2. Assesses the indicator trends and patterns occurring since 2013; the assessment grade will speak to impact potential, and will be done using the Table 4 template (Grading System);
3. Outlines national planning frameworks that facilitate and control the development of these sectors, and the current state of sectoral planning;
4. Presents main conclusions within the context of the SDG goals and recommendations (in terms of opportunities/outlooks).

7. Human Settlements

Scorecard 7: Human Settlements (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
PROPORTION OF URBAN POPULATION LIVING IN SLUMS	Estimated at 60.5%: mostly located in proximity to the coast.	VERY HIGH	2	2
HOUSING QUALITY	Housing quality index: Only 72.2% of the housing stock was considered adequate in 2015. – Declining availability of adequate housing.	MODERATE	2	3
HOUSING STOCK – COMPLETIONS PER MILLION PERSONS	**Housing completions (stock added): 75% decline since 2013 – declining availability of housing.**	HIGH	3	3
ACCESS TO POTABLE AFFORDABLE WATER	An estimated ~90% of urban population in 2015 have access compared to 64% access in rural areas (2015 estimate). Costs are relatively high.	HIGHER IN RURAL AREAS	3	2
ACCESS TO SANITATION SERVICES	66% of the population have exclusive access to flush toilets in 2015. No data on proportion of sewage that is treated.	VERY HIGH	3	3
ACCESS TO SOLID WASTE COLLECTION SERVICES	60% of household waste collected in 2016. Between 2014-2017 total amount of waste collected increased by 30%.	HIGH	2	3

7.2 Environmental Linkages

Although Jamaica's population growth is relatively stable, the re-distribution of population from rural to urban areas is creating problems that are not unique to Jamaica. Rural to urban migration occurs as the rural population seeks a higher quality of life, jobs that are not in primary industries (agriculture, forestry, hunting, mining and quarrying), better educational opportunities and a wider range of social services and amenities than are available in the rural areas. As the rural population migrates to urban centres the pressure on natural resources in rural areas declines, but increases in the locations of concentrated populations. Most of Jamaica's capital towns are located on the coast or in proximity to river systems.

While centralization and urbanization may allow resources to be used more efficiently, in developing countries it often leads to the spawning of unplanned settlements, with poor access to basic services (electricity, piped water, public transportation, sewerage, drainage, solid waste collection) and higher levels of pollution. Unplanned settlements or overcrowded inner city communities present a range of environmental challenges that are not easily addressed in the national development control framework.

As poverty and unemployment decline, and more people migrating to urban areas can afford to rent or purchase houses, the demand for residential developments is also on the rise. The KMA (like Montego Bay, St. Ann's Bay or Falmouth) is a classic example of a rapidly growing Caribbean city. It is Jamaica's capital, a coastal plain bound on one side by the sea and limited geographically by being ringed by marginal lands (upland areas or river floodplains) which are coming under increasing pressure for land development projects. Urban sprawl in the KMA is expected to continue to move towards the parish's inland boundary and along the major transportation routes into areas of St. Catherine, where dormitory suburbs are already being established. According to NEPA[82]the competition for land between urban and agricultural development is most intense in St. Catherine.

Unlike unplanned squatter settlements, the environmental and planning issues of Jamaica's larger urban centres will come under greater scrutiny, allowing room for provisions to be made for the mitigation of environmental impact. This will make it possible for the orderly development of roads, drainage, sewage disposal, solid waste collection, water and electricity supply and a range of social amenities (education, health care, emergency services, etc.). At the same time, it should be borne in mind that planned urban growth is not without environmental issues.

Environmental issues related to human settlements in Jamaica include:

- Urban encroachment (sprawl) into aquifer recharge zones, upper watersheds and agricultural areas;
- Haphazard developments that are not consistent with national environmental and planning guidelines and regulations, due to the unavailability of adequate affordable housing in planned settlements;
- Increasing demand for, and consumption of, urban landfill and cemetery space and sewage treatment;

[82] NEPA (2017a

- Increasing energy intensity (from air conditioning, public lighting needs, fuel consumption for cars etc.);
- Increased air and noise pollution associated with motor vehicles and public transportation;
- High levels of night-time light pollution; and
- Increased urban run-offs loaded with nutrients, bacteria, oil and grease, and solid waste.

While indicators of housing conditions and access to basic services such as safe water, electricity, solid waste and sanitation have been identified, there is no single or aggregate environmental KPI or SDG that reflects the country's capacity to manage rapid land use change around growing cities and all of the cumulative environmental problems that arise as a result. The MTF (2015-2018) identified "*sustainable urban and rural development*" as outcome #15, under National Goal #4 which was shown in Table 2. This outcome, also mapped to several SDGs, including SDG 11 ("Sustainable cities and communities).SDG 11 targets the following achievements (*inter alia*[83]) by 2030:

- Access for all to adequate, safe and affordable housing and basic services and upgrade of slums;
- Access to safe, affordable, accessible and sustainable transport systems for all;
- Universal access to safe and inclusive and accessible green and public spaces;
- Reduced adverse environmental impact of cities per capita by paying attention to air quality and municipal and other waste management; and
- Strengthened efforts to safeguard cultural and natural heritage.

7.3 Indicator Trends and Patterns

7.3.1 Proportion of Urban Population Living in Slums

The proportion of the urban population living in slums relates closely to SDG Target 11.1.1. "*The proportion of urban population living in slums, informal settlements or inadequate housing",* with the specific guidelines that by *2030 all citizens should have access to adequate, safe and affordable housing and basic services*. This is a critical indicator since more than half of Jamaica's population now live in urban areas, and this proportion is expected to increase. As many of the people migrating from rural areas to towns are poor, it can be anticipated that they will gravitate towards areas where they do not have to pay high rents. In many cases, the poor in Jamaica's towns and cities live in environmentally precarious areas, with insufficient basic infrastructure and municipal services. It is important to have data on the number of people affected, so that adequate policies for informal settlements and slums can be developed.

Two critical limitations to this indicator that have been identified by the UN Statistical Division[84] include the likelihood of underestimation, due to variable or inadequate definitions, and the lack of capacity to properly measure, monitor and collect the necessary data. Moreover, homelessness is not captured. Jamaica's Squatter Management Unit (SMU) in the Ministry of Economic Growth and Job Creation has made some strides towards defining a typology for squatter settlements (Table 32) and is planning to

[83] Targets pertaining to disaster management, climate change are addressed elsewhere in this report. Targets not directly relevant to environment management are omitted.

[84] https://sdg.tracking-progress.org/indicator/11-1-1-proportion-of-urban-population-living-in-slums/Retrieved September 18 2018

undertake a GIS-based census of these "*informal*" communities,[85] where residents/occupants have no secured legal title to the lands or houses they occupy.

Table 32 National Squatter Settlement Typology [86]

National Priority	Description	Strategy/Interventions
Tier 1. The protection of life and the natural environment, [and the stability of formal settlements].	Precarious, vulnerable and sensitive areas that pose serious threats to human safety and environmental resources.	Mitigation through structural (engineering) approaches. If mitigation is too costly - relocation.
Tier 2. The orderly development and efficient utilization of land and land resources	Major breach of planning and development regulations, including settlements within road reservations, riparian zones (located on river banks), along railway tracks or on lands earmarked for national development or public interest.	Regularization through application of planning tools and adjustments of plans. If remediation is not possible- relocation
Tier 3. The improvement in the quality of life of residents in squatter settlements	Clear spatial layout conforming to some planning and development standards but lack adequate infrastructure.	Upgrading and regularization of infrastructure (roads, drains, sewerage, electricity and water supply).
Split settlements	A section(s) fall can be classified in different tier levels.	Each sub-section treated as a separate settlement.

The SMU and the National Land Agency (NLA) undertook ground-truthing of 743 informal settlements that were identified in 2008 in the Rapid Assessment of Squatting Report, and found that 20% of these were located on legally tenured formal land settlements or Project Land Lease[87] sites that had taken on the appearance of squatter settlements, and were misclassified. The SMU/NLA therefore estimated the number of true squatter settlements to be closer to 600 sites. The estimation of the number of squatter settlements is not considered a reliable indicator of the number of people living in inadequate housing. Data on the current size and population of each site are required to be able to have a reasonable estimate of the percentage of the urban population living under these conditions.

The 2008 Rapid Assessment of Squatting Report represents the only available baseline data on the subject. It was estimated in that report that ~16% of Jamaica's population, at the time, lived in urban squatter settlements. However, 2009 findings from the Highway 2000 Corridor Plan, illustrate that there is some spatial variability, with data indicating that squatting accounted for 13% of the housing stock in St. Catherine and 19% in Clarendon[88]. The percentage of Jamaica's urban population living in slums was estimated to be as much as 60.5% by the UN in 2015,[89] which used the definition given in Box 7.[90]

[85]http://jamaica-gleaner.com/article/news/20180610/dr-glendon-g-newsome-squatter-management-census-or-cadastreRetrieved September 18 2018

[86] (Source: Written Communication from the National Squatter Management Unit)

[87] According the NLA website (estate management), this is a 50-year old programme that sought to redistribute land to the poorer people in the society. There are currently about 2,000 active accounts under the programme.

[88]Vision 2030 Jamaica Urban Planning & Regional Development Sector Plan p19 http://nepa.gov.jm/planning&development/vision_2030.pdfRetrieved September 18 2018

[89]http://mdgs.un.org/unsd/mdg/Data.aspxRetrieved September 18 2018

[90]http://mdgs.un.org/unsd/mdg/Metadata.aspx?IndicatorId=0&SeriesId=710Retrieved September 22 2018

A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions:

- Access to improved water
- Access to improved sanitation
- Security of tenure
- Sufficient-living area
- Durability of housing

Box 7UN Habitat Definition of a Slum Household

7.3.2 Housing Quality

Given the lack of reliable data on the relevant SDG indicator (proportion of urban population living in inadequate housing), the available data on quality may be useful. The **Housing Quality Index** (HQI) is an index of the percentage of the population living under housing conditions that are "*consistent with the standards established as acceptable"* as defined in the 2015 Survey of Living Conditions. The HQI components include outer wall materials (of the dwelling), domestic water supply source, toilet facilities, source of lighting, kitchen facilities and garbage disposal. Other parameters include household size, dwelling unit detachment, tenure arrangement and cost of utilities.

It is reported that the HQI declined from 75% in 2013 to 72.8 % in 2014, and continued to decline to 72.2% in 2015, which was on par with 2012 levels. Therefore, in 2015 almost 30% of the total housing stock was classified as inadequate. Since then there has been no report of significant improvement. HQI estimates are not available for 2016 and 2017.

Inadequate housing (lower HQIs) can be indicative of poor access to electricity, water supply, sanitation services, waste collection and hazard resilience (and associated infrastructure like effective storm water drainage), all of which have implications for environmental impact.

7.3.3 Housing Stock

The PIOJ reports annually on the number of housing starts, completions and mortgages undertaken in total and by the National Housing Trust (NHT). The proportion undertaken by the NHT is indicative of the number of statutory contributors (employed) who access financing for homes and who could not access it otherwise from commercial banks. Similarly, the NHT housing projects (e.g. Figure 39) are representative of more affordable homes available to NHT contributors.

Housing starts declined significantly between 2013 and 2015 (Figure 40 - a), with the number of non-NHT starts declining at a faster rate. In 2016 and 2017, the number of starts increased, and by 2017, the total number of housing starts was almost three times 2015 levels, with NHT starts driving the increase in both 2016 and 2017. This included schemes in Estuary/Friendship in St. James, and other projects in St. Mary's Field, Colbeck, and Orchards (St. Catherine), Winchester Estate (Hanover), Perth II (Manchester) and Masumure and Darliston (Westmoreland), which accounted for 2017 starts.[91] Public partners included the Urban Development Corporation, with which NHT planned 700 housing units at Caymanas in St. Catherine. Many of these, like the planned Monymusk housing schemes, are being developed on former sugar cane lands.

[91] http://www.jamaicaobserver.com/news/government-starts-ground-breaking-for-new-nht-housing-schemes_90820 Retrieved September 19 2018

Figure 39 Westmeade, Houses under construction (Source: NHT)

(a) (b)

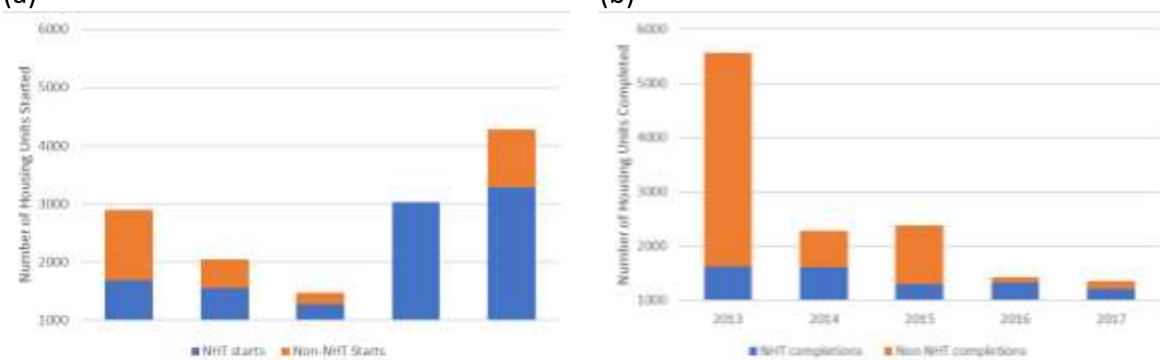


Figure 40 Housing Starts (a) and Completions (b) (2013-2017; Source: reproduced from PIOJ 2018a)

Housing completions declined significantly (~60%) between 2013 and 2014 (Figure 40 -b), and remained relatively low, with NHT completions dominating. This pattern suggests that the population was more reliant on NHT housing schemes during the review period than before. Expressed as the number of housing completions per '000,000 population, completions fell from 205 completions per '000,000 in 2013 to a low of 50 completions per 000,000 population in 2017.

Of these two indicators (starts and completions), the number of housing completions per annum is the most reliable indicator of actual housing stock added. This data indicates that less housing stock was added in the review period than in the previous period.

7.3.4 Access to Potable Water

This quality of life indicator falls under SDG Goal 6 (National Outcome #15). SDG Target 6.1 seeks to achieve universal access to safe and affordable drinking water by 2030.[92] The Sachs Report (Sachs et al 2018) estimated that, in 2017, 93% of Jamaica's population had access to piped water, assuming that piped water conforms to the SDG indicator of "*safely managed drinking water services".*

The 2011 Population and Housing Census found that 79.7% of the total households (881,089) had access to some form of piped water in 2011, which was more than a 10% increase from 2001 Census[93]. This included 56.2% (or 494,777 households) with water piped into dwellings (both public and private sources), which would be indoor tap water. The 2011 Census also found that there was a trend toward declining reliance on standpipes (falling from 18% in 2001 to 6% in 2011) and that only ~15% of the population relied on alternative water sources (catchment, tank, well, spring, river) in 2011.

[92]https://sustainabledevelopment.un.org/content/documents/19901SDG6_SR2018_web_3.pdfRetrieved September 19 2018
[93] NEPA 2017a)

The 2015 Jamaica Survey of Living Conditions [94] reported that 49% of all households had indoor tap water (less than the 2011 Census), and 80% reported having an '*improved'* (treated) source of drinking water. In the KMA, 99.5% reported having access to improved drinking water compared to ~89% in other urban areas and 64% in rural areas.

The NWC is the single largest producer of safely managed drinking water in Jamaica. Municipal Corporations and a few private water companies supply a small proportion of the total amount of treated water available in Jamaica. Between 2013 and 2017, PIOJ reported an 8% increase in total water production, and a 7% increase in the number of connections to piped water supply.Table 33 summarizes the NWC operations for 2017, including registered customers and water consumption in 2017. The water supply and sewage treatment facilities operated by NWC serve mainly planned housing developments.

Table 332017 NWC Operations, water and sewage supply [95]

Divisional Operations: Parishes Served	Water supply systems operated	Wastewater Systems managed	Registered Customers*	Consumption (million litres, 2017)
Western: Manchester, St. Elizabeth, Westmoreland, Hanover, St. James and Trelawny	71	15	152,805	24.0
Eastern: Portland, St. Thomas, Kingston, St. Andrew, St. Mary, St. Catherine, Clarendon and St Ann	280	58	297,437	62.6
Total	**351**	**73**	**450,242**	**86.6**
**includes commercial and institutional accounts as well as residential.*				

Access to treated water is a different issue than the affordability of water. The cost of water supply in Jamaica currently (2018) listed at the NWC website[96] is a variable rate scheme, beginning at J$103.67 (80 cents USD) per 1,000 litres, for the first 14,000 litres (the price per litre increases above 14,000 litres) These prices are exclusive of service charges and taxes. Between 2014 and 2017 a 14% charge (called a K-factor) was applied to water and sewerage and service charges. In 2018 this was increased to 16%.

Financial costs are not the only costs associated with access to water. In rural areas, costs may be associated with delivery of trucked supplies or the cost in human time of collecting water from standpipes or other sources that are located outside of the residence, which is likely to affect women and children disproportionately. In addition, the high cost of piped water and insufficient supply to homes also result in continued reliance on rivers for bathing, laundry, and even car washing, which adds to the phosphate loads in freshwater and receiving coastal waters. No data are available on these non-monetary costs in Jamaica.

7.3.5 Access to Sanitation Services

SDG Target 6.2 is to achieve universal access to adequate and equitable sanitation and hygiene by 2030, calling for an end to defecation in open spaces, ensuring that everyone has access to a basic toilet and that systems are in place for the management of excreta. SDG Target 6.3 is *to improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials,*

[94] PIOJ, 2015

[95] (Source: NWC 2017 Annual Report)

[96] https://www.nwcjamaica.com/RATES Retrieved September 25 2018

halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally, by 2030*.*

Aside from assuring a basic quality of life, and reducing the risk of bacterial water-borne diseases in water sources, this goal is also expected to reduce the incidence of water pollution with nutrients (nitrogen, in particular). Access to flush toilets is a proxy indicator, which is dependent on the availability of piped water. Despite the relatively high number of homes reportedly having access to piped water, the 2015 Survey of Living Conditions reported that only 65.9% of Jamaican households had exclusive use of flush toilets (77.7% have some access); this estimate is below the 2015 global estimate of 68%,[97] and 5% lower (71.2% of households) than the 2011 Census for households with access to water closets (STATIN[98]).

There is considerable variability at the parish level, in terms of WC access; with more urbanized parishes having over 69% reported access: Kingston (90%), St. Andrew (89%), St. Catherine (77%), St. James (73%) and Manchester (71%), according to the 2011 Census. The remaining parishes had between 53% (Westmoreland) and 63% (Portland) reported access to the WCs. It is likely that this parish level variability is not truly divided along parochial boundaries, but related to the relationship between urbanization and poverty levels. It is likely that households without flush toilets rely on outdoor pit latrines. Of those with flush toilets, many are likely to use on-site systems (dry excreta management, soil absorptive methods, package plants and evaporative systems with no effluent discharge).[99]

The 2015 Jamaica Survey of Living Conditions (SLC) indicates that in 2015 approximately 20.4% of WCs were connected to a sewage treatment plant (STP). In urban areas, this figure is 36.4%, and in rural areas, 2.5%. Some of the STPs are operated by the NWC. According to the NWC's 2017 Annual Report, the entity operates over 73 wastewater systems across Jamaica (Table 34), several of which serve planned housing schemes. While the households connected to these plants have off-site sewage disposal, it is the performance of these plants that will affect the level of environmental challenges that may be avoided by sewage collection and treatment systems in place for excreta disposal management.

Table 34 NWC STP Performance [100]

Reporting Period	Poor (% compliant with <three of six parameters)	Satisfactory (% compliant with three-four of six parameters)	Good to Very Good (% compliant with > four of six parameters
2015/2016*	12.0	49.0	31.0
2017/2018	46.3	41.5	12.2
**7% not sampled*			

NEPA conducted audits between April 2015 and March 2016 and April 2017-March 2018of 41 of the NWC facilities. In the latter period there was a significant increase in the number of NWC sewage treatment plants that were classified as having poor performance, with 46.3% not compliant with at least two effluent quality parameters (of six) compared to 12% in the earlier period. NEPA's audit report (2018a) indicated that the likely reasons for the poor NWC plant performance included:

- Condition of the plant and operational low efficiencies;
- The fact that 95% had no flow meters; and
- Inadequate chlorine supplies for disinfection.

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97 https://sustainabledevelopment.un.org/content/documents/19901SDG6_SR2018_web_3.pdfRetrieved September 19 2018
98 http://statinja.gov.jm/Census/PopCensus/2011%20Census%20of%20Population%20and%20Housing%20j.pdfRetrieved October 18 2018
99 http://nepa.gov.jm/Development-Invest-Man/Volume%203%20-%20Infrastructure,%20Utilities%20and%20Communication/Section%204%20-%20Waste%20Water%20Treatment%20System.pdfRetrieved October 18 2018
100 (Effluent Quality; Source: NEPA STP Audits)

7.3.6 Access to Solid Waste Collection Services

SDG Indicator 11.6.1 is the *"proportion of urban solid waste that is regularly collected and with adequate final discharge out of total urban solid waste generated by cities*." This falls under Goal 11, which is to "*make cities and human settlements inclusive, safe, resilient and sustainable".* The specific target of 11.6 is to *reduce the adverse per capita environmental impact of cities; this should include paying special attention to air quality and municipal and other waste management"*. Where urban populations are concentrated in proximity to the sea they typically generate more waste than rural areas. Therefore the environmental impact is expected to be greater in urban areas than they are in rural inland areas. The proportion of uncollected urban solid waste has implications for environmental aesthetics (visual and olfactory), health (in terms of being a magnet for pests) as well as direct pollution of water bodies with non-biodegradable solids, in particular plastic. Plastic waste chokes waterways and contributes to flooding. Eventually these environmentally undesirable wastes are transported to the marine environment where they are ingested by marine creatures , cause physical damage to marine organisms by entangling them and smothering their habitat, and release harmful chemical compounds, which may eventually end up in drinking water as or micro plastics.[101] In addition, plastic pollutes beaches and negatively affects fisheries and coastal tourism. According to the IUCN,[102] plastic comprises more than 80% of all marine debris. Data from STATIN (2018) indicate that the importation of plastic goods almost tripled between 2014 and 2017, increasing from 20 kilotons in 2014 to 56 kilotons in 2017.

The National Solid Waste Management Authority (NSWMA) is responsible for the regulation of solid waste services. The Regional Parks and Markets are responsible for collection of waste. To optimize efficiency in waste collection and disposal, Jamaica has been divided into four waste sheds (Table 35). Across the island there are a total of eight managed landfill sites.

In the 2011 Census (STATIN) approximately 64% of all households were estimated to be receiving either routine or irregular garbage collection. The 2015 Jamaica Survey of Living Conditions (SLC) indicated that 66% of households reported using a formal method of garbage disposal, and 50.4% reported having regular public collection. The 2015 SLC reported that "*burning continued to be the most common informal method, used by 32.1%*. According to the SLC, this statistic was higher in rural households (53.2%), and amongst the poorest households (60.8%).

The NSWMA estimates total collection coverage to have been 67.6% and 60.2% in 2014 and 2016 respectively.[103] No parish level information was available for the proportion of households having routine garbage collection during the review period (2014-2017).

[101]https://portals.iucn.org/library/sites/library/files/documents/2017-002.pdfRetrieved October 18 2018
[102]https://www.iucn.org/resources/issues-briefs/marine-plastics Retrieved December 04 2018
[103] NSWMA 2018, written communication).

Table 35 Waste collected by Waste shed

Waste shed	Managed Disposal Sites (feeder areas)	% households with solid waste collection*	Total tonnage			
			2014	2015	2016	2017
Western Parks & Markets (WPM) region	1. Retirement (St. James; Trelawny, Hanover and Westmoreland)	60%	153,222	154,694	188,747	208,163
Municipal Parks & Markets (MPM) region	2. Church corner (St. Thomas); 3. Riverton (St. Catherine, Kingston and St Andrew)	68%	390,585	507,030	475,389	539,138
Southern Parks & Markets (SMP) region	4. Martin's Hill (Manchester); 5. Myersville (St. Elizabeth)	58%	77,324	72,057	72,960	71,140
North Eastern Parks & Markets (NEPM) region	6. Haddon (St. Ann and parts of St Mary); 7. Doctorswood (Portland and St. Mary); 8. Tobolski (St Ann)	55%	50,916	44,095	60,025	53,603

**regular or irregular waste collection reported in 2001 Census*

The National Solid Waste Management Authority (NWSMA) estimates the total residential waste generated to have increased from 993,984 Mt in 2014 to 1,012,656 Mt in 2017. Using STATIN population growth estimates, this was an average of one kg of waste per person per day. Figure 41 shows that waste generation increased steadily. Between 2014 and 2017, the total amount of solid waste collected increased by 30% from 672,046 Mt (2014) to 872,044 Mt (2017) (shown in Figure 41, dissagregated by wasteshed). Most of this increased tonnage was in the two major urban wastesheds: MPM (which showed a tonnage increase of 38%) and WPM (which showed an increase of 36%). The other two wastesheds showed 6% and -8% changes over the same period.

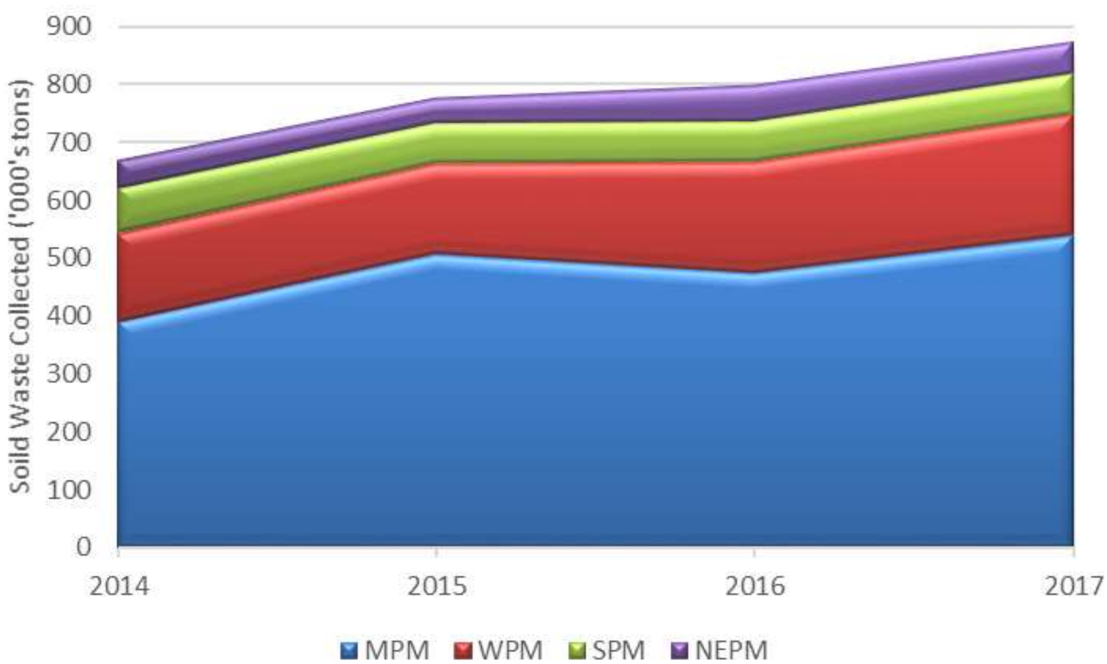


Figure 41 Total Solid Waste Collected (2014-2017)

Since the NSWMA has estimated that the overall proportion of the population served is declining, the increased tonnage is likely due to increasingly dense urban populations in areas where MPM and WPM operate. According to the NSWMA, in 2017, almost 60% of the waste collected nationally was taken to the Riverton City landfill which serves 44% of the total population (STATIN 2017, estimate). An additional 24% of the total collected in 2017 was taken to the Retirement Landfill, serving 18% of the population. The remaining 17% was taken to the other six landfills, which serves the remaining 39% of the population. These data imply that the Riverton City Landfill is receiving a disproportionately high amount of solid waste, and likely will have higher levels of associated environmental impact.

The environmental impact of landfills depends on the amount and type of waste, the location of the landfill relative to sensitive VECs, and the efficiency of management of the site.

The NSWMA estimated that in 2017, almost half of the waste collected was compostable organic waste (47.8%) and there was another 16.3% that could be classified as biodegradable (11.8% paper waste; 3.2% of cardboard waste and 1.28% of wood/board). In 2017, non-biodegradable waste collected accounted for ~36% respectively, amounting to a total of 313,238 Mt. Almost half of this non-biodegradable waste was plastic.

The high proportion of organic waste contained in landfills is of concern. It is estimated that approximately 50 Nm^3 (Normal cubic meters) of methane is generated per ton of municipal solid waste.[104] This suggests that Jamaica's landfills emit close to 21 million Nm^3 of methane per year.

[104] Themelis and Ulloa, 2007. Methane generation in landfills. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.558.9057&rep=rep1&type=pdfRetrieved December 04 2018

Table 36 Environmental Impacts of the Riverton City Dump

<table>
<tr><th>Impact Cause</th><th>Impact</th></tr>
<tr><td>Land take</td><td>Consumption of scarce land resources</td></tr>
<tr><td>Attracting and harbouring disease vectors</td><td rowspan="3">Deleterious impact on human health</td></tr>
<tr><td>Animals (pigs and goats) consumed by humans likely to forage here</td></tr>
<tr><td>Animals in human contact (e.g. dogs, cats) likely to take contaminants back to human environments</td></tr>
<tr><td>Methane emissions (decaying organic waste)</td><td>Contribution to climate change (13 million Nm3 generated annually at Riverton)</td></tr>
<tr><td>High risk of fire from flammable gases and materials, and high temperatures.</td><td>Particulates are likely to be carried by the wind and contribute to smog levels and visibility on the nearby highway and adjacent urban areas. Very high health risk due to particulates and benzene emissions were associated with three major fires in the review period:
March 2014: 500,000 tyres were burned, [105]releasing an estimated 200 tons of air emissions.
March 2015: Fire (smouldered for seven days).
July 2018: Fire (smouldered for 14 days)</td></tr>
<tr><td>Fugitive dust from garbage truck, deposition of payloads, and other activities.</td><td>Particulates emissions (routine, high baseline levels)</td></tr>
<tr><td>Decomposition of materials from percolating rainfall.</td><td rowspan="2">Odours impacting adjacent communities (quality of life); and leachates contaminating groundwater, surface waters and marine environment – bio-accumulation of heavy metals. Riverton City is located in proximity to the Duhaney River and Hunt’s Bay.</td></tr>
<tr><td>Improper disposal of oil and grease</td></tr>
<tr><td>Improper landfill and burial</td><td>Visual intrusion to nearby communities of Riverton City, New Haven, Callaloo Mews, and Seaview Gardens.</td></tr>
</table>

7.4 Conclusions

Many of Jamaica’s environmental issues are driven by matters related to the development of human settlements. As more of the country’s population moves into the major cities of Kingston and Montego Bay, municipal services are not keeping up with the rate of growth, in terms of planned developments, adequate affordable housing stock, and waste disposal (both sewage and solid waste).These issues have serious implications for the health of the most vulnerable groups, on the environment as well as major deleterious impact on nearshore ecosystems. Much of the sustainable planning appears to function at a parish level rather than at the level of the cities or towns, which are directly affected.

Parish Development Orders require the Local Planning Authorities to consult with the Natural Resources Conservation Authority under circumstances where development is occurring in an environmentally sensitive area (e.g. coastal zone, near a water body or conservation area). Planning Authorities are subject to an environmental audit, including plans for land. These orders also provide for consultation

[105]http://nepa.gov.jm/new/services_products/subsites/air_quality/docs/reports/Report-Air_Monitoring_and_air_quality_impact_Riverton_2014.pdf Retrieved December 04 2018

with various regulatory agencies (e.g. the Ministry of Health and Environmental Control, the Office of Disaster Preparedness and Emergency Management (ODPEM), the Water Resources Authority and the Jamaica National Heritage Trust etc.).The main issue with the planning framework, as outlined in the Development Orders, is that it applies to planned projects where the proponents or developers have to seek planning permission from the local authority. To some extent, the Local Sustainable Development Plans are expected to address wider spatial planning issues that are not necessarily subject to the development permitting process.

Rapid urbanization and the intensification of population densities in existing urban areas produce cumulative environmental impact that overwhelms municipal services. There is a need for major city-level sustainable development, which would include a range of planning issues that deal with municipal waste management (both solid waste and sewage), orderly development of housing and communities, as well as planning for climate change adaptation, energy efficiency, water conservation and natural hazard resilience. A higher priority needs to be placed on urban planning, particularly in the Kingston Metropolitan Area (KMA) and Montego Bay. Jamaica also lacks a framework for cumulative effects assessment. Although project or development level environmental impact is addressed within the existing permitting framework, smaller scale pressures that collectively have major effects are often missed. Cumulative environmental effects are characterised by:

- Multiple or diffuse points of origin that may spread and coalesce at different rates;
- Non-linear or abrupt change as a result of a tipping point. This is especially the case if effects are synergistic (two or more effects interact to produce an effect that is greater than the sum of the two individual effects); and
- Complex response relationships between VECs and environmental pressures and drivers.

Major data gaps exist in relation to spatial planning, for example information is needed to determine the ratio of land consumption to population growth rate in cities (SDG indicator 11.3.1), which sets as a target by 2030 the enhancement of inclusive and sustainable urbanisation and capacity for participatory, integrated human settlement planning and management.

8. Fuel Supply & Energy

Scorecard 8: Fuel Supply & Energy (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
SHARE OF ENERGY GENERATED BY RENEWABLES	Stands at 1.7% in 2017 of TPES which falls short of the 12.5% target set for 2015, and is not on track to meet the 20% target set for 2030. As a proportion of electricity production, renewables account for 12%.	VERY HIGH	3	3
ENERGY INTENSITY & EFFICIENCY	Estimated at 0.13 tonnes of oil equivalent/1000 USD GDP. Losses in electricity production > renewables contributions.	MODERATE	2	2
PROPORTION OF POPULATION WITH PRIMARY RELIANCE ON CLEAN FUELS AND TECHNOLOGY	Estimated at 87% to 93.3%.	LOW	2	1
ACCESS TO ELECTRICITY	98% of population in 2016 have access. Rural electrification rate in 2016 estimated at 96%.	LOW	2	2

Photo: Wind turbines in Jamaica, NEPA. Used with permission.

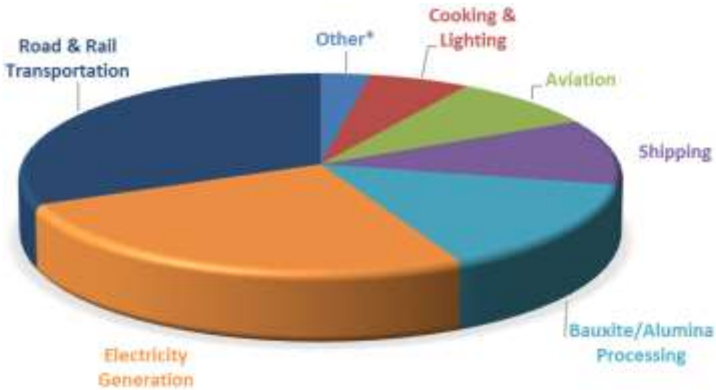
8.2 Environmental Linkages

Energy is needed by all sectors of national life for meeting basic needs such as water supply, cooking and domestic lighting, transportation, and all other aspects of human endeavour including production of goods and services, infrastructure, education and health care, tourism and recreation. Air pollution and impacts on household environmental health result from the burning of solid fuels or the use of inefficient technologies. Burning of fossil fuels (petroleum and coal) contribute to both air pollution (through the emission of particulates and nitrous oxides, ozone, mercury, and other hazardous elements) and climate change (carbon emissions). Power plants using fossil fuels also have localized environmental footprints, including high water consumption and discharge of hot water. Jamaica's energy sustainability is discussed in the international context in Box 8.

- Jamaica's main utility provider is the Jamaica Public Service Company (JPS). In 2017 JPS generated 58% of the electricity used in Jamaica and purchased the balance. Total power generation increased by 5% over the review period, with a total generation of 4360.5 GWh in 2017. In terms of efficiency, reported losses amounted to an average 27% during the review period (~1151.6 GWh lost in 2017). Steam and slow speed power plants using heavy oil and gas (Rockfort, Hunts Bay and Old Harbour Bay) produced 62% of the total power generated by JPS. The combined cycle gas turbine at Bogue (Montego Bay, St James) produced 32% of JPS's power in 2017. Eight hydropower plants contributed another 6% of the total electricity generated by JPS in 2017. The contribution of hydropower increased by 24% between 2013 and 2017.

Understanding how petroleum is being used in an economy is important in determining national policies for reducing overall consumption and related emissions, and strategically improving efficiencies in targeted sectors. Figure 42 shows the percentage breakdown of major users of petroleum in Jamaica in 2017.

- Transportation (road and rail) accounted for more than 30% of the total petrol consumption; if aviation and shipping are added to the category of transportation consumption, this number jumps to more than half of the total petroleum consumption in Jamaica in 2017. Data from STATIN indicate that during the review period use of unleaded gasoline (87) increased by ~3% and the use of heavy diesel declined by more than 44%, which are better for emissions quality. Power generation (electricity) accounted for approximately a quarter of consumption. Economic activities such as bauxite/alumina processing and other manufacturing (cement, sugar, petroleum refining etc) accounted for only ~18% direct petroleum usage (not including electricity consumption). Domestic uses (cooking and lighting) accounted for the smallest use at 6% (not including electricity consumption).



Other*	3%
Cooking & Lighting	6%
Aviation	9%
Shipping	11%
Bauxite/Alumina Processing	15%
Electricity Generation	26%
Road Rail Transportation	31%
Total	100%

* includes petroleum refining, cement manufacturing, sugar manufacturing and other manufacturing

Figure 42 Petroleum Consumption Activity (by major sector; Source: reproduced from Energy Economics and Planning Unit, Energy Division MSETM May 2018)

The total amount of petroleum consumed in Jamaica in 2017 was ~19.64 million barrels.[106] Average consumption for the review period was 19.83 million barrels, with a marginal (2.3%) decrease in consumption since 2015. Since 2013, declines in petroleum consumption in road and rail, aviation, electricity, bauxite/alumina amounted to 1.49 million barrels of petroleum (mbp). These were off-set by increases in consumption in shipping, cement manufacturing, petroleum refining and domestic use (cooking and lighting) which amounted to 1.14 mbp, resulting in a net reduction in total consumption of 0.35 mbp. The increased demand was, in part, due to a significant increase in petroleum use for cement manufacturing, with consumption jumping from ~16,262 barrels to 44,200 barrels, which is almost a 300% increase in demand in that sector (albeit relatively small compared to other sectors).

Oil use in petroleum refining increased by ~50%, while shipping consumption increased by 54%. Petroleum consumption for cooking and lighting also increased by ~30% in the review period. Of these, the largest absolute increase in petroleum consumption was by far shipping which increased by 0.74 mbp, moving from 1.37 mbp to 2.11 mbp.

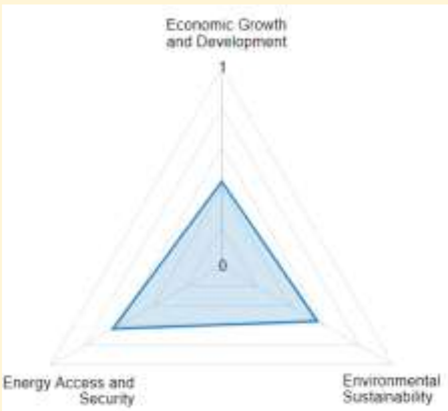
Petroleum consumption for road and rail transportation decreased by a small amount (2%), compared to bauxite/alumina processing and electricity generation (each showing a 12% decline since 2013). The small change in oil consumption by the bauxite/alumina industry is significant, because it amounted to a total reduction in ~0.7 mbp used. The largest decline was noted for aviation, which showed a 15% decline (amounting to a reduction of 0.3 mbp used).

[106] https://www.mset.gov.jm/sites/default/files/pdf/PETROLEUM%20CONSUMPTION%20ACTIVITY%202013-2017.pdf Retrieved December 04 2018

In the 2017 **Global Energy Architecture[107] Performance Index**, Jamaica ranked 92nd out of 127 countries, with an overall score of 0.54 (the maximum score being 1.0). The country has significantly improved its overall international ranking, compared to the 2009 benchmark, moving from 116th, and making the "most improved" list, and was described in the 2017 report as "*A regional leader in transitioning to a sustainable energy system, whose national energy policy is now praised as a model for lawmakers across the region*". The main criteria were evaluated by the World Economic Forum in arriving at the international rankings were (Jamaica's score in brackets):

1. Economic growth and development (0.43)
2. Environmental sustainability (0.56)
3. Energy access and security (0.64)

Each of these forms a point on the "energy triangle"



Environmental Sustainability KPIs:

- Alternative energy (low carbon sources): 19% total energy use incl biomass
- Nitrous oxides emissions in the energy sectors: 25.8 Mt of CO2 equivalent/million pop
- CO2 emissions from electricity production: 668 g CO2/kWh
- Methane emissions from energy sector: 47.4 Mt of CO2 equivalent/million pop.
- Particulate matter (2.5) concentration: 11.1 mg/m3
- Average Fuel economy for passenger cars: 11.7 l/100 km

Economic Growth & Development KPIs:

- Energy Intensity: 7.8 PP$[108] GDP/kg oil equivalent[109]
- Costs - Fuel imports: 8.19 % of GDP
- Affordability - price distortion through subsidy (0-1 best): 0.77 (super gasoline) and 0.71 (diesel); electricity prices for industry: n/a[110]
- Fuel exports: 1.39% GDP

Energy Access and Security KPIs:

- Electrification rate: 92% population
- Quality of the electricity supply (1-7 best): 4.7
- Population using solid fuels for cooking: 12.5%
- Diversity of TPES (Herfindahl Index) 0-1 best: 0.61
- Import dependence - energy imports: 82.5% net energy use; diversification of imports counterparts (Herfindahl Index) 0-1 best: 0.29

To some extent, Jamaica's improvement can be attributed to lower fuel prices (as a proportion of the GDP) and incremental improvements in all areas of the triangle. Through its national energy policy, Jamaica has taken steps to lower fuel imports, decrease energy intensity and increase its reliance on fossil fuels through development of alternative energy sources.

Box 8World Energy Architecture Performance Index 2017: Jamaica

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107 http://reports.weforum.org/global-energy-architecture-performance-index-2017/economies/#economy=JAMRetrieved December 04 2018

108 PP$ GDP is gross domestic product (GDP) converted to current international dollars using purchasing power parity rates based on the 2011 ICP round

109 The Energy Economics and Planning Unit of the Energy Division, Office of the Prime Minister estimates the energy intensity as BOE/ 1000 USD of GDP: which was estimated to be 1.89 BOE/ $1000 USD GDP in 2017. The average annual energy intensity is 1.9, so there has been no real change.

110 In Jamaica, this would correspond to Rate 70 (largest power customers). According to JPS the 2017 rate is 25.66 J$ per kWh (~0.20 USD/kWh). Trinidad & Tobago and South Africa have the lowest rates (0.02 USD/kWh). Jamaica would rank in the top 60 (if the data had been used) as Dominican Republic ranked 59 with a rate of 0.21 USD/kWh.

8.3 Indicator Trends and Patterns

8.3.1 Energy Intensity

Energy intensity is indicative of energy efficiency (i.e. the amount of energy that is needed for economic output), and is measured in terms of primary energy and GDP. It is specifically defined as "*the energy supplied to the economy per unit value of economic output*" (SDG definition). The relevant SDG target (7.3) is doubling the global rate of improvement in energy efficiency by 2030. Lowering of the energy intensity indicates increasing efficiency. Lower energy demand per economic output means that the carbon footprint (in terms of GHG emissions associated with energy use) of the economic output is lower.

The Energy Economics and Planning Unit of the Energy Division, Office of the Prime Minister, estimates the energy intensity as BOE (Barrel of Oil Equivalent)/ $1000 USD of GDP: which was estimated to be 1.9 BOE or 0.27 tonnes of oil equivalent (TOE) per 1000 USD GDP in 2017, which was roughly the same as the average annual energy intensity for the review period. The International Energy Agency (IEA) publishes international statistics on the SDG energy indicators (Goal 7) for individual countries.[111] This is useful to rate Jamaica's performance, relative to the rest of the world. For 2016, the IEA estimated Jamaica's energy intensity to be 0.13 TOE/$1000 USD GDP, which is lower than the national estimate. Since ~2008, the IEA estimated that Jamaica's energy intensity was lower than both the world average, and the average for developing countries. However, during the review period, Jamaica's energy efficiency showed a decline, with a steadily rising energy intensity, on par with the global average in 2016.

The average annual 27% (1,151,620 MWh) losses reported by JPS, is also indicative of the inefficiencies in the electricity infrastructure.

8.3.2 Renewable Energy Share

In 2017 fossil fuels (coal, crude oil, natural gas and petroleum products) and carbon-based sources accounted for 98.3% of the total primary energy supply (TPES) in Jamaica, with petroleum products and crude oil accounting for most of this. Of the fossil fuels, an average of 452,000 barrels of oil equivalents (KBOE) were used in the review period, accounting for 2.3% of the TPES. The contributions of crude oil and petroleum products (gasoline, diesel, kerosene, fuel oil, liquefied petroleum gas (LPG)etc) for the bulk of the energy sources used in Jamaica, accounted for almost 90% in 2017, which was a marginal improvement from the 91.3% contribution in 2014. Other carbon-based sources accounted for 6% in 2017, down from 8% in 2014. Renewable energy's supply increased by less than one percent point (0.8%) between 2014 and 2017.

Because renewables now represent such a tiny fraction of the TPES (1.7% in 2017), their relative contributions cannot be clearly shown along with the carbon-based fuels. Figure 43 shows the changes in the renewables mix between 2014 and 2017.

[111] https://www.iea.org/sdg/efficiency/ Retrieved December 04 2018

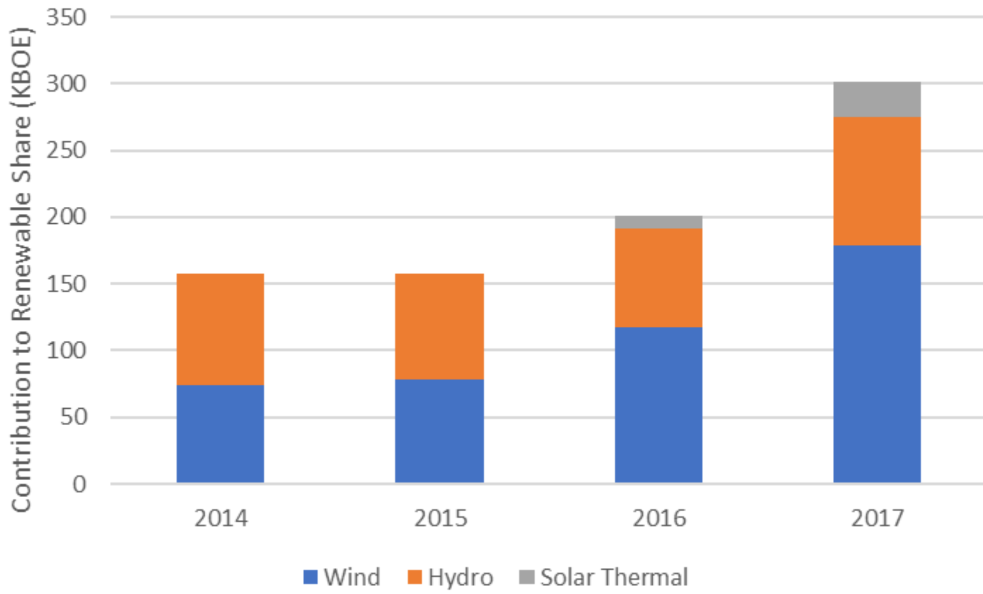

Figure 43 Mix of Renewables (2014-2017; Source: reproduced from MSTM)

The following general trends were noted in the review period:

- There was a major increase between 2014 (151 KBOE or 256,611 MWh)and 2017 (301.5 KBOE or 512,372 MWh),[112] although this change barely makes a dent in TPES;
- Wind is becoming a relatively more important source than traditional hydro-electric power (HEP) generation, which may already be developed close to its capacity in Jamaica. JPS operates a three MW wind farm in Malvern, St. Elizabeth (Figure 44) and purchases power from the Wigton Wind Farm (Manchester). HEP accounts for 29MW, with the Maggotty plant (St Elizabeth) contributing ~39% of the installed HEP;
- Within the last two years of the review period, solar energy has become a contributor, and is expected to be increasingly more important, as prices and policies become more enabling. The production of electricity from solar energy tripled between 2016 and 2017 (45,884 MWh);
- Geothermal and biogas (waste to energy) are not presently making any contributions;
- Natural gas as an energy source has also come into use in the past two years of the review period, moving from 81 KBOE in 2016 to 508 KBOE in 2017 (contributing ~3%, which is more than the total renewables share). According to the JPS 2017 Annual Report,[113] natural gas is expected "*to result in the stabilization of fuel costs over the long term, while enhancing energy security and the integration of more renewables on the grid.*" Based on this trend, it is expected that the role of natural gas in electricity production will increase significantly. Although natural gas is a fossil fuel, it is considered a good option (a "bridge fuel"), particularly for electricity generation when transitioning away from traditional fossil fuels (like coal, crude and petroleum products) to clean renewables. Renewables such as solar and wind provide intermittent supplies as the resource fluctuates, and can destabilize the grid, if cost-effective battery storage is not available. Natural gas (methane) which can be used to sustain the baseload, has significantly lower carbon emissions than other fossil fuels, and gas plants have greater fuel efficiencies than traditional fossil fuels.[114] However, if methane is leaked to the atmosphere (from pipelines or

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[112] *Source: Energy Economics and Planning Unit, Energy Division MSETM May 2018*
[113] https://s26303.pcdn.co/wp-content/uploads/2018/07/JPS-2017-AR.pdf Retrieved December 04 2018
[114] https://www.yaleclimateconnections.org/2016/08/is-natural-gas-a-bridge-fuel/Retrieved December 04 2018

storage facilities) its global warming potential is 120 times that of carbon dioxide (from the burned gas) even though it is shorter lived than CO_2 in the atmosphere.

The Ministry of Energy's website reports Jamaica's total alternative energy consumption in terms of the TPES rather than total final energy consumption (TFEC)as required for reporting of Indicator 7.2.1 (renewable energy share of TFEC). Data from the World Energy Balances (IEA)[115] for Jamaica, up to 2016, estimated the country's modern renewables share in TFEC to be 11%, which was above the world average of 10.1%. The source of this data is unclear, and is not consistent with statistical reports available from the Ministry of Energy, Science and Technology.

Figure 44 Windmills, Malvern, St Elizabeth (Source: NEPA)

If the contributions of non-carbon based renewables (wind, solar and hydro) are considered as a fraction of the total amount of electricity produced (including electricity purchased by JPS), it can be said that renewables contributed 12% (or 505,491 MWH) of the electricity generated by JPS in 2017. The National Renewables Energy Policy has indicated that 20% of the *TPES* must come from renewable energy by 2030.

8.3.3 Reliance on Clean Fuels and Technology

The SDG 7.1.2 indicator "*proportion of population with primary reliance on clean fuels and technology*" is calculated as the number of people using clean fuels and technologies for cooking, heating and lighting divided by total population expressed as percentage. "Clean" is defined by the World Health Organization's guidelines for indoor air quality as household fuel combustion.[116] The guidelines include the following recommendations (*inter alia*) for household fuel combustion:

1. $PM_{2.5}$ should not exceed 0.23 mg/min when unvented (i.e. without a chimney or hood) and 0.80 mg/min when vented (i.e. with a chimney or hood)
2. CO should not exceed 0.16 g/min for unvented devices and 0.59 g/min for vented devices;
3. Unprocessed coal should not be used as a household fuel;
4. Household use of kerosene is discouraged.

These recommendations exclude solid fuel sources such as wood, animal dung, charcoal, crop wastes and coal, which are burned using inefficient or polluting stoves or ovens, as well as kerosene stoves and lamps. Household access to clean fuels is important, as it impacts air quality (and therefore environmental health) but also has implications for poverty alleviation, gender issues (especially as women are primarily responsible for cooking) and climate action. In the context of Jamaican culture, where jerked meat traditionally relies on a cooking process involving smoking with 'sweet' wood or pimento, it is unlikely that use of wood would be completely eliminated.

The 2011 National Census reported on the type of fuel used for cooking, disaggregated by parish. This data were used to estimate the relative portion reportedly using clean fuels (LPG and electricity) versus polluting sources (e.g. wood, charcoal, kerosene etc). It was found that 84% of households used clean fuels at that time. Parishes that had higher proportions of their population using clean fuels tended to

[115] https://www.iea.org/sdg/renewables/Retrieved December 04 2018

[116] https://www.who.int/airpollution/guidelines/household-fuel-combustion/en/Retrieved December 04 2018

be the ones with a higher urban population (KSA, St. James, St. Catherine and Hanover). The parishes with the lowest reported use of clean fuels included St. Elizabeth (70%) and Clarendon (66%). Use of polluting and inefficient fuels is likely to have remained an issue in the more rural areas, where electricity and LPG are either unavailable or too expensive for household use. As people move from remote rural areas into urban centres and gain employment in well-paying jobs, the use of clean fuels is likely to increase.

Data available from the World Bank estimated that the proportion of the population with access to clean fuels was 87% in 2011, which was higher than the Census count of 84%. [117] The World Bank estimated the indicator to be 88.4% in 2013, increasing to 90.5% by 2016. Sachs et al (2018) estimated this indicator to be as high as 93.3% of the population in 2017. The IEA estimate for Jamaica for the review period, in respect of this indicator, was ~87%. At a sub-national level, it is expected to vary between 70% (in very remote rural areas) and a 100% in the wealthier parts of urban areas.

Data from STATIN on LPG use indicated a 300% increase in butane use, which is the main LPG used in Jamaica as cooking gas.[118] This may be indicative of a trend towards increasing accessibility of LPG (considered a clean fuel) in Jamaica during the review period.

8.3.4 Access to Electricity

SDG Target 7.1 aims to have universal access to affordable, reliable and modern energy services by 2030. The main indicator set for this target is the proportion of the population with access to electricity. The 2015 Survey of Living Conditions reported that 95% of households used electricity as their main source of lighting. This was a 4% increase in the 2011 national census estimate, where nine out of 10 households reported access to electricity (NEPA 2017a). JPS reported the total consumption of electricity by residential customers (Rate 10) to have increased by 9% since 2014 (from 982 GWh in 2014 to 1,069 GWh in 2017), and a 5% increase in residential customers for the same period.

Interestingly, the total number of registered JPS customers stood at 572,337 in 2017, which represented only 65% of all households (using 2011 Census estimates). According to the 2011 Census, 91% of the total households reported using electricity as their main source of lighting. The difference between the JPS registered customer base and the number of households actually using electricity may be indicative of informal arrangements.

Jamaica's SDG Country Profile (Sachs *et al* 2018, p 247) indicated that Jamaica was making good progress on this goal, with a reported 97.1% of the population having access to electricity in 2017.This is also consistent with the IEA 2016 estimate of 98%. It is likely that there is considerable sub-national variability in this, with rural populations having less access to electricity than urban populations. The IEA estimates that in 2016 Jamaica's rural electrification rate was 95.6%.

8.4 Conclusions

Road and rail transportation are the largest users of imported fuel, and are likely to have a major impact on urban air quality, where vehicle traffic is densest. There is a tremendous opportunity here to reduce carbon and other combustion emissions by electrifying road transportation fleets. The second major opportunity is associated with the high oil dependency of the electricity generation sector (which uses 26% of total petroleum consumed), with renewables contributing less than 2% of the total energy mix (2017). In the review period, there was a shift to modernization of the electricity generation sector to reduce losses and utilize natural gas, while contributions from renewables slowly ramped up. Increasing use of renewables reduces GHG and other emissions that adversely impact air quality, but also

[117] World Bank, Sustainable Energy for All (SE4ALL) database from WHO Global Household Energy database.

[118] http://www.petrojam.com/products/residential Retrieved December 04 2018

increases national energy security and improves the balance of payments as it minimizes reliance on imported fuels.

Jamaica's performance, in terms of energy intensity (efficiency), is generally good, but has declined in the review period, according to the IEA. The proportion of the population with access to clean domestic fuel and electricity in 2017is estimated at 91% and 97% respectively.

9. Extractive Industries

Scorecard 9: Extractive Industries (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
INTENSITY	Bauxite mining remains the most important extracted ore, followed by limestone/marl production. The environmental footprint of these operations is likely to be more important in forested or ecologically sensitive areas. Sub-sectors with smaller production (e.g. river or beach sand extraction) may have more adverse environmental effects.	UNABLE TO DETERMINE BASED ON AVAILABLE DATA	1	1

Photo: Bauxite mining in central Jamaica by Shanti Persaud-Levy

9.2 Environmental Linkages

Mines and quarries fall under the category of National Outcome #12, National Goal #3 of the Vision 2030 Jamaica National Development Plan (NDP), which seeks to lay the foundations of a more prosperous Jamaica by ensuring there are internationally competitive industry structures. This goal maps to SDG 12, which seeks to ensure sustainable consumption and production patterns. SDG Target 12.2 is that, by 2030, countries would have achieved sustainable management and efficient use of natural resources. Sustainable management implies that environmental impact associated with extraction assumes that reasonable efforts are made to avoid significant adverse impact, or to minimize long-term (inter-generational) or persistent losses and rehabilitate or restore disturbed ecosystems to baseline conditions or better. Efficient use implies that, where trade-offs or environmental compromises are made in favour of economic benefits accruing from mining, natural resources (land, extracted materials, water, and energy) involved will be used with minimum wastage.

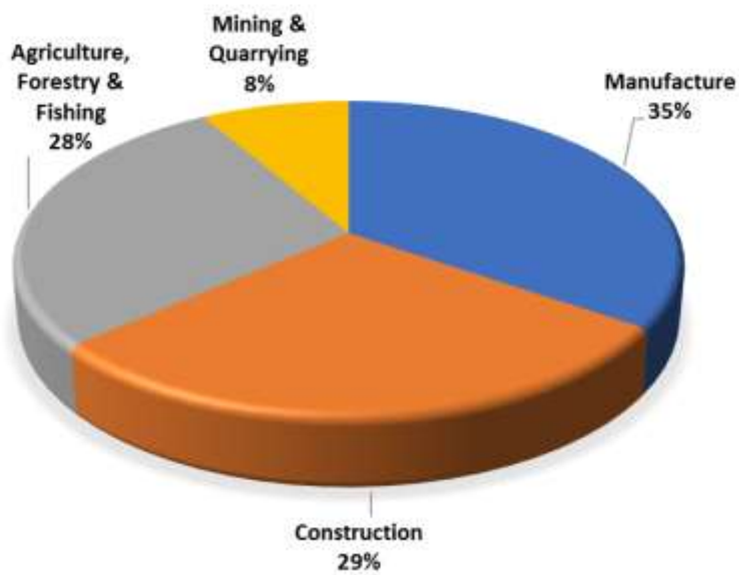


Figure 45 Goods Producing Industry (Value Added by Industry at 2007 Prices) PIOJ 2018a

Jamaica currently extracts bauxite (a metallic mineral), various other non-metallic industrial minerals, (e.g. gypsum), and quarry materials such as sand, gravel, silica sand, stone (mainly limestone).The Mining and Quarrying sector was estimated to account for2.1% of national GDP of Jamaica, which is marginally less than its contribution in 2013 (2.3%). According to the PIOJ (2018a) the value-added (at 2007 prices) of this sector has been in decline since 2015, falling 8% to a low of US $15,803 million in 2017. In 2017 the Mining and Quarrying sector was the smallest contributor to value-added estimates for goods produced in Jamaica (PIOJ 2018a; see Figure 45). The relative value-added by primary industries (agriculture, forestry, fishing, plus mining and quarrying) contributes ~36% of the total value-added goods production. The contribution of primary industries remained constant over the review period.

A key distinction between a mine and a quarry is the fact that minerals are produced in mines, and materials like stone or aggregate are produced in quarries. In some countries like the UK a mine may be legally defined as an underground working, whereas a quarry is a site of material extraction without a roof. This is not the case in Jamaica, where many bauxite ore mines are at surface, with any overburden being first removed (open cast mining).

Box 9 Mines vs. Quarries

Environmental impact associated with extractive industries in Jamaica include:

- **Land encroachments** When forested lands are encroached on, the result is a loss of biomass, soil erosion, soil degradation, water pollution, habitat fragmentation, changes to hydrology and micro-climates as well as deleterious impact on biodiversity (both flora and fauna). When lands used either legally or informally by a community are encroached on, this can lead to a temporary loss of amenity or livelihood for example loss of pasture to silica sand mining, or the creation of hazards such as increased flooding).

- **Consumption of land** associated with excavation sites, haulage routes, staging areas, settling ponds and secondary processing;
- **Consumption of raw water** to control dust, for excavation operations, or for production activities;
- **Consumption of fuels** for electricity, transportation and equipment and generation of associated greenhouse gases (GHGs);
- **Generation of waste materials**, including mine waste), storm water run-offs, and sewage from workers. Metal ore processing can have especially far-reaching adverse impacts on the pH of groundwater as well as contaminant loads related to the environmental impact of the residue disposal sites. There can be high concentrations of total suspended solids and oil and grease from equipment in receiving water bodies associated with mines;
- **Development of haul roads into environmentally fragile areas**, which opens up the areas to continued human exploitation after material extraction is completed (e.g. small farming, logging);
- **Haulage of quarried materials over public roads** increases wear and tear on these roads , with attendant maintenance costs if payloads are not properly secured or are overloaded. The haulage vehicles can also increase road related hazards;
- **Generation of night-time lighting** (security) as well as operational fugitive dust (other air emissions); noise from mining/quarry operations at the site, and along transportation corridors (road and rail haulage) to processing sites, and at processing plants themselves. This kind of impact affects not only ecologically sensitive populations (e.g. bats and birds) but also human populations;
- **Mines and quarries that are not properly rehabilitated can create additional** negative impact. Bauxite mines that are not restored to the required standards for housing can cause problems if this was not the intended land use at the time of rehabilitation works; bauxite is generally mined in limestone terrain; if sinkholes and caves become blocked by impervious fill or materials such as clay, it can lead to ponding of storm water, flooding, and possible loss of aquifer recharge. Limestone quarries can create major visual intrusions in that hillsides are scarred. They can also lead to changes to drainage patterns in the quarry floor, dust nuisance, and the threat of landslides from unstable slopes.

9.3 Indicator Trends and Patterns

9.3.1 Intensity Indicators

Bauxite: Vision 2030 Jamaica NDP recognizes the importance of bauxite as an economic mineral in Jamaica, and notes that it is "*vulnerable to international competition and fluctuations in the global economy and commodity markets".* Average earnings from the bauxite/alumina industry over the review period was ~US$634 million per year, with 2014 being the best year; industry earnings closed at US$672 million.

Bauxite ore is either exported as crude bauxite or processed to yield alumina. Between 2013 and 2015, the ratio of produced crude to processed bauxite was roughly 1:1. In 2016, the amount of bauxite being used for alumina was roughly 33% more than crude bauxite, and in 2017 this figure climbed to 44%. This demonstrates a trend towards increased processing of ore, which yields a higher profit.

In general, earnings from crude bauxite, in comparison to overall earnings in the bauxite and alumina sector, were less than 20% for the review period, decreasing to 13% in 2017. Since 2013, exports related to bauxite mining (i.e. made up of crude bauxite and bauxite processed into alumina locally) fell by 15%.[119]

Table 43 shows the production of bauxite and industrial minerals in the review period. Although bauxite is still the most important in terms of quantities (~almost half of the total for 2017), it showed a 13% decrease in production over the period.

Table 37 Minerals and Stone Production 2013-2017 (Source: PIOJ 2017b)

Mineral ('000 tonnes)	2013	2014	2015	2016	2017*	Change between 2013 and 2017 (%)
Bauxite	9,435	9,677	9,627	8,540	8,245	-13%
Marl and Fill	1,198	10,312	4,304	3,013	3,524	194%
Limestone	1,949	2,138	1,961	2,748	2,912	49%
Sand and Gravel	1,902	2,118	2,208	1,767	1,996	5%
Shale	205	308	241	181	357	74%
Pozzolan[120]	112	129	108	129	95	-15%
Gypsum	48	45	43	50	46	-4%
Silica Sand	16	16	16	20	23	44%
Clay	12	0.2	0.4	0.4	0.5	-96%
Marble	0.1	0.1	0.1	0.1	0.2	100%
TOTAL	**14,877**	**24,743**	**18,509**	**16,449**	**17,199**	
** preliminary*						

Limestone: Of the main non-metallic materials that are mined/quarried in Jamaica, marl and limestone are the most important categories. Limestone is by far Jamaica's most abundant natural resource. It is estimated that there are over 150 limestone and sand quarries operating on the island.[121] Limestone has a wide range of uses including whiting for toothpaste, aggregate (crushed), and for making concrete blocks. Marl is typically used as fill material in construction and as sub-grade for roads. Both the marl and limestone sub-sectors showed solid growth in the review period (Table 37), with marl production almost tripling (to ~3.5 million mts in 2017 from ~1.2 million mts in 2013) (PIOJ 2017b). In addition, limestone production increased by a million mt from 2013 levels (49% increase). However, as limestone production climbs, without proper management environmental issues (dust, landscape scarification, loss of limestone forest; possible hill slope instability etc.) are also expected to increase.

Sand and Gravel Aggregate: annual production fluctuated, with an average annual production of ~2 million mt. Production for 2017 was up by ~5% over 2013 levels. As in the case of other sub-sectors, sand and gravel quarries come with their own suite of environmental impact issues, including changes to

[119] Economics Division, Jamaica Bauxite Institute, personal communication 2018

[120] Pozzolan is a very finely ground pumice. Typically pozzolan is used as **cement** replacement rather than **cement** additions. The use of natural pozzolans results in a reduction of CO_2 emissions associated with Portland cement production. A 50% Portland cement replacement by a natural pozzolan would mean a reduction of such greenhouse gas emissions in cement production by one half, which could have enormous positive consequences for the environment. https://www.sciencedirect.com/topics/engineering/natural-pozzolans

[121]http://www.developmentminerals.org/index.php/en/countries/jamaicaRetrieved December 05 2018

the stability of clastic beaches and river banks, riparian disturbances; changes in hydraulic properties and river pathways, possible hazard creation, sedimentation downstream, and other effects.

Other quarried materials showed relatively modest growth (Table 37). With the possible exception of silica sand, production in these smaller sub-sectors showed minor fluctuations over the review period.

No data are available in respect of quantities of carbonate sand that may have received quarry licences for the review period. However, there are some significant issues related to this sub-sector. Carbonate sand is described in depth in Box 10.

Beach sand mining in Jamaica is cause for grave concern, as it has the potential to be very damaging to the stability of borrow areas[122] resulting in shoreline erosion, loss of turtle nesting areas and inter-tidal habitats as well as potential negative effects on coastal infrastructure (e.g. bridges or roads) and fish landing sites.

White sand beaches are mainly made up of carbonate shells of marine organisms (bioclasts) that live in the nearshore area immediately adjacent to the beach. Typically, white sand beaches found along the north coast of Jamaica (in the parishes of St. Ann and Trelawny in particular) have been the subject of illegal beach sand mining. White sand beaches are a critical part of Jamaica's north coast brand of sand-sand-sea sold to the mass tourism market. Legal sand mining has also caused outcry from locally impacted communities.

With climate change and climate variability associated with global warming, it is expected that the normal annual patterns of sediment movements (summer accretion and winter erosion) will change, and be more sensitive to storm activities, with longer beach recovery periods needed. This situation is likely to have an impact on the tourism industry, increasing the demand for white sand to help with beach recovery from storms and winter erosion cycles. Although this sub-sector of the quarrying and mining industry is relatively small, in direct economic terms, it has far reaching environmental and tourism implications.

Beach sand mining is regulated under the Quarries Control Act (1984), the Beach Control Act (1956) and the Natural Resources Conservation Authority Act (1991).

Box 10Beach Sand Mining in Jamaica

9.3.2 Land Use/Land Cover Change (LULC)

While the following indicators give a reasonable picture of economic performance of the sector, in terms of production and earnings, these are only proxy indicators of environmental performance in the sector- indicators that address issues of encroachment into or proximity to environmentally sensitive areas or the LULC change that occurred after rehabilitation. However, at this time, environmental KPIs for the sector are not monitored. Some limited information is available about the environmental footprint, but these data are not disaggregated. Therefore, it is not possible to evaluate the environmental impact of the sector. For the purposes of the SOE, indication of spatial extent of mined -out or rehabilitated lands is virtually meaningless without geographic context.

According to the MGD, all pit areas certified (PACs) and related swell areas (adjacent lands that are disturbed while ore body is being reclaimed) have been certified as rehabilitated every year since 2013. On average, the annual net swell area, as a proportion of the PAC, ranged between 24% and 57%. Since 2014, the total swell area has been increasing steadily, although the total annual PACs has declined significantly since 2013 (when it was 394 ha) to ~183 ha in 2017.

9.3.3 Material footprint per capita of GDP

The available mining/quarrying intensity data give an indication of the relative economic importance of the sector but are not considered good environmental KPIs. SDG Target 12.2 specifies sustainable

[122] Borrow area, also known as a sand box, is an *area* where material (usually soil, gravel or sand) has been dug for use at another location.

management and efficient use of natural resources, in support of ensuring the goal of sustainable consumption and production. The relevant indicator is the material footprint per capita, where material footprint (MF) is "*the amount of raw materials extracted globally that are used to meet the domestic final consumption demand of a country.*"[123] Based on this definition, it is the net amount of raw materials used by a country, taking imports and domestic production into account against exports, expressed in metric tonnes/capita. Unfortunately, there is insufficient data at this time to calculate the MF/capita. The PIOJ (2017b) reported on the imported and exported raw material in terms of dollar value for 2015, and reports mining and quarrying production as a percentage of the GDP). The MF value was not assessed in Sachs et al 2018.

9.4 Conclusions

Bauxite mining is likely to have the largest environmental impact, as gross production in 2017 was almost half of all material extracted. However, the relative importance of bauxite declined in the review period (moving from 63% of all extracted material produced in 2013 to 47% in 2017). Much of this change was due to increases in marl/limestone production which grew from 21% of all material produced in 2013 to 37% in 2017.

The environmental footprint of the mining and quarrying sector is difficult to gauge from the available intensity indicators. The footprint is likely to be proportionate with the physical area impacted. It is estimated, for example, that total area of quarries involved in mineral development was relatively small at ~769 ha (Lewis et al.2017). However, it should be noted that the physical footprint (land take[124]) is not the same as the environmental footprint, and there is likely to be far reaching environmental impact related to ecosystem services, biodiversity, energy, water, waste, hazards and air quality that are not necessarily represented in an assessment that is limited to the physical footprint of mining operations.

The location of mines relative to environmentally sensitive areas

as well as the physical extent and nature of operations are more important to SOE reporting than raw production changes. Moreover, cumulative environmental effects may also be quite important; while the effects of one small mine may not be cause for concern, at a national scale there may be VECs that are disproportionately impacted.

[123] https://unstats.un.org/sdgs/report/2017/goal-12/Retrieved December 05 2018

[124] Land Take refers to change in the amount of agricultural, forest and other semi-natural and natural land taken by anthropogenic land development.

10. Manufacturing

Scorecard 10: Manufacturing (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
INTENSITY (BY SUBSECTOR)	• Cement production remained close to 2013 levels. • Marginal decline in CO2 emissions related to cement production.	VERY HIGH	3	3
	• Alumina production declined by 4%, and exports declined by 8% since 2013. • 1.83 million MT red mud added per year Ewarton and Clarendon facilities).	MODERATE	3	3
	• Crude oil imports for refining declined 14% between 2013 and 2017.	HIGH	3	3
	• Construction value-added to the GDP grew by 4% since 2013.	HIGHER IN RURAL AREAS	3	3
	• Sugar and molasses production fell by 40% between 2015 and 2017. • Rum production fell by 20% in the same period.	VERY HIGH	3	3

Photo: Port Kaiser, Jamaica, by Shanti Persaud. Used with permission.

10.2 Environmental Linkages

The manufacturing sector is comprised of what can be considered secondary industries (cement production, petroleum refining, and sugar by-products), with primary industries being extractive ones like forestry, mining and quarrying. Manufacturing involves value-adding to raw materials, and is driven by the basic need for economic growth. Alumina processing has not been included in the economic reporting for this sector, although it is a value-added product. The value-adding processes typically require less land space and water inputs than primary industries, but tend to be more energy intensive.

Secondary industries also create direct environmental pressures on natural resources (raw materials), air quality (through process and energy use emissions), climate (through CO_2 emissions), and ecosystems (mainly terrestrial) and through wastewater or effluent discharges. Inadequate management systems (i.e. containerization, maintenance of bulk storage or conveyance/piping systems) for raw materials and products can also increase the risk of unintentional release of polluting materials to the environment, which can have deleterious effects on air quality, soils and aquatic habitats. Solid waste generation also creates pressures on municipal services and landfills. These environmental impacts must be balanced or, to some extent, traded off against the wider social and economic benefits created by the secondary industries involved in manufacturing.

In the review period the manufacturing sector accounted for a little over a third of the value-added goods produced in Jamaica (PIOJ 2018a).The MICAF 2016 Annual Report indicates that, as a whole, the sector grew by only 0.2% in 2016 (relative to 2015; MICAF 2016). Manufacturing Value Added (MVA), as proportion of GDP, remained at ~8.5% for the review period, with the bulk of that growth attributed to food and beverage sub-sectors (PIOJ 2018a, JAMPRO 2017; Table 38). Negative manufacturing growth was recorded in 2017, which is in line with the negative growth in GDP experienced in 2017. In general, Jamaica's GDP and, in particular the manufacturing sector, has demonstrates very slow growth in recent times, compared to other nations.

Table 38 Manufacturing KPIs (Source: World Development Indicators -World Bank)

Year	MVA* /capita	MVA/GDP (%)	MVA growth/a	GDP growth/a
2013	404.41	8.5	0.03	0.04
2014	391.02	8.4	0.03	0.03
2015	388.19	8.5	0.00	-0.02
2016	370.84	8.5	0.04	0.01
2017	384.76	8.6	-0.04	-0.05

**MVA = manufacturing value added*

Although manufacturing export earnings fell by 38% between 2013 and 2017 (from US$794 million to US$574), the sector employed 10% more workers than it did in 2013 (with 79,675 manufacturing jobs in 2017) accounting for 6.6% of the total employment (PIOJ 2014b and 2017b). Jamaica's economic wellbeing relies on the creation of a balance between manufacturing value-adding and sustainability in the exploitation of and impact on natural resources.

10.3 Indicator Trends and Patterns

10.3.1 Sub-Sector Intensity Indicators

Cement: Since 2013, cement production has increased by 2.6%, to 845,932 tonnes in 2017 (CCCL 2018), after peaking in 2016 (at 911,325 tonnes). In Jamaica, one company produces clinker and cement. The main environmental concern with this subsector is the CO_2 emissions which are associated with the decarbonation process involved in clinker[125] production. Using a standard factor to estimate CO_2 emissions from clinker production (Andrew 2018) and reported cement production (CCCL 2018), CO_2 emissions are shown in Table 39. During the period 2014-2017 clinker production peaked in 2015 at 804,296 tonnes, but returned to 2013 levels by 2017 (691,588 tonnes in 2017 compared to 696 077 tonnes in 2013). Process CO_2 emissions, therefore, remained at roughly the same as 2013 levels.

Table 39 Clinker and Cement production and CO_2 emissions (Source: CCCL 2018)

Year	Process CO_2(t)	Clinker Production (Kt)	Clinker Exports (Kt)	Cement Production (Kt)
2013	362	696.1	36.6	824.9
2014	413	795.0	155.4	830.1
2015	418	804.1	180.4	807.8
2016	396	761.1	395.4	911.3
2017	360	691.1	33.5	845.9

Globally, the cement production industry is responsible for ~5% of all CO_2 emissions. However, recent research has documented that concrete carbonation has the potential to off-set the embedded carbon footprint associated with its initial production (Possan et al 2017). Other environmental issues with cement production include energy consumption and fugitive dust emissions. CO_2 emissions from fuel consumption occur as a result of the process of heating up the kiln (to temperatures well in excess of 1400 ^{o}C).

Alumina: alumina is produced by three main plants (Table 40): JISCO ALPART Alumina Jamaica Ltd. (formerly Alpart), Jamalco, and the West Indies Alumina Co (WINDALCO). Since 2013, alumina production declined by 4%, with average annual production of 1.83 million mt produced annually between 2014 and 2017. Average annual export of alumina also declined (~8%) since 2013.

Table 40 Alumina Production Capacity in Jamaica (2017)

Company	Alumina Production Design Capacity (million metric tonnes per year)	Plant Location
Alumina Partners (JISCO)	1.65	Nain, St Elizabeth
Jamalco (Clarendon Alumina Production/GoJ and Noble Resources Ltd)	1.45	Halse Hall, Clarendon
WINDALCO (Rusal)	1.28 (583 KT produced in 2017[126])	Ewarton, St Catherine Kirkvine, Manchester (closed)

The main environmental impacts are directly proportionate to the quantity of alumina production (WAO 2018). The environmental impact of alumina refineries is listed in Table 41.

[125] Cement is made by adding a small portion of gypsum to clinker. Clinker is made by heating raw materials (limestone and silica) to a very high degree

[126] https://www.reuters.com/article/us-usa-sanctions-rusal-operations-detail/factbox-rusals-overseas-operations-key-to-supply-chain-idUSKBN1HO2E3 Retrieved December 05 2018

Table 41 Environmental Impacts of Alumina Processing

Cause	Environmental Impact	Quantifier
Red mud tailings (sodium hydroxide) and residues	Groundwater contamination.	Generally, one ton of red mud per ton of alumina produced. Therefore, on average, 1.83 million tons of red mud waste per year was added to the existing ponds over the review period.
Particulate emissions	Air quality (dust) in host communities	No factor available
Energy demand	CO2 emissions	2.87 million barrels oil consumed with an estimated CO_2 emission of ~1.23 million mt in 2017 Imports: ~42% Bunker C (to low Vanadium)
Sulphur dioxide and Nitrogen oxides emissions	Increased potential for acid rain[127] and associated ecological impacts.	No factor available
Other air pollutants (carbon monoxide; CO2, polycyclic aromatic carbons) and chlorides	Air quality (health impacts) and atmospheric warming.	No factor available
Water demand	Competing for potentially scarce natural resource.	0.9 m^3 of freshwater is need to produce one tonne of alumina (WAO 2018), so with 1.84 million mt alumina produced (annual average), water demand is estimated at 1.6 million m^3.

Of all the environmental effects associated with alumina production, the legacy red mud (bauxite residue) disposal ponds have, by far, the most large-scale environmental footprint. The first alumina refinery in Jamaica was established in the 1950s by ALCAN, (now part of Rio Tinto Alcan - RTA). When RTA sold its assets, it included 13 ponds (45 ha) at its Kirkvine plant in Manchester (now closed), the Mount Rosser red mud pond lake (37 ha) and several other landfills near to Ewarton. At the time of sale, six of the 13 Kirkvine impoundments were classified as "exposed ponds", where no restoration had been attempted. According to a 2013 RTA case report,[128] both the Kirkvine and Ewarton disposal sites have been significantly remediated and rehabilitated through revegetation. The company introduced 'soil-less' remediation in the mid-1990s, using gypsum and poultry manure

(Evans 2016).

Refining of Petroleum: For the review period (2014-2017), Jamaica imported an average of 20.5 million barrels of oil equivalent (BOE) per year. Crude oil imports have varied between 6.9 million barrels and 7.3 million barrels in the period under review. There was a 14% decline in crude oil imports between 2013 and 2017.

Air pollution is a major environmental consequence of oil refining, which is tied ultimately to the quantities being refined and the technologies being used. Air pollutants associated with oil refineries include: particulates, sulphur dioxide, nitrogen oxide, CO_2, carbon monoxide, methane, dioxins, hydrogen fluorides, chlorine, and BTEX compounds (benzene, toluene, ethyl benzene, xylene).[129] Other negative effects include noise, wastewater and solid waste generation.

[127] https://www.epa.gov/acidrain/what-acid-rain Retrieved December 05 2018
[128] http://www.riotinto.com/documents/RT_Prf6%20Jamaica%20case%20study.pdf Retrieved December 05 2018
[129] https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileID/14522 Retrieved December 05 2018

Construction: This sector accounts for an annual average contribution to the national GDP of 7.2%, and supplies almost 100,000 jobs. It is a major consumer of cement, sand, gravel and limestone, as well as a range of other products. The total value added by the sector has increased by ~4% since 2013. During the review period, a total of 16,510 construction permits were issued by the municipal corporations, averaging 4,130 permits per year. Almost half (43%) of all the construction permits issued were for the KMA, Portmore and St. Catherine areas. A total of 1,022 sub-division (residential) permits were issued for the same period, averaging ~250 per year. Almost 20% of all subdivision permits were issued for the parish of St. Catherine. Another 38% of the sub-division permits were issued for Clarendon (14%), St. Ann (13%) and Portland (11%).

JAMPRO (2017) reported that major tourism related construction projects accounted for capital expenditure of J$ 34 billion (Moon Palace, Hospiten Group, Secrets, Melia Braco Village, Royalton and Grand Bahia Principe).

While the construction industry creates jobs, adds building stock and stimulates the economy by demand for raw materials, its contribution has significant environmental repercussions, which tend to occur during the construction phase of development projects. These include:

- Change in LULC (which may involve loss of agricultural lands or loss of amenities to informal users of land, loss of habitat, disturbances of ecosystems, soil erosion etc);
- Carbon footprint (arising from the consumption of cement and transportation of construction materials);
- Nuisances during construction (e.g. haulage traffic, fugitive dust and noise, visual intrusion, night time light pollution);
- Alteration of surface hydrology (drainage), which may result in increased storm water run-offs, change in run-off coefficient, diversion of natural watercourses, loss of recharge area etc;
- Energy and water consumption; and
- Waste production: air emissions from equipment and vehicles; sewage and effluents from site; solid waste production from packaging materials, cuttings, food packaging.

At present, only large-scale construction projects and sub-divisions are subject to environmental impact assessments (EIAs);many of the smaller individual projects are not required to have environmental permits.

Sugar, Molasses and Rum: Sugar cane cultivation has been declining for many years. Consequently, sugar, rum and molasses production has also been falling. Figure 46 shows the dramatic fall-off in production of sugar cane products since 2015. According to STATIN data, in the last two years of the review period, sugar and molasses production[130] declined by almost 40%, and rum production fell by 20%. This decline is reflected in the export earnings of sugar and rum, which fell from US$101.4 million in 2013 to US$55.6 million in 2017 (PIOJ 2015; 2018).

[130]Molasses represents on average 20% of the total tonnage reported for sugar and molasses production.

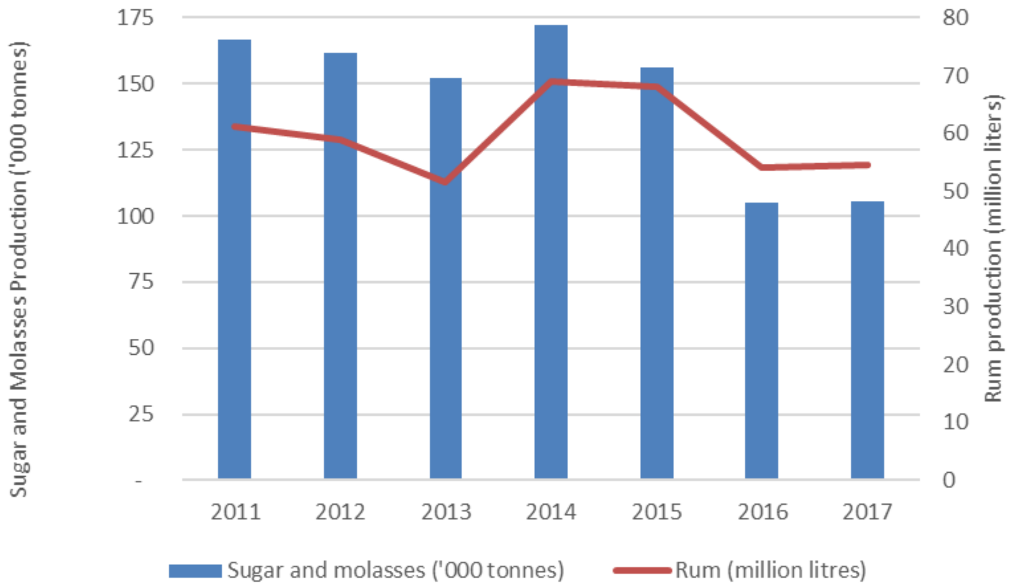


Figure 46 Sugar, Rum and Molasses Production (Source: reproduced from Statistical Institute of Jamaica)

As with the case of other manufactured goods, the environmental impact is proportionate to production. With the contraction of the industry, it is expected that some of the worst environmental issues associated with sugar cane processing may see some reduction. These include effluents from sugar and rum production (dunder), which contaminate water with high turbidity, bacteria levels, residues and sugars. Dunder contributes to high BOD (biological oxygen demand), high COD (chemical oxygen demand) and low pH. It also produces a strong odour and colour and a bad taste in water. Dunder samples from Appleton Estate, St. Elizabeth (2014) indicated BOD and COD levels consistently in excess of the Trade Effluent Standards. Faecal coliforms, phosphate and sulphate levels also exceeded national standards in most samples tested in 2014. Sample data available for the Clarendon Distillery (2015) also showed non-compliant levels of BOD and COD, as well as high levels of copper. Both these operations were licenced to apply dunder to sugar cane fields by drip. Effluents from the processing plants in St. Andrew and St. Catherine (Worthy Park) generally tended to be more compliant with national trade effluent standards.

10.4 Conclusions

For the purposes of the SOE report, a few traditional manufacturing subsectors have been evaluated. There are many other manufacturing industry sub-sectors that have cumulative environmental impact (e.g. dairy milk producers, beer distilleries, feed mills, food processing plants, power plants). The industries that are discussed (cement, alumina, petroleum refining, construction and sugar products) are indicative of the range of environmental impact generally associated with manufacturing in Jamaica. Typically, these effects are associated with very intensive use of water and energy, and high levels of waste generation , including air emissions, effluents and solid waste.

There are a number of SDG Indicators (pressure) of relevance to manufacturing for which Jamaica's data are considered insufficient at this time. These data gaps include:

- **Indicator 12.2.1 Material footprint**. Goal #3 of Vision 2030 Jamaica NDP focuses on the need for a prosperous Jamaica. Under this goal, national outcome #12 speaks to creating competitive industry sectors, including manufacturing. This national outcome is consistent with the UN SDG #12, which focuses on responsible consumption and production. The relevant environmental pressures indicator required for this goal, not available for Jamaica, is the material footprint

(12.2.1), which is an estimate of the net raw materials (including forestry, fossil fuels, metal ores and non-metallic mineral production) consumed in a country, taking into account imports and exports.

- **Indicator 12.4.2 Hazardous waste generated (per capita)** and proportion of hazardous waste treated by type of intervention. The methodology to evaluate this indicator is still under development.
- **Indicator 12.5.2 National recycling rate** (tons of material recycled). The methodology to evaluate this indicator is still under development.
- **Indicator 12.c.1: Amount of fossil-fuel subsidies** per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels. This includes electricity as well as fuels. According to the IMF Working Paper (Di Bella 2015) "*Despite high technical and non-technical losses of about 24 percent, tariffs appear to be covering costs and the price-gap approach does not estimate any pre-tax subsidy*".

11. Transportation

Scorecard 11: Transportation (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
ESTIMATED # VEHICLES ON JAMAICA'S ROADS	The total number of vehicles registered in Jamaica has increased by 40%. The highest increase has been for motor cycles (81%) followed by cars (42%).	HIGH	3	2
ESTIMATED ROAD NETWORK IN KILOMETRES AND DENSITY	There has been an increase of 43% in the length and density of Jamaica's roads network in the 2009-2017 period.	MODERATE TO HIGH	3	2
NO. SHIP CALLS (BY PORT)	There has been a slight (5%) increase in total overall number of ship calls. Montego Bay has experienced the highest increase (109%).	MODERATE TO HIGH	3	2
ANNUAL AIR TRAFFIC (PASSENGERS AND FREIGHT)	Air traffic has increased, both in the number of passengers (14%) and quantity of freight (10%) arriving at Jamaican airports.	MODERATE	3	2

Photo: Transporation hub in Jamaica, NEPA. Used with permission.

These indicators reflect the intensity of the various modes of transport in Jamaica but are not direct indicators of the effects of transport on the environment. The increase in the number of registered vehicles and licenses indicates an augmentation in fuel used for transportation and associated emissions. Marine and air traffic have increased in the 2014-2017 period. In addition, specific concerns are associated with increases in each mode of transportation. For example, the expansion of roads contributes to the degradation of habitat quality and has an impact on biodiversity, while the operation of ports and airports can cause environmental incidents such as oil spills and have an impact on wildlife.

11.2 Environmental Linkages

The need for transportation and associated infrastructure is mainly driven by population and economic growth. Sustainable transportation can enhance economic and social growth, promote linkages between rural and urban areas, improve accessibility and facilitate the integration of the economy (UN 2016). In the 2030 SDGs, the conditions for a sustainable transport infrastructure and activity are mainly captured[131] in the SDG 3 (health)SDG 9 (resilient and clean infrastructure)and SDG 11 (sustainable cities and communities). In terms of Vision 2030 NDP, these primarily relate to the National Outcome #15 (sustainable urban and rural development).

Jamaica has a multi-type transport infrastructure (Figure 47) which includes the following: a main road network throughout the island; three international airports and four domestic aerodromes; three public deep-water ports and nine ports dedicated to specialised commodities; a mainline railway system, and six privately owned mining railway lines (Ministry of Transport and Works 2007).

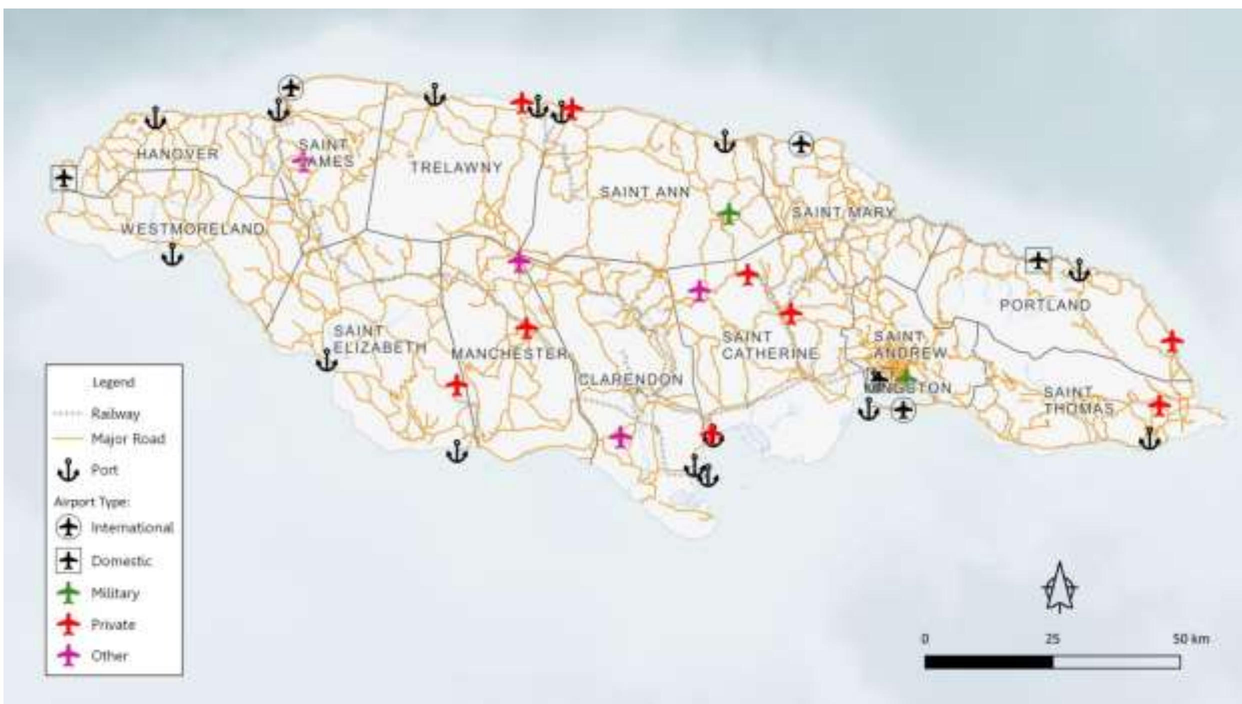


Figure 47: Transportation infrastructure in Jamaica

Transport infrastructure and activities have multiple effects on the environment (van Essen 2008). The emissions from transport vehicles contribute to air pollution and climate change. Air pollutants and noise cause nuisance and health risks for nearby communities, and transport infrastructure itself is responsible for habitat loss and degraded habitat quality. As the data for the indicators in this section

[131] https://sustainabledevelopment.un.org/topics/sustainabletransport Retrieved December 05 2018

suggest, transport activity in its different forms (road, marine and air) has been steadily increasing in Jamaica in recent years.

- **Air pollution:** Air pollution from road transport has been identified as a main concern for urban environment for many years.[132] Increased motor vehicle use affects air quality through the emission of certain pollutants, including: SO_2, NO_2, volatile organic compounds (VOCs), PM, ozone, carbon monoxide (CO) and lead. Some of the increased health effects in the last decade such as respiratory tract infections, eye irritations, cardiovascular disease and skin irritations have been attributed to worsening air quality (NEPA 2010a).
- **Greenhouse gas emissions (GHGs):** Greenhouse gas emissions are another key impact. The land transport sub-sector is an important consumer of petroleum, accounting for 21% of total consumption in 2006 (Transport Task Force 2009) and 42% in 2010 (NEPA 2010b).
- **Noise emissions:** Noise emissions are a non-persistent environmental impact of motor vehicles. Traffic noise can have greater impact where there are noise-sensitive receptors such as schools, hospitals, offices, residential and ecological areas. Generally, the intensity of this impact is greatest during peak traffic hours and in areas with high motor vehicle densities.
- **Terrestrial ecosystems:** Road construction has also contributed to the loss of ecosystems such as wetlands (Ministry of Land and Environment *N.D.*). Historically, the construction of access roads for bauxite mines as well as the expansion of the road network into forest areas has led to increased deforestation (NEPA 2010b).
- **Erosion and runoff:** Weather extremes and changes to th**e** climate are affecting the transport system in Jamaica and, by extension, the ecosystem. A recent report (Zermoglio and Scott 2018) analy*zed* the vulnerability of the transport sector under changing climate conditions. Roads and other impermeable surfaces have reduced the absorptive capacity of the landscape, exacerbating erosion from flooding caused by extreme storm activity. Erosion and increased runoff from roads can pollute water bodies and coastal areas.

11.3 Indicator Trends and Patterns

11.3.1 National Motor Vehicle Fleet

The intensity of transportation related environmental impact is directly proportional to the number of vehicles on the roads. Data are available from the Tax Administration of Jamaica (data cited in Potopsingh2018) on the numbers of registered vehicles that comprised the national fleet during the period under review (Table 42). Between 2013 and the end of the review period (2017) the national fleet doubled, with the number of registered motor cars increasing to over half a million. The number of motor cycles on the road also dramatically increased by a factor of almost seven times (2013 levels).

Table 42National Motor Vehicle Fleet (2013-2017)

Vehicle type	Number of registered vehicles				
	2013	2014	2015	2016	2017
Motor cars	265,122	269,524	36,6002	424,701	507,797
Motor trucks	76,370	76,100	12,2262	134,408	150,470
Motor cycle	8,779	10,024	48,073	53,149	58,705
Trailers	1,745	1,602	5,128	5,395	5,661
Motor tractor	431	405	1,299	1,340	1,402
Total	**352,447**	**357,655**	**542,764**	**618,993**	**724,035**

[132]Jamaica's National Environmental Action Plan (JANEAP) for the 1999-2002 period first raised the concern

In general, motor cars comprised 70% of all registered motor vehicles, while trucks comprised another 21%. In 2017 there were roughly 265 motor vehicles per thousand people in Jamaica, compared to 130 motor vehicles per thousand people in 2013. While this is indicative of improving social equity, it also points to increasing intensity of associated environmental impact, and fuel-related emissions per capita. In general, due to increasing fuel efficiencies the rate of carbon emissions per unit distance is declining in Jamaica (estimated by Potopsingh 2018 at ~167 g CO_2/km in 2017 compared to 200 g CO_2/km in 2005).The potential for air pollution from motor vehicles is also affected by the age and condition of the vehicle. It is estimated (Potopsingh 2018) that in 2017 the average age of newly registered vehicles in Jamaica was 3.82 years.

11.3.2 Road Network

Jamaica's road network consists of both publicly and privately operated and maintained roads. The total length of the road network, including main, parochial, forest and farm roads, is estimated at 22,077 km (Table 43) (Ministry of Transport and Mining).

As expected, the Kingston Metropolitan Region (KMR) has the highest road density (~94 km/km^2). All other parishes have road densities ranging between three km/km^2 (St. Catherine) and one km/km^2 (Trelawny). This parish density is an average, and it is likely that road densities are higher in the more urban areas around parish capitals than in the more rural areas of the same parish. The density of roads within an area is a good indicator of the extent of fragmentation or disturbance to a landscape (Meijer et al. 2018). The specific thresholds vary according to the species or habitat under study, but a road density of 0.6 km/km^2 has been identified as an apparent threshold value above which natural populations of certain large vertebrates decline (Beazley et al 2004).

The Sector Report of Jamaica's 2030 Vision (Transport Task Force 2009) reported a total of 15,394 km of road network in 2009, including: 844 km of arterial roads, 717 km of secondary roads, 3,225 km of tertiary roads, 282 km of urban roads, and 10,326 km of parochial roads. This means that there has been an increase of 43% in the length and density of Jamaica's road network since the baseline year of 2009.

Table 43 Road network in Jamaica by Parish (Source: Ministry of Transport and Mining2018)

Parish	Farm road (km)	Forest road (km)	Main road (km)	Parochial road (km)	Total (km)	Area (km^2)	Road density (km/km^2)
KMR			243.48	1,800.00	2,043.48	21.8	**93.7**
St. Catherine	262.2		457.05	3,000.00	3,719.25	1,192.40	**3.1**
St. Mary	378	7.25	274.57	863	1,522.82	610.5	**2.5**
Portland	340.8	33.75	287.07	1,141.00	1,802.62	814	**2.2**
Manchester	31.8		398.22	1,225.00	1,655.02	830.1	**2.0**
St. Thomas	171.7	33.05	432	829	1,465.75	742.8	**2.0**
St. James	65.5		362.64	729	1,157.14	594.9	**2.0**
Hanover	156		231.6	406	793.6	450.4	**1.8**
Clarendon	54.5	3.2	494.59	1,360.00	1,912.29	1,196.30	**1.6**
St. Ann	87.2	1.6	423.24	1,265.00	1,777.04	1,212.60	**1.5**
Westmoreland	63.8		340.42	713	1,117.22	807	**1.4**
St. Andrew	140.8	36.35	395.89	*	573.04	430.7	**1.3**
St. Elizabeth	262.2		291.92	960	1,514.12	1,212.40	**1.3**
Trelawny	123.6		289.33	604	1,016.93	874.6	**1.2**
Total	**2,138.10**	**115.2**	**4,922.02**	**14,895.00**	**22,070.32**	**10,990.50**	

11.3.3 Marine Transportation

Marine transportation infrastructure includes ports, harbours and supporting intermodal terminals, and the ships and barges that use these facilities. In Jamaica, this infrastructure comprises three public cargo ports, four cruise ports and 16 private wharfs. The ports of Kingston, Montego Bay, Falmouth and Ocho Rios account for 90% of marine traffic.

The data (Table 44) for marine traffic show that the country's main cargo port (Kingston) has, by far, the most vessel traffic, accounting for 65% of all vessel calls in 2017. However, in 2013, Kingston accounted for 75% of all vessel traffic. This shift in the share of vessel traffic was due to a decline in the number of calls, as well as a relative increase in the number of vessels calling at the cruise ship ports at Montego Bay, Falmouth and Ocho Rios.

During the review period, Montego Bay more than doubled its share of marine traffic, from 7% in 2013 to 15% in 2017. This is likely due to increases in cruise ship calls over the same period. Other cruise ship ports (Ocho Rios and Falmouth) saw 5% increase in vessel traffic over the same period. Vessel traffic to all other ports remained roughly the same over the review period (~10% of total annual vessel traffic). Port Antonio continued to have very low traffic, with the number of vessel calls per year fluctuating between three (2016) and eight (2017).

Table 44 Number of ship calls in Jamaican ports, and change between 2014-2017 (2013-2017; Source: Pilotage Daily Reports (Port Authority of Jamaica))

Port	2013	2014	2015	2016	2017	% change (2014-2017)
	Number of ship calls (% of national traffic)					
Kingston (all)	2,669 (75%)	2,401 (72%)	2,383 (70%)	2,522 (70%)	2,281 (65%)	-5%
Montego Bay	236 (7%)	244 (7%)	324 (10%)	404 (11%)	511 (15%)	109%
Falmouth	156 (4%)	187 (6%)	190 (6%)	160 (4%)	181 (5%)	-3%
Ocho Rios	139 (4%)	146 (4%)	150 (4%)	178 (5%)	185 (5%)	27%
Port Antonio	3 (0%)	7 (0%)	5 (0%)	3 (0%)	8 (0%)	14%
Port Esquivel	75 (2%)	71 (2%)	58 (2%)	64 (2%)	77 (2%)	8%
Port Kaiser	-	-	12 (0%)	2 (0%)	13 (0%)	NA
Port Rhoades	120 (3%)	124 (4%)	106 (3%)	68 (2%)	75 (2%)	-40%
Port Bueno	30 (1%)	33 (1%)	31 (1%)	40 (1%)	47 (1%)	42%
Rocky Point	76 (2%)	82 (2%)	92 (3%)	94 (3%)	79 (2%)	-4%
Other ports	47 (1%)	46 (1%)	46 (1%)	51 (1%)	42 (1%)	-9%
Total	3,551	3,341	3,397	3,586	3,499	**5%**

11.3.4 Air Traffic

Airport facilities and air traffic are critically important to support the tourism industry as well as to serve the travelling public and, to some extent, to facilitate air cargo. In general, the main environmental impact associated with air traffic is carbon emissions from fuel consumption, which has a global impact. Other adverse operational effects are more localized, and include noise pollution, airport waste generation (sewage and solid waste), storm water run-offs (from extensive paved areas), energy and water consumption, as well as potential conflicts with migratory flying species (birds, bats, insects).

Passenger data are used as a proxy to indicate air traffic. Most of Jamaica's air traffic is routed through the Sangster International Airport (SIA), with ~72% of passengers using this airport (Table 45). The Norman Manley International Airport (NMIA) accounts for almost all the remaining passenger traffic. The other international airport (Ian Fleming) and all other aerodromes account for less than 0.2% of air traffic. Total passenger traffic (arrivals and departures) for Jamaica increased by 15.6% over the review period. The two main international airports saw increased passenger traffic of 19.2% (SIA) and 8.5%

(NMIA) respectively. There was a general decline in passenger traffic at all other airports during the review period.

Table 45 Passengers statistics (2012-2017) for all the airports in Jamaica (Source: Airports Authority of Jamaica (Annual Report 2016-2017))

Airports	Total number of passengers					% change (2014-2017)
	2012/13	2013/14	2014/15	2015/16	2016/17	
NMIA	1,462,072	1,370,893	1,467,993	1,553,928	1,586,362	8.06%
SIA	3,351,751	3,526,733	3,731,028	3,867,968	3,995,151	7.08%
Ian Fleming International Airport and other aerodromes	21,665	11,020	11,215	12,196	10,354	-7.68%
Total	**4,835,488**	**4,908,646**	**5,210,236**	**5,434,092**	**5,591,867**	**7.32%**

11.4 Conclusions

The indicators reported in the section refer to the intensity of the transportation activity and, therefore, provide an indirect indication of the impact of this pressure on the environment. Building on existing monitoring efforts, data collection should target the following indicators:

- Changes in road density per parish. The potential impact of a road depends heavily on its location (i.e., the impact of a road on an undisturbed forest is greater than the addition of a road in an already disturbed region). Data on road density would be made more meaningful if information on the proximity or overlap of roads with protected areas and other sensitive ecosystems was also collected;
- Environmental incidents (e.g., spills, effluent discharges, etc.) at airports and ports; and
- Incidents with wildlife, such as collisions, at airports and ports.

12. Tourism

Scorecard 12: Tourism (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ADVERSE IMPACT POTENTIAL	CONFIDENCE Grade	CONFIDENCE Trend
SPATIAL DISTRIBUTION OF ROOMS	87% of all hotel rooms are concentrated in the parishes of St Ann, Trelawny, St James, Hanover and Westmoreland. This has increased by 3% since 2014.	VERY HIGH	3	3
TOTAL NUMBER OF VISITORS	Combined total for stopover and cruise ship arrivals increased by 31% since 2013. Annual rate of increase for cruise ship arrivals is increasing faster than stopover arrivals. Example of increased pressure on resources: an estimated 40,000 mt of solid waste was produced by stopover guests in 2017.	MODERATE TO HIGH	1	3
PORT CALLS	There was an 62% increase in cruise ship calls at the cruise ports between 2013 and 2017. The Port of Montego Bay saw a 177% increase in calls for the same period. Ocho Rios had a 40% increase and Falmouth had an 18% increase in calls for the review period.	MODERATE TO HIGH	3	3
FRESHWATER DEMAND	Cruise ships replenish freshwater supplies – combined demand tripled in the review period (2013 to 2017) to 62,603 m^3. Estimated stopover freshwater demand for 2017 is of the order of 19.4 million m^3 and represents a significantly larger environmental pressure.	MODERATE TO HIGH	1	2

12.2 Environmental Linkages

During the review period Jamaica's tourism sector experienced substantial growth. This sector is very important to the Jamaica economy in terms of revenues and employment. The World Travel & Tourism Council (WTTC) has estimated that the direct contribution of travel and tourism to Jamaica's GDP was 10.3% in 2017 (compared to ~8% in 2013). Total contribution to GDP was estimated at 32.8% in 2017 (WTTC, 2018).The sector also directly supported 109,500 jobs in 2017, which was ~9.3% of the total employment (WTTC, 2018; see also Section 2.3.3). Total contribution of the sector to employment (including indirect jobs) was estimated to be closer to 30% of total employment (354,000 jobs).

The Jamaican tourism sector is dominated by coastal tourism (GoJ 2017a), mainly in the form of mass tourism (resorts with more than 2,000 rooms) and cruise ship tourism, with related activities concentrated along the north coast of Jamaica between Negril and Ocho Rios (see Figure 48). It is important to recognize that the environmental footprint of mass tourism and the cruise ship sub-sector is very different from lower intensity tourism (as seen in industry activity in the south and north-east coasts of Jamaica).

The relation between tourism and the environment is a symbiotic one in that, while tourism relies on the quality of the natural and human environment for its long-term viability (IISD 1993), tourism activities exert demands on the natural resources and infrastructure which place significant stress on the environment. Jamaican tourism is strongly dependent on a healthy coastal zone and associated ecosystems (GoJ 2017a). For example, coral reefs and sea grass meadows on the north coast of the island play a critical role in providing carbonate (bioclastic) sand for the beaches in this area (PIOJ 2006). White sand beaches created by coral are a powerful drawing card for international tourists (WRI 2011). Reefs are a major attraction for persons interested in snorkelling, diving and fishing tours, and also serve to protect coastal infrastructure and beaches from storm surges.

Along with overfishing and pollution, shoreline development is one of the main factors causing the degradation of Jamaica's coral reefs and sea grass meadows, which are important producers of carbonate (bioclastic) sediment that make up the popular white sand beaches. This degradation is an important factor contributing to the decline in the supply of beach sand which, when coupled with seasonal erosion cycles and extreme weather events, can result in persistent beach erosion.The quality of coastal waters (which are directly tied to public health, the provision of healthy coral reefs and fisheries, and visual landscape quality) are therefore critically important to the tourism experience which traditionally has been largely coastal.

Given the coastal locations, and reliance on good weather, the sector is also very vulnerable to the effects of climate change and variability, particularly as this impacts the frequency and magnitude of extreme hydro-meteorological events such as hurricanes, storm surges, heavy rainfall and heat waves.

While being heavily reliant on environmental resources, the tourism sector has strong potential to compromise these resources. The environmental impact associated with mass tourism is concentrated in the resort centres, including the physical footprint of the industry's infrastructure (including hotels, highways, drainage, water and energy supply, sewage treatment and waste disposal). Because of its reliance on the beauty and opportunities offered by the natural environment, tourist facilities are often built in environmentally sensitive areas. The physical and operational footprint of supporting facilities can disrupt the sensitive ecological processes that often occur in these areas, especially if facilities displace mangrove forests, salt ponds, or other delicate ecosystems. The development of tourist facilities in Jamaica has resulted in the removal of coral reefs and wetlands (Johnson 2014). The development and operation of desired facilities have also been significant contributors to marine biodiversity loss. (NEPA 2016).

Besides the physical impact of tourism infrastructure and facilities, the presence of tourists (including certain behaviours) can have adverse environmental impact in some particularly sensitive eco-systems. Mass tourism places significant pressure on protected marine areas in Jamaica, particularly if the **carrying capacity** of the natural system is exceeded. A ready example is the impact on coral reefs from recreational users. The mere presence of large numbers of snorkelers or divers in the water is often damaging to the delicate coral reef ecosystem. Construction and operational activities associated with tourism present a major threat to marine and coastal protected areas such as the Montego Bay Marine Park and the Negril Environmental Protection Area (Figure 48).

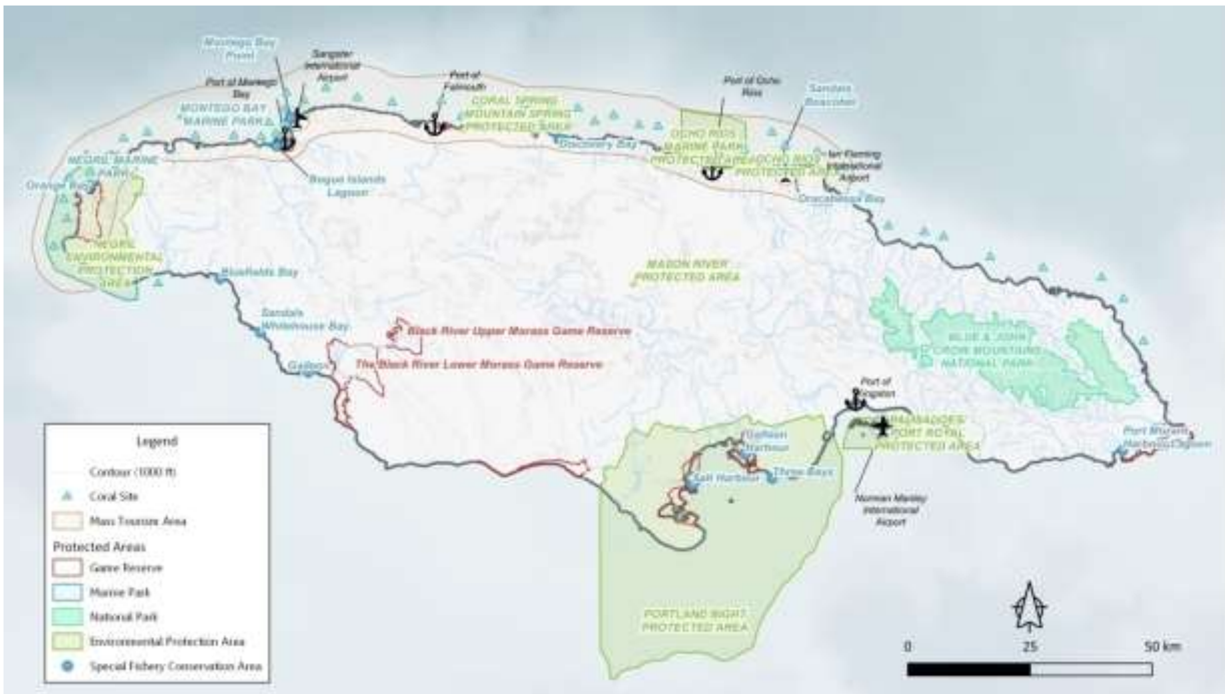


Figure 48 Location of Mass Tourism relative to Protected Areas and Coral sites (source: NEPA)

Resource exploitation (e.g. land take, demands for freshwater, food, tours, beaches, etc.) also accounts for a range of effects on natural resources along the supply chain such as demand for fresh water, food supply (including fisheries), consumption of carbon fuel for transportation of visitors, workers and goods. It is recognized that demand for these goods and services is important to the national economy, generating foreign exchange revenues, creating jobs, and allowing the positive economic benefits of tourism to trickle down outside of the immediate industry players. However, many of the enterprises that serve the needs for goods and services demanded by the tourism sector are small and diverse, and may not always fall within the statutory requirements for environmental permitting or monitoring, and consequently may be unregulated in terms of environmental awareness and empathy.

Coastal water quality may be impacted by storm water effluents from large paved areas (including parking lots that may contribute oil and grease. Treated sewage effluent (TSE) is likely to be re-used for landscape irrigation or outfalls directly to the sea or wetlands, which may result in higher nutrient loads. Fertilizer and pesticide use associated with landscaping and golf courses also contribute to the nutrient and contaminant load in the nearshore. High bather density can also increase bacterial loads in the beach areas.

Induced settlements–housing tourism workers create indirect environmental stress. While some planned and regulated medium to low-income housing schemes within proximity to tourist areas have been developed, many high-density informal or unplanned squatter settlements continue to grow close to major resort centres. These unplanned communities develop on marginal areas (such as unstable hillsides or vulnerable riparian zones), providing accommodation for tourism workers as well as those providing indirect services to the sector (e.g. transportation and entertainment). In the absence of adequate and affordable public transportation and low-income housing, these settlements facilitate persons who are unable to commute from more rural areas to work in the tourism sector. On the other hand, the negative environmental impact of these unplanned and unregulated settlements include many of those outlined in Chapter7:

There are also a range of social issues associated with these settlements including crime, sex workers, inadequate education and health care for vulnerable populations (such as children and the elderly), higher risk of communicable disease and exploitation of the poor (through low wages and inadequate work benefits).While most new resort or port developments require some level of environmental impact assessment (EIA), the cumulative effects of mass tourism and cruise ship tourism in Jamaica have not been assessed.

12.3 Indicator Trends and Patterns

Sustainable tourism falls under NDP Vision 2030 Goals #3 and #4, which focus on national prosperity and a healthy natural environment. National Outcome #12 in particular (under Goal 3) seeks to develop international competitive industry structures, particularly referencing tourism. This outcome maps to SDG 12 (Responsible consumption and production). National Outcome #13 (under Goal 4) seeks to foster sustainable management and use of environmental and natural resources, and maps to SDGs 14 and 15 (life below water and life on land respectively). As a result of close ties to other key sectors (agriculture, water, energy, transportation) and themes (poverty, gender equality, economic growth and decent work) the sector has potential to impact other SDGs and national outcomes indirectly.

Concentration of Hotel Rooms

In 2017, 87% of the 21,858 hotel rooms on the island were located on the North Coast (JTB 2018). These are recognized as having a high potential for environmental impact because of the intensity of demand for natural resources and proximity to sensitive coastal ecosystems that generate the natural capital used by these products (e.g. white sand, recreational tour experiences etc).

Figure 49 shows the 2017 distribution of hotel rooms by parish (with percentage of total number of rooms shown in brackets), which are aggregated into three main areas.

- **North Coast:** Hanover (13.4%), St. James (35%), Trelawny (4.5%); St. Ann (22.1%) and Westmoreland (11.2%)
- **South Coast:** St. Elizabeth (0.6%); Manchester (0.9%), Clarendon (0.4%), St. Catherine (1.1%), Kingston & St. Andrew (6.2%)
- **North-east Coast and East Coast:** St. Mary (3.2%); Portland (0.6%) and St. Thomas (0.4%)

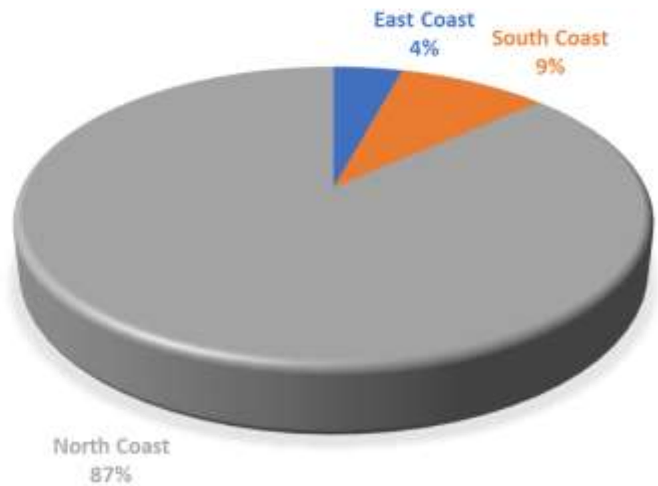


Figure 49 2017 Distribution of Hotel Rooms by Parishes (Source: reproduced from Jamaica Tourist Board 2018)

From the breakdowns given, it is evident that North Coast parishes (with the exception of Trelawny) have a higher share of the total number of rooms (ranging from 11% to 35%), compared to all other parishes where percentage shares by parish tend to be lower than 5% (with Kingston & St Andrew being an exception.).

In the review period, the Jamaica Tourist Board (JTB) reported a 16.5% increase in hotel rooms for the island, with much of that growth occurring in 2015-2016. However, the three main tourism areas grew at significantly different rates, with a 21% increase in rooms in the north coast area compared to 7% increase in rooms on the east coast, and a 10% decline in available rooms on the south coast over the review period. Hotel development was most significant in Trelawny, where the number of hotel rooms grew from 156 to 972. It is important to flag Trelawny as a hotspot for cumulative environmental affects, as the impact of construction on coastal ecosystems tends to be different from the operational impact that would likely affect the more established resort areas in St. James and St, Ann, in terms of intensity and scale.

The Jamaica Hotel and Tourist Association indicates that Jamaica has a target of 50,000 rooms by 2030 (GoJ 2017b), which is a 129% increase in the 2017 hotel room stock. In the review period there has been an increase in the concentration of rooms in the North Coast, moving from 84% in 2014 to 87% in 2017.

The Jamaica Roadmap for SDG Implementation (GoJ 2017b) notes that the focus has been "*developing large, all-inclusive 'sun and sand' hotels in major centres such as Montego Bay, Ocho Rios and Negril."* Given the increasing levels of regional competition and participation in the mass tourism and cruise ship markets, and the "*substantial external costs on the natural environment,"* the Jamaica Roadmap for SDG Implementation (GoJ 2017b) has indicated that a critical objective should be to prioritize diversification (and investment) of tourism to include alternatives to the mass/cruise tourism model.

If successful, this would result in growth in the number of rooms outside of the North Coast resort centre, and an increasing number of ecotourism and community-based tourism facilities. The proportion of rooms concentrated in the North Coast parishes (St. Ann, Trelawny, St. James, Hanover, Westmoreland) is considered a good indicator of progress towards spatial (and product) diversification. Clearly, reversing the trend to concentrate tourism investment on the North Coast will be challenging, given the fact that foreign investors are drawn to the successful model of the large-scale sun and sand tourism product and its proven viability.[133] A dependency on this mass tourism model has also been established with the preponderance of tourism infrastructure being located in this area, and relatively little in the other parishes that may have substantial natural assets to offer.

[133] The JTB annual reports (http://www.jtbonline.org/report-and-statistics/ (Retrieved December 04 2018)) indicate that on average for the period, the annual occupancy rate for all-inclusive hotels (which typically is used in the mass tourism product) is ~73% for the review period (2014-2017) compared to an average occupancy rate of 41% for non-all-inclusive accommodations for the same period.

12.3.1 Intensity (Number of Visitors)

Tourists can stress local resources through the demands for freshwater, energy (especially for cooling, transportation and lighting), food, souvenir and craft items as well as impact related to infrastructure supporting hotels, and tourism-related interactions with the natural environment (e.g. beach bathing, snorkelling, zip-lining). The total number of visitors is therefore a proxy indicator of this stress.

Cruise Arrivals

Figure 50 illustrates that the annual rate of growth in cruise ship arrivals is much faster than the corresponding rate for stopover visitors. The total number of visitors (stopover and cruise arrivals) increased by 31% between 2013 (3.27 million) and 2017 (4.28 million). In 2013, stop-over visitors accounted for 61% of the total arrivals, but by 2017 this figure declined to 55%, driven by significant growth (52% increase between 2013-2017) in cruise arrivals. Table 46 shows cruise ship calls by port for the review period and 2013.

The total number of calls increased from 364 in 2013 to 588 in 2017, representing a i62% increase, with an average annual growth rate of 13%. Montego Bay saw the most dramatic increase moving from 81% in 2013 to 224% in 2017 (177% increase). The ports of Falmouth and Ocho Rios saw increased numbers of calls as well (118% and 140% respectively).

In terms of relative distribution of calls, in 2017, Montego Bay received 38% of all cruise ship calls, while the Ocho Rios and Falmouth cruise ports received ~30% each. Of the four ports, Port Antonio receives ~1%, and this has remained the case over the review period, which is generally consistent with the low-intensity tourism in eastern Jamaica.

Environmental Impact

While cruise ship visitors stay for a shorter time than stopover visitors and may produce less waste-related stress, pressures on natural resources created by this sub-sector are significant.

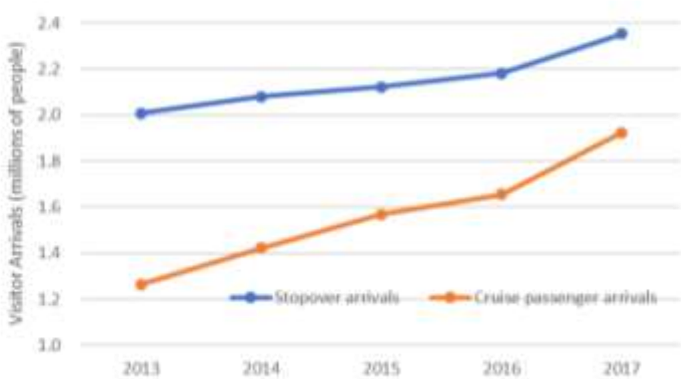


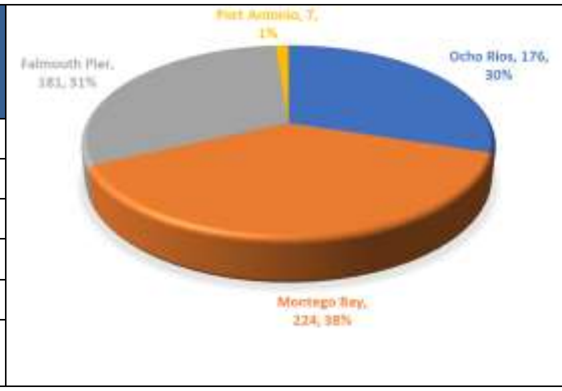
Figure 50 Growth in Tourist Arrivals (2013-2017)

An example of how intensive this pressure can be is the amount of solid waste generated by cruise tourists (between one kg and 12 kg per day) (WMR 2015). With an estimated 2.35 million stopover visitors in 2017, an average length of stay of 8.4 days (PIOJ 2018a) and a factor of two kg solid waste produced per day, it can be deduced that stopover guests generated close to 40,000 metric tonnes of solid waste in 2017.

The centres of mass-tourism and cruise ship tourism are considered environmental 'hotspots' as these sub-sectors are generally located in environmentally sensitive and vulnerable coastal areas and continue to grow rapidly. The main environmental hotspots for tourism in Jamaica are associated with the mass tourism resort centres occurring along the North Coast between Negril and Ocho Rios; this coincides with the three main cruise ports (Montego Bay, Falmouth and Ocho Rios). The industry is highly dependent on natural resources and the ecosystem for services required by tourism, such as relatively low rainfall and warm sunny climate, clear coastal waters, white sand beaches, nature attractions in proximity to the coastal areas as well as investments in tourism infrastructure (highway, international airport, reliable water and power supply).

Table 46 Cruise Ship Calls by Port (2013-2017; left) and cruise ship calls by port (2017; right)

Year	Number of cruise ship calls by Port				Total
	Ocho Rios	Montego Bay	Falmouth Pier	Port Antonio	
2013	126	81	154	3	364
2014	131	86	187	6	410
2015	135	129	190	3	457
2016	167	181	160	3	511
2017	176	224	181	7	588
% Change (2013-2017)	**40%**	**177%**	**18%**	**133%**	**62%**



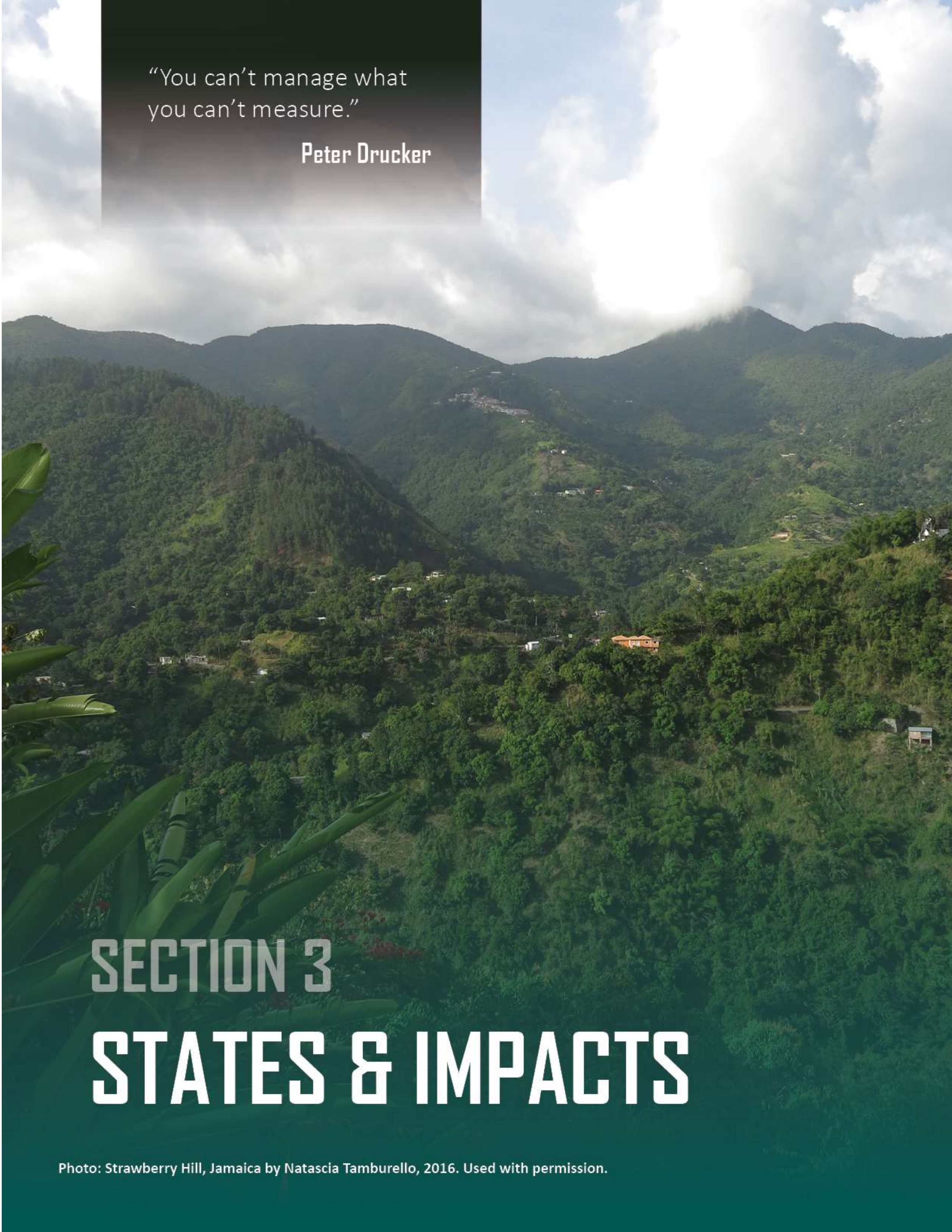
12.3.2 Freshwater Demand

Water demand is an indicator of environmental pressure created by tourism. Increasing demand for freshwater from both accommodations and cruise ships is one of the impacts associated with the tourism industry identified in the 2013 SOE. In the review period the combined demand for treated freshwater at the ports of Montego Bay and Falmouth tripled from just under 20,000 m^3 (in 2014) to 62,603 m^3 in 2017. Cruise ship demand for freshwater supplies far exceeded the rate of growth in either port calls or passenger arrivals, which increased between 2014 and 2017 by 148% and 133% respectively.

However, compared to the hotel sub-sector, cruise ship water demand was very small. Direct water use includes showers, toilets, and tap water use. Indirect use includes kitchens, laundries, swimming pools and spas, and landscaping and grounds maintenance. It has been estimated that the average tourist in Jamaica uses an average of ~980 litres of water per day (Meade and del Monaco 1999, cited in Gossling et al 2011). It is estimated that the sector's demand for freshwater steadily increased with arrival numbers, hotel standards, and water-use intensity (Gossling et al 2011). Using the 2017 stop-over estimates (PIOJ 2018a) of 2.35 million visitors, staying an average of 8.4 days, and the dated estimate of 980 litres of water per day, it is estimated that stop-over visitor demand on freshwater was approximately 19.4 million m^3 in 2017. Conclusions

The proxy indicators used herein rely on routinely collected data (with the exception of freshwater use by stopover guests) and, as a result, are useful indicators of environmental pressure of the tourism sector. However, there is a need to collect data to support assessment of sustainability indicators, which may include energy use (energy intensity) for example. For future SOEs, it may be useful to consider developing indicators specific to the sector for freshwater use intensity, energy intensity (e.g. kwH consumed per tourist per day) but this will require classification of private accounts (water and electricity), collection and collation of private sector billing data and estimation based on total annual stopover arrivals.

It is also noted that many of the indicators of tourism's impact on natural resources require continued monitoring of spatial data (e.g. encroachment into sensitive areas; changes in the footprint of informal dormitory communities near to resort areas).



"You can't manage what you can't measure."

Peter Drucker

SECTION 3
STATES & IMPACTS

Photo: Strawberry Hill, Jamaica by Natascia Tamburello, 2016. Used with permission.

STATE refers specifically to the condition of valued environmental components (VECs) or natural resources based on the assessment of specific indicators. The VECs that are examined in this report include the following:

1. Environmental Health and Air Quality
2. Watersheds and Land Resources
3. Marine and Coastal Ecosystems
4. Biodiversity.

As indicated in Table 2, these VECs:

- Are physical, chemical or biological attributes or specific parameters that can be measured/quantified and monitored (i.e. characterized by specific metrics) but are not reported in terms of monetary or socio-cultural metrics;
- Are directly affected by pressures within a specific timeframe;
- Have 'normal' operational ranges of fluctuation (system baseline or reference condition) and carrying capacity (threshold to major system change), which may be changed by pressures; and
- Can be temporally and spatially variable in magnitude.

For each VEC, the SOE Report:

1. Outlines the linkages, identifying drivers and pressures that are affecting the condition of the VEC;
2. Assesses the indicator trends and patterns occurring since 2013;
3. Outlines national planning frameworks that regulate these natural resources;
4. Identifies consequences for humans that occur as a result of changes in the condition/STATE of the natural resources. These consequences are qualitatively described as IMPACTS on the quality, functioning and availability of ecosystem services provided by natural resources. Typically, impacts on ecosystem services:
    a. can be temporally and spatially variable in magnitude;
    b. can affect future state of VECs depending on resilience (capacity to recover from stresses or return to natural state), risk (likelihood and consequences of impacts), and outlook (likely future state);
    c. have a value or cost of that can be measured/quantified and reported in monetary or socio-cultural terms;
    d. occur as a result of a shift in the baseline/reference conditions of the VEC, and is attributable to the occurrence of pressures. Deleterious VEC state shifts represent adverse impacts to ecosystem services (damage and loss). Positive impacts on ecosystem services can be caused by responses designed to remediate or restore ecosystem services.
5. Presents main conclusions and recommendations.

13. Environmental Health & Air Quality

Scorecard 13: Environmental Health & Air Quality (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ASSESSMENT GRADE Condition / Trend	CONFIDENCE Grade	CONFIDENCE Trend	RISK
MEAN ANNUAL CONCENTRATION OF FINE PARTICULATES IN URBAN AREAS	Kingston PM_{10} - Rockfort and Spanish Town Road do not meet standards.	POOR (For the monitored areas – generally poor and declining in some areas. Insufficient data on public health cases)	2	1	Insufficient data.
HOUSEHOLD AIR QUALITY	No data on air quality but trash burning appears to be prevalent (32.1% of households reported burning trash in the 2015 SLC). The 2011 Census (STATIN) found ~16% of households reported using fuels not considered clean-burning (mainly wood and charcoal).	UNCLEAR	1	1	Insufficient data.
% MONITORED SITES MEETING SO2 AND NO2 WHO STANDARDS	SO_2 compliance: down from 85% in 2014 to 62% in 2017. NO_2 compliance: down from 100% compliance in 2014 to 75% in 2017.	POOR / NET LOSS Poor data coverage (not generally representative). Net loss -compliance has declined in the review period.	2	2	Insufficient data.
MORTALITY DUE TO UNSAFE WASH	No data. Proxy indicators – Improved drinking water sources coverage – 80% population in 2015. Sanitation – 82% population (2015) Outbreaks of dengue, Zika and Chikungunya – *Aedes aegypti* mosquito	STABLE (Likely to be stable except for possible increasing outbreaks of mosquito borne diseases (standing water)	2	2	Insufficient data. Likely to impact the poor and very young dispropor-tionately.
EXPOSURE TO HAZARDOUS WASTE	Insufficient data. Lead poisoning appears to be locally important.	UNCLEAR (insufficient reporting of hazardous waste production and blood lead levels)	1	1	Insufficient data.

Photo: Air quality monitoring in Jamaica, NEPA. Used with permission.

13.2 Environmental Linkages

Environmental health is a branch of public health that is concerned with how the environment (both natural and built) impacts human health. The World Health Organization (WHO), through its department of Public Health, Environmental and Social Determinants of Health[134] (PHE), seeks to "*promote a healthier environment, intensify primary prevention and influence public policies in all sectors so as to address the root causes of environmental and social threats to health. PHE develops and promotes preventive policies and interventions based on an understanding and an in-depth scientific analysis of the evidence base for environmental and social determinants of human health.*" The WHO estimates that globally almost a quarter of all disease and deaths can be attributed to environmental factors. Environmental and social determinants of environmental health (being different from *ecosystem* health) are therefore risk factors that have to be taken into account in the sustainable development planning process.

In respect of environmental health, there are three main categories of concern: air quality, water and sanitation hygiene (WASH), and environmental exposure to harmful chemical compounds.

6. **Air Quality**: Air quality is the main focus of this chapter, as it is not addressed elsewhere in the SOE. The main indicators of air quality are reported in respect of urban and industrial environments, where concentration levels of both pollutants and exposed populations tend to be higher. The air pollutants that are typically monitored contribute to smog, acid rain and respirable particulates. Sources of air pollution in Jamaica include:
    - **Industrial emissions:** Point source emissions from major industrial plants: e.g. bauxite/alumina, electricity generation, cement and petroleum refining plants. Smaller scale industrial emitters include incinerators;
    - **Vehicular emissions:** Emissions from fuel combustion in motor vehicles consuming an annual mean of ~6 million barrels of fuel per year between 2013-2017 in Jamaica. Although emissions from vehicles may be more concentrated in urban areas, this is generally a non-point source;
    - **Fires**: open burning of domestic and yard waste, bush fires; accidental fires at solid waste disposal sites; burning of tires; fires associated with sugar cane harvesting; household cooking and lighting (using wood, charcoal or kerosene);
    - **Atmospheric dust**: like most of the Caribbean, Jamaica experiences air quality impacts associated with Sahara dust events. NASA estimates that annually hundreds of millions of tons of dust is transported from Africa to the Caribbean Basin (Figure 51). These events tend to be episodic and affect the entire country by increasing the particulate loads.

    The health impacts of urban air pollution include the incidence of breathing and lung conditions (asthma, allergies, chronic obstructive pulmonary disease), heart conditions and stroke. Air quality can also impact health, causing headaches/dizziness, coughing and sneezing, wheezing, as well as irritation of the eyes, nose and throat.[135]

[134] https://www.who.int/phe/about_us/en/ Retrieved December 01 2018

[135] https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.htmlRetrieved December 01 2018

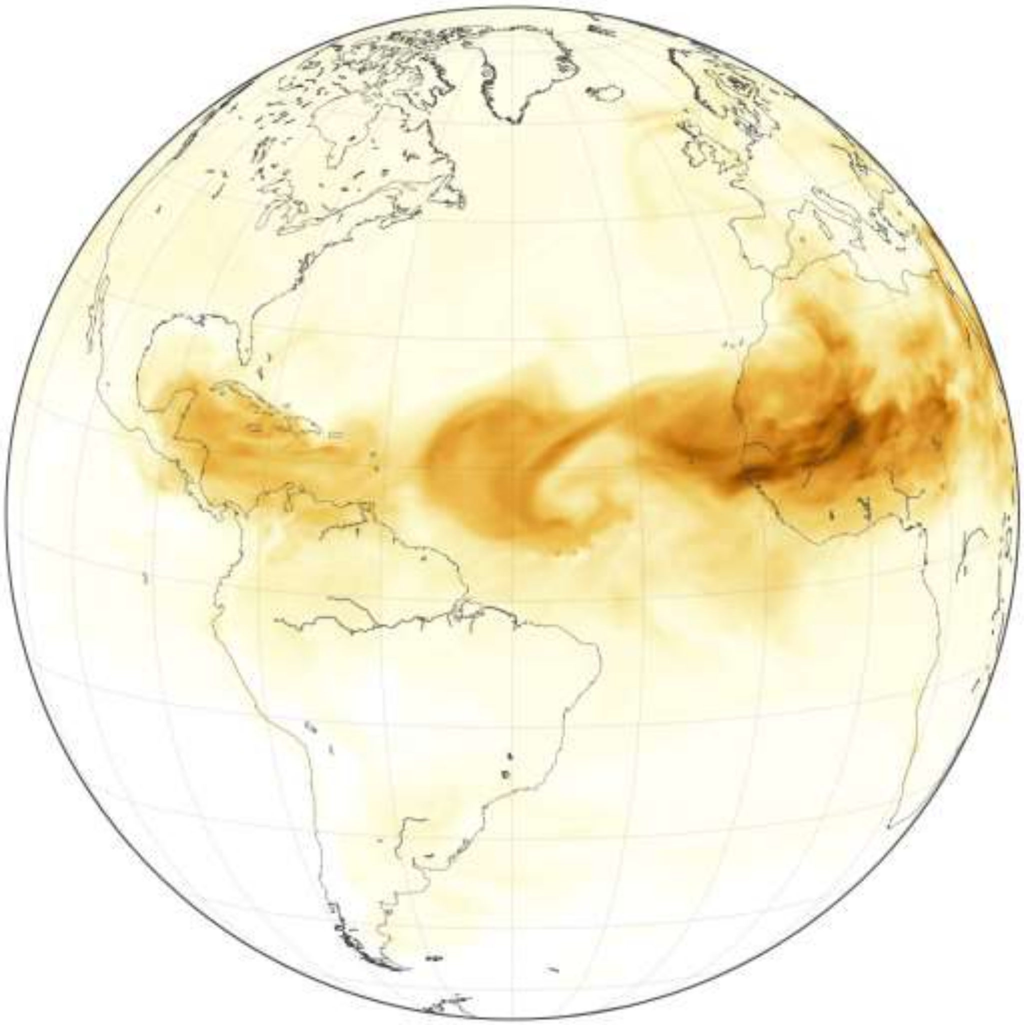


Figure 51Sahara Dust (June 28, 2018) Dust Column Mass Density (g/m^2; Source: reproduced from NASA Earth Observatory[136])

The WHO (2018) COP24 Special Report focused on Health and Climate Change, and made explicit the inter-connections between health and climate change. The main driver of climate change is carbon emissions to the atmosphere. GHG emissions associated with fuel consumption and other industrial processes include carbon dioxide, carbon monoxide and methane are all major air pollutants that impact air quality. Climate change itself can be considered a cumulative effect of atmospheric pollution occurring at a global scale over the medium to long-term. Climate change has numerous impacts on environmental health (e.g. creating conducive conditions for disease vectors; heat waves), and natural hazards that impact human health (e.g. waterborne illnesses, occurrence of wild fires). The combination of drought and high temperatures can result in an increased risk of wild fires, which create positive feedback loops (see Box 11), resulting in increased emissions of both carbon and particulates. These emissions add to atmospheric pollution and represent a loss of sequestered carbon, resulting in further warming that increases the risk of wild fires even more.

[136]https://earthobservatory.nasa.gov/images/92358/here-comes-the-saharan-dustRetrieved December 01 2018

Natural systems that become disrupted by some form of stimulus (e.g. increased energy in the atmospheric system associated with global warming) tend to 'adjust' to regain equilibrium/stability. Feedback loops (linkages between drivers, pressures, VEC states and impacts on ecosystem services) can compound or reduce the changes that occur. Positive feedback loops amplify the change, and moves the system further away from equilibrium. Negative feedbacks make the system more stable (achieving a new or previous equilibrium state) by dampening effects of stimulus.

Box 11 Feedback Loops

Industrial and energy related carbon emissions are also closely associated with other air pollutants that impact human health more directly: particulates, black carbon, ozone, sulphur dioxide, nitrogen dioxide, lead etc.

7. **Water & Sanitation Hygiene (WASH)**: Access to treated running water, proper sanitation and waste disposal has been discussed elsewhere in the SOE, in terms of the stress that poverty places on the environment. However, WASH is also a major environmental priority area for the World Health Organization as it impacts human health in terms of bacterial diseases and the prevalence of vectors and pests (e.g. *Aedes aegypti* mosquito, flies, roaches, vermin). WASH factors tend to be exacerbated by the geographies of social inequalities (income, age, gender) and the incidence of natural hazards such as floods.
8. **Exposure to Environmental Contaminants**: This includes exposure to harmful chemicals in the air, water and soil. These can include hazardous materials, pesticides, heavy metals (e.g. lead and mercury), and radiation. As in the case of WASH, pesticides have also been discussed elsewhere in the document (in connection with food production). The intensity of impact related to exposure is usually related to industrial point source waste discharges or accidental discharges.

The management of the health impacts or public exposure of these three areas essentially falls within the realms of environmental pollution control and hazard management (e.g. spills, floods, fires). Hazardous chemicals leach into the environment, resulting in increased exposure. Water borne illnesses (bacterial and viral) are likely to be more prevalent if untreated sewage contaminates food or water used for drinking. The likelihood of this occurring increases greatly where there is inadequate or no sewage treatment and a reliance on unimproved water sources (e.g. directly from a river). Vector borne diseases are also likely to be more prevalent if conditions conducive to their life cycle are widespread (e.g. rainwater collecting in garbage, stagnant ponds after a flood event).

13.3 Indicator Trends and Patterns

13.3.1 Mean Annual Level of Particulates

Jamaica's air quality monitoring network comprises 75 field stations, which are set up across eight parishes (Table 47). Of these, six field stations are primarily focused on general population exposure (versus compliance or impact monitoring). During the review period, eight new air quality monitoring stations were added to the network.

Table 47 Air Quality Monitoring in Eight Parishes

Parish	No. of Stations	PM_{10}(1)	SO_2(2)	NO_2(3)	Other Parameters	Comment
Kingston & St. Andrew	13	12	7	6	1 O_3(4) station at Eastbourne Road	
St. Catherine	12	4	4	3	6 stations monitor TSP(5), one monitors O_3 1 Spanish Town station monitors $PM_{2.5}$(6)	8 bauxite/alumina impact related
Clarendon	8	5	4	4	2 stations monitor TSP	bauxite/alumina impact related
St. Ann	12	2	1	1	9 stations monitor TSP	bauxite/alumina impact related
Manchester	21	11	0	0	1 station monitors $PM_{2.5}$ (Mandeville) 9 stations monitor TSP	20 bauxite/alumina impact related
St. Elizabeth	6	2	0	0	4 stations monitor TSP	bauxite/alumina impact related
St. James	2	0	1	1	1 station monitors $PM_{2.5}$ (Catherine Hall)	1 station at Bogue and NEPA station at Catherine Hall

(1)Particulate matter 10 micrometers or less in diameter
(2)Sulphur dioxide
(3) Nitrogen dioxide
(4) Ozone, or trioxygen
(5) Total Suspended Particulates
(6) Particulate matter 2.5 micrometers or less in diameter

As the most populous urban area, the KSA air quality monitoring network is the most useful indicator of urban[137]air quality in Jamaica. Five of the 13 stations are located in East Kingston: Harbour View, Mona, Rockfort Mineral Spa, Palisadoes, Eastbourne Road and Bournemouth Drive. Three stations are located along Marcus Garvey Drive: two on Spanish Town Road, one at Cross Roads, one at Old Hope Road and one in Mona (Figure 52). Three other urban areas are monitored: Spanish Town (St. Catherine), Mandeville (Manchester) and Montego Bay (Catherine Hall, St. James). Unlike the KSA stations, these three stations measure $PM_{2.5}$.

[137] The SDG indicator specifies urban air quality.

Figure 52 Air Quality Monitoring Stations in KSA (Source: NEPA)

PM_{10}

Given the availability of data sets, the mean annual PM_{10} data are used as an indicator of urban air quality for the purposes of this SOE report. PM_{10} is measured more widely (than $PM_{2.5}$), at ~36 locations across the island. PM_{10} exceedances (i.e. values above the Jamaica Ambient Air Quality Standards-JAAQS for Annual Mean PM_{10}) for the review period are presented in Table 48. For the review period, PM_{10} data for all stations are not consistently represented for all the years. For example, in 2017 data are available for only seven of the 14 air quality stations in the KSA. The stations exceeding the JAAQS outside of urban areas tended to be related to bauxite/alumina plants and food processing operations in St. Catherine.

Table 48 Stations exceeding PM_{10} Annual Mean Guidelines Value (2014-2017; Source: NEPA Air Quality Management Branch)

Year	Stations exceeding JAAQS Standard for Annual Mean PM_{10}(50 ug/m^3)	
	Kingston & St Andrew and Portmore	**Monitoring Stations outside of KMA**
2014	1. Rockfort: 82 µg/m^3 2. Spanish Town Road: 66 µg/m^3 3. Cross Roads 58 µg/m^3 4. Marcus Garvey Drive: 57 µg/m^3 5. Eastbourne Road: 51 µg/m^3 11 stations monitored (45% compliance)	1. Spring Village (St Catherine): 57 µg/m^3 (Ja. Broilers) 2. Portmore: 52 µg/m^3 20 stations monitored
2015	1. Rockfort: 97µg/m^3 2. Spanish Town Road: 71µg/m^3 3. Eastbourne Road: 54µg/m^3 9 stations monitored (33% compliance)	1. Freetown, St Catherine: 75 µg/m^3 (Ja. Broilers) 2. Portmore: 57 µg/m^3 25 stations monitored
2016	1. Rockfort: 70 µg/m^3 2. Marcus Garvey Drive: 50 µg/m^3 6 stations monitored(33% compliance)	No exceedances recorded. 22 stations monitored
2017	1. Rockfort: 97 µg/m^3 2. Spanish Town Road: 63 µg/m^3 3. Palisadoes: 53 µg/m^3 7 stations monitored(42% compliance)	No exceedances recorded. 12 stations monitored

** values given in table indicate the annual mean for the station.*

Key observations in air quality trends include:

- The JAAQS for PM_{10} was consistently exceeded between 2013 and 2015 at the Portmore station, located in the Waterford area. This monitoring station is located west of Spanish Town Road, and based on the NEPA air quality reports, it is impacted to a large extent by emissions from the Riverton area;
- The mean annual concentrations of PM_{10} recorded at the Spanish Town Road air quality monitoring station exceeded the JAAQS for three of the four years; and
- For the four years in the review period, the highest concentrations of PM_{10} were recorded at the Rockfort Mineral Spa monitoring station. Since the last review period there has been a consistent increase in the concentrations recorded each year except for 2016 where a decline was experienced (Figure 53). Notwithstanding, the concentrations remained in excess of the JAAQS annual standard for PM_{10}.

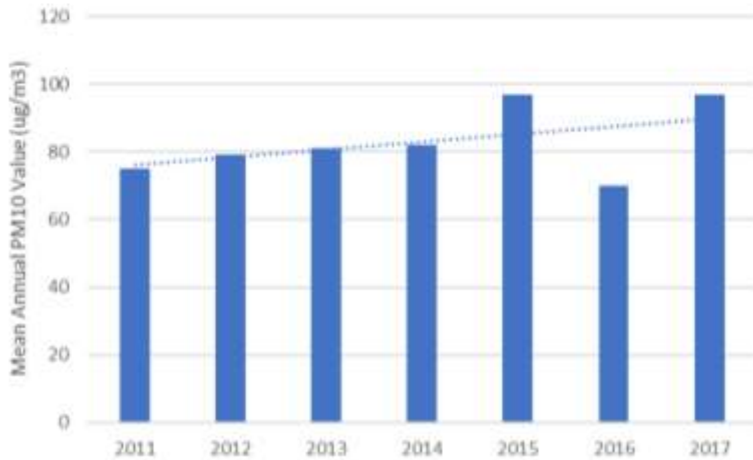


Figure 53 Seven Year Trend in Annual Mean PM_{10} Values for Rockfort (Mineral Spa)

$PM_{2.5}$

Jamaica has not yet established standards for $PM_{2.5}$; in the interim the United States Environment Protection Agency (USEPA) standard is used as reference. The USEPA daily standard for $PM_{2.5}$ is 35 $\mu g/m^3$ and the annual standard is 12 $\mu g/m^3$. Average daily concentrations[138] for this parameter were reported in **2017** as 8.4 $\mu g/m^3$ for Mandeville, 12.3 $\mu g/m^3$ for Montego Bay and 21.4 $\mu g/m^3$ for Spanish Town. Of the three urban stations monitored for this parameter, the Spanish Town station exceeded the daily standard on six occasions (compared to once for Mandeville and twice for Montego Bay), with the highest recorded value of 72.3 $\mu g/m^3$.The WHO[139] reported 2016 annual mean value[140] for Jamaica of 13.6 $\mu g/m^3$; the source of the data /estimate is unclear. $PM_{2.5}$ for other years in the review period was not available from the WHO database.

13.3.2 Household Air Quality

While outdoor urban air quality may be a bigger issue, in terms of international indicators; indoor air quality is likely to also have an important impact on many Jamaican households, particularly in rural areas.

SDG #3 (Ensuring healthy lives and promoting well-being for all ages) sets the mortality rate attributed to household and ambient air quality as a KPI (SDG Target 3.9.1). While this data may not be readily available in Jamaica, proxy data are useful indicators of trends. In Jamaica, there are two major sources of emissions that impact household air quality: the use of solid fuel for cooking and reliance on burning for disposal of household garbage. If either is practised, it is typically not done within the walls of the dwelling unit, but within the yard or communal outdoor space.

In the 2011 Census (STATIN) it was reported that ~16% of households used fuels not considered clean burning (e.g. charcoal and wood – see Section 8.3.3). It was estimated that ~12.5% of the population of Jamaica still used solid fuels for cooking in 2017 (see Box 8). This number is expected to decrease in the coming years as affordable butane becomes more available to rural communities.

[138] NB data on mean annual concentrations were not available.

[139] The WHO maintains a database of air quality (annual mean concentrations of particulate matter) in urban areas, with a guideline value of 10 ug/m^3 ($PM_{2.5}$ annual mean) and 25 ug/m^3 ($PM_{2.5}$ 24-hour mean).

[140] http://apps.who.int/gho/data/node.sdg.11-6-data?lang=enRetrieved December 01 2018

The burning of trash is a widely practised means of disposal of household and yard waste in Jamaica in both urban and rural areas, particularly among households without garbage collection services. The Jamaica Standard of Living Conditions (SLC) estimates that ~32.1% of households burned trash in 2015; the number of households reporting trash burning as the main method of waste disposal was higher amongst rural and the poorest households (see Section 7.3.6).

With a reported only 60% waste collected in 2016, it is likely that the amount of burning still remained relatively high. It is also likely that even households that had waste collection services available tended to burn yard waste,[141] despite the regulations (The Public Health (Nuisance) (Amendment) Regulations 2013) that prohibit open burning without a permit. Household trash burning produces particulates, methane, carbon monoxide, polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs). Kerosene, which is used in Jamaica for lamps, stoves and as an accelerator for open burning of waste, is also a major localized source of fine particles.[142] According to the 2015 SLC, less than 1% of the total number of Jamaican households still use kerosene; this is higher than the 2011 national census, in which only ~680 households reported using kerosene (<0.1%).

The 2011 census found that wood and charcoal was the reported main cooking fuel used by 9% and 6.1% of all households respectively. According to PIOJ (written communication) the number of households using wood and charcoal in 2015 was respectively 9.5% and 7.4%, suggesting a slight increase in the reliance on what would not be classified as clean sources of cooking fuels.

13.3.3 Percentage of Monitoring Sites Meeting Non-Particulate Standards

[141] http://jamaica-gleaner.com/article/lead-stories/20180612/educate-and-enforce-stop-open-burning-stanley Retrieved December 01 2018
[142] https://www.who.int/airpollution/household/health-impacts/en/ Retrieved December 01 2018

Table 49 shows the available data for exceedance of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) air quality standards, relative to the WHO air quality standards. Although Jamaica has established ambient air quality standards, the WHO standards are used to assess compliance for two reasons (a) the WHO standards allow international compliance comparisons and (b) the Jamaica standards are considerably lower, and would allow more sites to be classified as compliant, although they do not meet international standards.

The SO_2 sites monitored in KSA include four stations along Marcus Garvey Drive. Based on the available data, the major observations are that stations within the KSA are the ones that are not compliant, and that performance in respect of SO_2 is worse than NO_2 performance, with performance in 2016 and 2017 being worse than previous years. The station at Spanish Town Road exceeded the WHO annual mean guideline for SO_2 in 2014, 2015 and 2016. No data were available for this station in 2017.

Table 49 Compliance of 17 Monitoring Stations for SO_2 and NO_2 with international annual mean standards during the Review Period (Source: NEPA Air Quality Management Branch)

Year	**% Sites Meeting WHO Guidelines for Sulphur Dioxide** 80 µg/m³ (**JAAQS)** annual mean 20 µg/m³ (**WHO)** annual mean	**% Sites Meeting WHO Guidelines for Nitrogen Dioxide** 100 µg/m³ (**JAAQS)** annual mean 40 µg/m³ (**WHO)** annual mean
2014	5 sites in KSA: 60% compliant (3/5 compliant) 1 site in Montego Bay: 100% compliant 4 sites in St Catherine: 100% compliant 4 sites in Clarendon: 100% compliant **86% compliance with WHO Guidelines**	2 sites in KSA: 100% compliant 1 site in Montego Bay: 100% compliant 4 sites in St Catherine: 50% compliant 3 sites in Clarendon: 100% compliant **100% compliance with WHO Guidelines**
2015	3 sites in KSA: 1/3 compliant 1 site in Montego Bay: 100% compliant 1 site in St Ann: 100% compliant 5 sites in St Catherine: 100% compliant 2 sites in Clarendon: 100% compliant **83% compliance with WHO Guidelines**	3 sites in KSA (66% compliant): 2/3 compliant 1 site in Montego Bay: 100% compliant 4 sites in St Catherine: 100% compliant 4 sites in Clarendon: 100% compliant **92% compliance with WHO Guidelines**
2016	5 sites in KSA: 2/5 compliant 4 sites in Clarendon:100% compliant **66% compliance with WHO Guidelines**	5 sites in KSA:4/5 compliant 3 sites in Clarendon: 2/3 compliant **75% compliance with WHO Guidelines**
2017	4 sites in KSA: 1/4 compliant 4 sites in Clarendon:100% compliant **62% compliance with WHO Guidelines**	4 sites in KSA: 3/4 compliant 4 sites in Clarendon:3/4compliant **75% compliance with WHO Guidelines**

13.3.4 Mortality Rate Attributed to Unsafe Water, Unsafe Sanitation and Lack of Hygiene

SDG Indicator 3.9.2 uses the mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene services. Proxy indicators of this include:

- **Improved drinking sources coverage**: this was estimated by PAHO (2017) and UNICEF[143]to be 94% in 2015. This value is inconsistent with the 2015 Jamaica SLC, which estimated that 80% of all households had an improved source of water.
- **Sanitation**: PAHO (2017) also estimated that the proportion of the population with sanitation coverage in 2015 was 82%, (compared to the 99% estimated by UNICEF, and 66%[144] estimated by the 2015 Jamaica Survey of Living Conditions). According to PAHO, half of the 190 STPs that are monitored monthly by the Ministry of Health do not meet public health standards for treatment of faecal coliforms (mostly comprising the bacteria *E. coli*, which is a leading cause of diarrhoea).
- **Incidence of diarrhoea mortality/ morbidity in children <5**.This was reported to be three per year between 2012 and 2016[145]. The number of deaths from diarrhoea is ~2% of all under five deaths compared to the global average of 8%.
- **Incidences of vector borne diseases**. The four serotypes of dengue are endemic to Jamaica and tend to be more prevalent where there is standing water. The *Aedes aegypti* mosquito is carrier of the disease, and thrives during times of the year when there is sufficient ponded water for reproduction (e.g. periods of heavy rainfall and flooding). Climate change impacts (e.g. higher temperatures and more frequent high intensity rainfall events) are likely to enhance breeding conditions for mosquito vectors in the environment.

[143] https://data.unicef.org/country/jam/Retrieved December 01 2018
[144] 66% of the population have exclusive access to flush toilets; 77.7% of the population have access to flush toilets.
[145] Source: UNICEF website (above) citing the source as WHO and Maternal and Child Epidemiology Estimation Group

According to the WHO[146] there was a major outbreak of dengue in 2016, with 2,297 cases reported (WHO); the last major outbreak of dengue was in 2012. Two other diseases spread by the same vector (*Aedes aegypti*) emerged in this review period: Zika (2016) and Chikungunya (2014). The Caribbean Public Health Agency (CARPHA) reports that in Jamaica, Chikungunya has declined steadily since 2014 (54.2 cases per 100,000 population) to 10.6 (2015) and 7.31 in 2017.[147]CARPHA also reported the occurrence of a total of 72 Zika cases between 2015-2016. The malaria virus (spread by the *Anopheles* mosquito) also occurs in Jamaica, although it is much less prevalent.

13.3.5 Hazardous Waste

SDG 12 (responsible consumption and production) has been mapped to Goal #3 of the Vision 2030 Jamaican NDP (Table 2) and Goal #4 (Healthy Natural Environment).A KPI for this SDG is the amount of hazardous waste that is produced, expressed per capita, and the proportion of that waste that is treated (by treatment type). SDG 3 (healthy lives and wellbeing) sets the KPI (3.9.3) to reduce mortality rates from unintentional poisoning, which also has a bearing on exposure to hazardous chemicals.

Since 2003, Jamaica has been a signatory to the Basel Convention, which controls transboundary movements of waste and their final disposal. Hazardous wastes are defined under the Jamaican NRCA Regulations (1996) as *"any substance which by reason its chemical activity, toxicity and explosivity, corrosivity or other characteristics, causes or is likely cause, danger to health or the environment, whether of itself or on contact with other waste."*The NRCA Hazardous Waste (Control of Transboundary Movements) Regulations (2002) include wastes from a wide range of industries (e.g. bauxite/alumina, chemicals industries, electronics, agriculture, petrochemicals, pharmaceuticals) or wastes containing specific compounds (e.g. lead; biomedical wastes, pesticides, oily waste and sludge, asbestos etc) that are considered harmful to human health and the environment.

Table 50 shows available data for the review period (Electronic Reporting System of the Basel Convention, reported by NEPA). There is a general lack of consistently reported data for the review period.

Table 50 Exported Hazardous Waste Quantities (Source: PIOJ 2018a)

Hazardous Waste Types	2014	2015	2016	2017
Used lead acid batteries (Mt)	-	-	3,288	2,209
Paint related materials (Ml)	-	-	0.12	-
Solids contaminated with polychlorinated biphenyl (PCB) (Mt)	-	-	127	-
Obsolete Pesticides (Mt)	-	-	80	3.3
e-waste	-	-	-	-
Oily water and sludge (bauxite and power generation companies) (Ml)	3.74	1.83	-	-

Household hazardous wastes include any of the following that are disposed of with other solid waste: medications, paints, detergents, solvents, pesticides, fluorescent bulbs, batteries and electronics. These wastes are either dumped into the environment (finding their way to soils and gullies), burned, or hauled to the municipal dump where the waste can also cumulatively leach into the soils.

[146]https://www.who.int/csr/don/4-february-2019-dengue-jamaica/en/ Retrieved December 01 2018
[147]http://carpha.org/downloads/State-of-Public-Health-in-the-Caribbean-2014-2016.pdf page 125. Retrieved December 01 2018

E-wastes: Cell phones, computers, screens, televisions, copy machines and other electronic devices are built using compounds such as arsenic, lead and poly-brominated flame retardants[148], which are considered hazardous waste at the product's end-of-life. Aside from these harmful compounds there are also useful and valuable elements that can be recycled (e.g. copper, aluminium and gold). It has been estimated that it is less expensive to recover these metals from e-waste than to mine the ores. In 2016 it was estimated that Jamaica generated between 1900 (TMG, 2017) and 17,000 tonnes per year of e-waste[149], with an estimated annual value of between four and six million USD.

As early as 2011 the Government of Jamaica (GoJ) was investigating the feasibility of establishing an e-waste recycling industry in Jamaica. In 2014 NEPA issued environmental permits to allow the NSWMA to handle and store e-waste, used tires and asbestos, provided sound environmental management of these categories was implemented. Although it was reported in 2015[150] that the NSWMA would launch a pilot project to collect e-waste from six communities (Duhaney Park, Harbour View, Patrick City in St. Andrew and Hellshire, Angels Estate Phase 1 and 2 and Angels Grove in St. Catherine), a recent report (TMG, 2017 (indicated that very little was collected. Without practical programmes to collect, recycle or safely dispose of e-waste, much of it ends up in municipal dumps, or informal garbage disposal sites, eventually leaching into soils and polluting natural waters and ecosystems. In 2017, a report on a possible regulatory framework for e-waste in Jamaica was produced (TMG, 2017).

The KPI for hazardous wastes in the environment is mortality rate from unintentional poisoning. The WHO estimated that, in 2016, the mortality rate from unintentional poisoning per 100,000 population was 0.2 in Jamaica.[151] Globally, values range between 4.2 (Eritrea) and 0.0 (Maldives).The Jamaica Green Paper on Environmentally Sound Management of Hazardous Waste (2017) indicates a particular concern with lead levels in the soil, citing the International Centre for Environmental and Nuclear Sciences (ICENS) study on the abandoned Hope mine in Kintyre (St Andrew).Lead poisoning in children in the Mona Commons (St Andrew), due to exposure from a backyard lead smelter, is another example. Lead acid battery contamination was also reported to have caused high lead blood levels. The most recent island-wide study (Lalor et al2007) that was done on 1,081 school children age two to six found that 21% of the sampled population had blood lead levels higher than 10 µg/dl (with samples collected between 1994 and 1995). They noted that higher blood lead levels were found mainly in the poor areas of KSA and St. Catherine. A more limited study (Rahbar et al 2015) found from a sample of 125 children (ages two to eight) that only 6.4% had blood lead levels 10 µg/dl and above. Rahbar et al (2015) attributed the difference between Lalor's et al (2007) and their study to be due to phasing out leaded petroleum in Jamaica between 1999 and 2002. The environmental risk factors Rahbar et al (2015) identified included residence near to high traffic roads, and the consumption of ackee. An additional risk factor is the presence of lead in paint, which enters the environment as paint chips and dust as it degrades.

13.4 Ecosystem Services

Unlike other VECs it is more difficult to identify specific ecosystem services provided by environmental quality parameters (air, WASH and soil). The main ecosystem services include:

- Quality of life (healthy population) which, in turn affects the economic productivity and prosperity of the country in general. At key monitoring stations in Kingston (along Spanish Town

[148] https://ifixit.org/ewasteRetrieved December 01 2018
[149] https://www.itu.int/en/ITU-D/Climate-Change/Documents/GEM%202017/Global-E-waste%20Monitor%202017%20.pdfRetrieved December 01 2018
[150] http://electronicwastejacomp1220uwi.weebly.com/electronic-waste-in-jamaica.htmlRetrieved December 01 2018
[151] https://www.who.int/gho/publications/world_health_statistics/2018/EN_WHS2018_AnnexB.pdf?ua=1 (Annex B Part 2) Retrieved December 01 2018

Road, Marcus Garvey Drive and Rockfort) air quality continues to be poor, particularly with regard to levels of particulate matter; and

- A natural asset to limit the quantity of resources that have to be dedicated to surveillance, remediation, pollution control and health care. Where there is a decline in air quality or WASH, or poor management of hazardous waste, the need for these resources increases;
- Cleaner air also means lower maintenance costs for equipment. High levels of particulates in the air can adversely impact the efficiency of equipment functioning (especially those with air intakes like air conditioning); and
- High levels of dust in the air can impact urban smog (haziness) and visibility on the road. High levels of smog and urban dust increase the heat island effect, making urban places hotter than surrounding areas.

Risk Factors

- There has been no improvement in the management of dust emissions from the Rockfort station, which has had the highest mean annual concentrations of PM_{10} over the past seven years. The number of vehicles contributing to air pollution is expected to continue increasing (see Chapter 11); the number of vehicles using ultra-low sulphur fuel as proportion of total vehicles would influence sulphur emissions associated with engine emissions. It is noted that ultra-low sulphur fuel is widely available in Jamaica.
- There were repeated incidents of fires around Spanish Town Road and Riverton City Solid Waste Disposal Site during the review period. Based on this track record, it is likely that air quality will continue to decline in Kingston.
- Data recovery from the air quality monitoring network is variable and inconsistent. The coverage of the air quality monitoring network in urban areas outside of Kingston is generally inadequate (comprising one station in three other towns) to properly satisfy assessment of the urban air quality indicator requirement.
- There is insufficient reporting of diseases and losses caused by environmental factors (air quality, contaminated water, poisoning). The available data to assess risk are therefore insufficient.
- Information on inventories of hazardous waste, their collection and safe disposal needs to be more easily available to ensure proper management and reporting. At present, hazardous waste inventories appear only to pertain to applications to export waste.
- Available estimates suggest that it is likely that 20% of the population did not have access to treated water and 34% did not have access to flush toilets. These relatively high numbers with lack of access to WASH are inconsistent with the low level of deaths (2%) attributed to diarrhoea in children under five and may be under-reported. WHO reports that globally, diarrhoea is the second leading cause of death in this age group. It is also possible that gastro-intestinal illnesses that do not end up in death significantly impact productivity, nutrition and health care resources.
- The impact of *Aedes aegypti* mosquitoes on the health of Jamaica's population remains a significant challenge to society, especially with increasing outbreaks of new diseases carried by this vector as well as the possible effects of climate change in its breeding conditions and prevalence.
- KSA has the highest population density in the island, with an estimated 1,471 persons per km^2, resulting in a high level of exposure to hazardous chemicals that may occur in the environment.

13.5 Conclusions

The major industries impacting air quality were discussed in Chapter 13; these industries are required to have air pollutant emissions licences and submit annual reports to NEPA. Based on available data for 2013 and 2016 (Table 58):

- Electricity power plants represent the most significant source of sulphur dioxide and nitrogen dioxide emissions. These are typically located within urban areas and are expected to contribute significantly to urban air pollution. The data suggest that emissions of SO_2 and particulates emitted by power plants increased during the review period.
- The alumina industry remains the most significant source of particulates emissions, and the second largest (regulated) emitter of SO_2 and NO_2 (after power generation). Chapter 13 indicates that alumina plants are typically located outside of major urban areas and are unlikely to contribute to urban air pollution. However, alumina plants will be point sources for SO_2 and NO_2 within their respective air sheds.

Table 51 Percentage of Emissions of Major Pollutants emitted by Regulated/licensed Sources (Source: NEPA[152])

Regulated Sources	Major Pollutant					
	Sulphur Dioxide (SO_2)		Nitrogen Dioxides (NO_x)		Particulate Matter (PM)	
	2013	2016	2013	2016	2013	2016
Electric Power Generation	49%	52%	83%	82%	7%	14%
Alumina Industry	43%	39%	12%	15%	68%	78%
Cement and Concrete	< 1%	< 1%	3%	1%	2%	1%
Refined Petrol Products & Bulk Storage	5%	7%	< 1%	<1%	<1%	<1%
Other Sources	2%	2%	2%	2%	22%	6%

[152] The percentages are calculated by dividing the tonnes of a particular pollutant (e.g. SO_x) emitted by a particular source category/activity (e.g. Electric Power Generation) by the total tonnes of that pollutant (SO_x) which is emitted by ALL the source categories. That value is then expressed as a percentage. The calculation only includes data that has been reported by the licensed facilities in their annual emissions report.

14. Watersheds & Land Resources

Scorecard 14: Watersheds & Land Resources (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ASSESSMENT GRADE Condition / Trend	CONFIDENCE Grade	CONFIDENCE Trend	RISK
FOREST AREA AS A PROPORTION OF TOTAL LAND/ WATERSHED AREA	Net loss of **primary forests** for 2014-2017 estimated at ~49 km^2 (using rates for 1998-2013).	POOR / DEGRADED	2	2	Moderate Risk Four
MOUNTAIN GREEN COVER INDEX	43% of Jamaica's total area is covered by mountains. With a Mountain Green Cover Index (MGCI) of 86%.	GOOD / STABLE	2	3	Moderate Risk Three
WATERSHED STATUS	**36% of all watershed area is currently classified as degraded or severely degraded. These are mainly located on the eastern side of the island.**	POOR / UNCERTAIN	3	3	High Risk Six
AQUIFER STATUS	Insufficient data.				High Risk Six
WETLAND STATUS	Insufficient data.				High Risk Six
PROPORTION OF BODIES OF WATER WITH GOOD AMBIENT WQ (meeting BOD, N, P and FC standards)	Nitrates levels are within standards. Higher proportion of sites are exceeding PO_4 and BOD standards.	STABLE / NET LOSS	2	3	High Risk Six

14.2 Environmental Linkages

The management of these land-based natural resources relates directly to SDG Goal 15 (life on land), and details the objectives to "*protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss."* Biodiversity (both terrestrial and marine) is discussed as a separate theme in this SOE, in Chapter 16. The information discussed here is more directly linked to *Target 15.3: "by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world*." The National Forest Management and Conservation Plan 2016 - 2026 (Forestry Department, 2017) has identified the strategic actions that are critical to achieving not only SDG 15, but also making major contributions to sustainable water (SDG 6), sustainable consumption (SDG 12), climate action (SDG 13), and life under water (SDG 14). This plan, in particular, highlights the inter-connectedness of these major environmental systems, and will continue to govern the forestry sector until 2026.

SDG 6 *"ensure availability and sustainable management of water and sanitation for all"* is also considered relevant, as ground and surface water contamination and watershed degradation impact water quality and quantity/availability respectively. The key objective under SDG 6 is 6.6, which is "*by 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.*" Freshwater quality has an impact on receiving coastal water bodies, and marine eco-systems.

Both these SDGs map to Vision 2030 NDP Goal #4, National Outcome #13 (sustainable management and use of environmental and natural resources). In addition, forestry and watershed conservation also apply to National Outcome #14 (hazard risk reduction and adaptation to climate change) as these natural assets serve to reduce flood and drought risks, reduce landslide and soil erosion risks, and function as a carbon sink. It is also noteworthy that Jamaica's terrestrial biodiversity is largely based in its forest eco-systems.

Watersheds support various types of terrestrial habitat, as well as freshwater bodies and, as a result, provide a variety of eco-system services (water supply being one, others being flood mitigation, sediment control, assimilation of nutrient loads, recreational/tourism use). These indicators are designed to approach the management of these systems using integrated approaches. The spatial connections between mountain forest areas, the soil, rivers, ponds and the coast have to be considered simultaneously. As with other VEC there is some overlap with other sections of this report. Namely; water resources, forestry, agriculture and river sand mining. There is also a high degree of overlap with the biodiversity section (Chapter 16) as the watersheds support plant and animal bio-diversity.

Jamaica is subdivided into 10 major hydrological basins (Figure 54), which represent 26 major water management units (WMUs). These WMUs reflect not only the physiographic river basins, but also major groundwater resources (aquifers), both of which are important freshwater resources that support terrestrial ecosystems and human needs for domestic water supply, food production and industrial demands. The largest of these WMUs is the Rio Bueno – White River system (mainly St. Ann, the western part of Trelawny and a small part of western St. Mary). It represents 14% of Jamaica's total land area, which is characterized by extensive underground drainage and groundwater resources. The Black River WMU (mainly in St. Elizabeth) is the second largest WMU (12% of total land area), with the longest river in Jamaica, and considerably more extensive surface water resources, which are associated with the Black River Great Morass (BRGM). The BRGM is roughly divided into upper and lower wetlands, which support a wide range of both freshwater and brackish water endemic species.

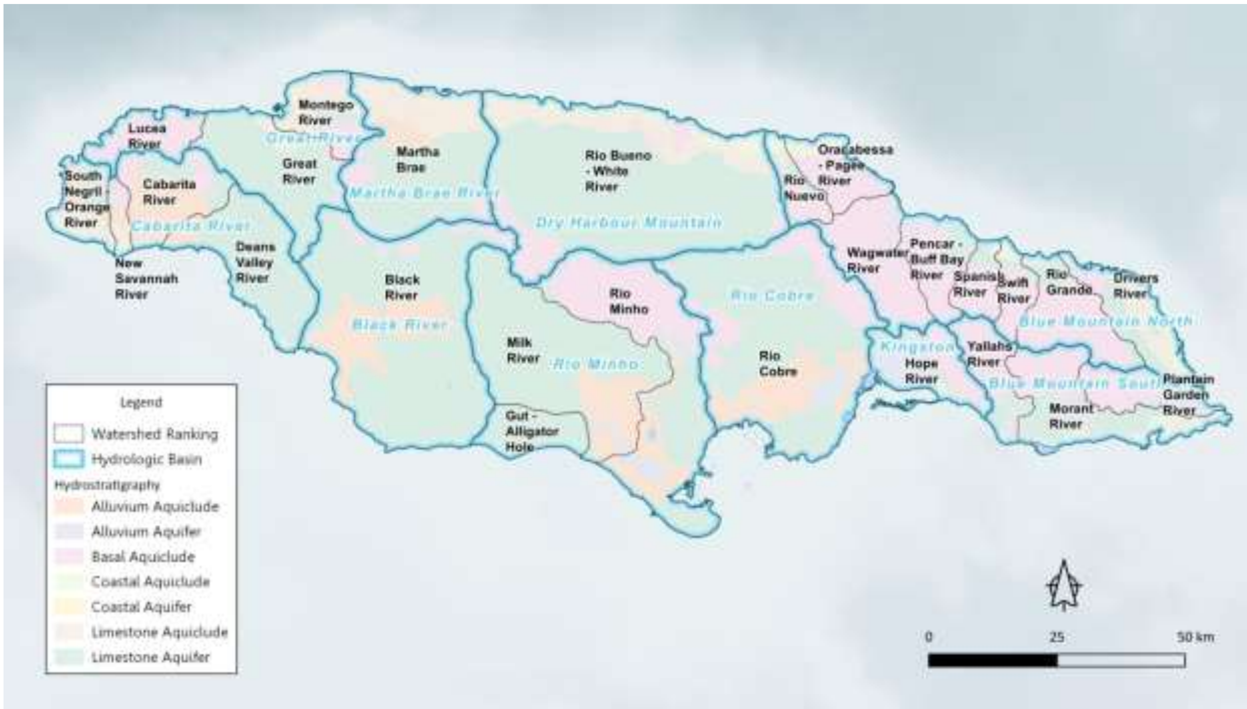


Figure 54 Map showing the ten hydrological basins and the different types of aquifers in Jamaica

14.3 Indicator Trends and Patterns

14.3.1 Forest area as a proportion of total land/watershed area

SDG indicator 15.1.1. is the "*forest area as a proportion of total land area*". According to the Draft National Forest Management Conservation Plan [153]the 2013 estimate of forest cover of Jamaica was ~4400 km^2, or ~40% of Jamaica's total land area. However, if secondary forests and plantations are excluded, the percentage of primary forest cover was 28% in 2013. That number falls to 12% if disturbed broadleaf forests are excluded.

Figure 55 shows the relative proportion of the main forest cover categories identified in the 2013 assessment[154]. Secondary forests (SFs), disturbed broadleaf forests (DBFs) and plantation forests or (PFs) collectively comprise ~70% of the assessed forest cover. Primary forests are defined herein as forests which are not disturbed, secondary or planted, and include the standard forestry classes of closed broadleaf (CBF), dry limestone forests (DLF; see Figure 57) and swamp/mangrove forests (SMF) which, collectively, accounted for the remaining 30% of forest cover.

[153] (Forestry Department 2017, page 34 Table 6),

[154] as given in Forestry Department 2017, page 34 Table 6

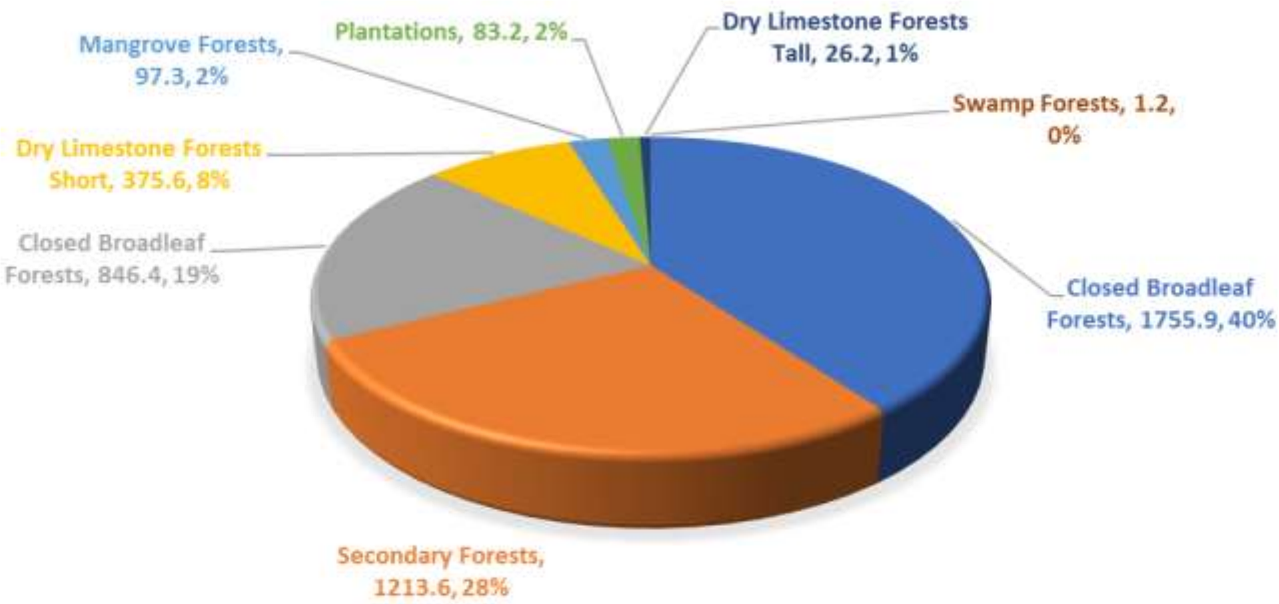


Figure 55 2013 Relative Proportion of Forest Cover (area shown in km^2 and %; Source: reproduced from the Forestry Department Draft NFMCP, 2017)

Figure 56 is a reproduction of the Forestry Department's mapping of the 2013 land cover, showing the distribution of forest classes. The CBF is generally restricted to the higher elevation areas found mainly in the central parts of the island, with the largest areas occurring in the Blue and John Crow Mountains (Portland and St. Thomas) and the Cockpit Country (mainly southern Trelawny).

In 2013 dry limestone forests were also restricted in range, found mainly in the southern parishes of Manchester, Clarendon, St. Catherine, Kingston and St. Thomas, with some relatively small occurrences in St. Elizabeth, Trelawny and St. Ann. It is important to note that Trelawny contains significant reserves of CBF as well as DLF, and SMF. The lower elevations of the parish also contain large areas of secondary or disturbed broadleaf forest, which have potential to mature into CBF in the coming decades.

Although there was a net gain of 0.4% per year in total forest cover between the 1998 and 2013 forestry land cover assessments, there was a concurrent net loss of primary forest of ~12.28 km^2 per year, or 196.4 km^{2}over the 16-year period (1998-2013). Serious concern was raised during that period because the Short DLF category declined at a rate of ~5.93 km^2 per year, while Tall DLFs declined at a rate of 2.77 km^2 per year. According to the Forestry Department, the dry tropical ecosystems are among the most threatened globally, and therefore a major cause for concern in Jamaica. CBFs declined at a rate of 2.25 km^2 per year while the area classified as DBFs increased marginally at a rate of 0.54 km^2 per year. Another very disturbing trend noted was the loss of swamp forests, which declined from 22.5 km^2 to 1.23 km^2 in the same period. The area classified as mangrove forest remained roughly constant over the 16-yearperiod.

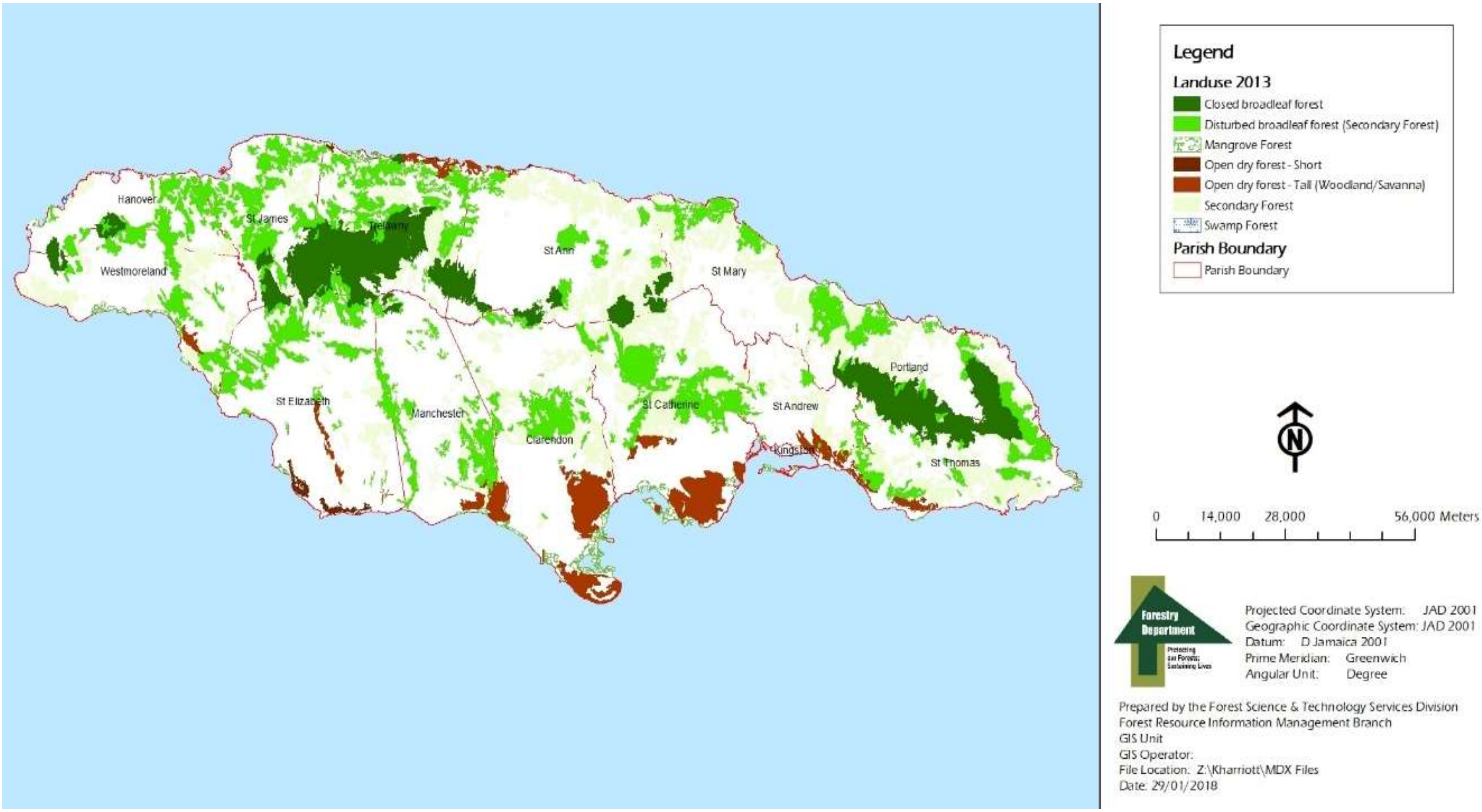


Figure 56 2013 Distribution of Forest Classes (Source: reproduced from Forestry Department)

Using the estimated rates of loss for primary forest (as defined in this SOE) for the preceding 16 years ($12.27km^2$ per year), between 2013 and 2017 there was a net loss in primary forest cover of ~$49km^2$, which is roughly an area the size of Spanish Town. The Forestry Department (2017) estimated that the most rapid deforestation rates have occurred in St. Ann, Hanover and Clarendon.

Total forest cover as a proportion of total land area is a useful indicator that can be compared internationally. However, the situation in Jamaica indicates that gains in this index may be skewed by gains in secondary forest cover, attributable to improved remote sensing techniques, conversions of ruinate plantations and disturbance of primary forests. Forest cover, regardless of forest classification, offers a range of ecosystem services (e.g. aquifer recharge, carbon sink, habitat, and timber). However, the core of Jamaica's terrestrial biodiversity rests mainly in the undisturbed primary forests, where very range-restricted endemic species may be found. For this reason, it is recommended that the total forest cover indicator be augmented with an indication of the relative changes in respect of **primary forest cover**, specifically excluding changes to the disturbed, secondary or planted forests.

Figure 57 Dry Limestone Forest, Coral Spring-Mountain Spring Protected Area (Source: NEPA)

14.3.2 Mountain Green Cover Index

SDG Target 15.4 requires that, by 2030, conservation of mountain ecosystems should be ensured in order to enhance their capacity to provide benefits that are essential for sustainable development. The "Mountain Green Cover Index" (MGCI) measures changes of the green vegetation in mountain areas (i.e. forest, shrubs, trees, pastureland, cropland) to provide an indication of the conservation status of their environment. The MGCI is an effective tool to assess changes in state of conservation and health.[155]The indicator recognizes the positive correlation between green coverage of mountain areas and their state of health and capacity to fulfil their ecosystem roles. The MGCI is calculated using land cover/land use data derived from remotely sensed images of the world's mountainous areas. A reduction in MGCI is generally linked to forest exploitation, timber extraction, fuel-wood collection and fire. An increase will be due to vegetation growth, possibly linked to reforestation or aforestation programmes (FAO *N.D.*).

Disaggregated information by elevation class (UNEP-WCMC mountain classification by Kapos et al. 2000) and for each IPCC land cover class (forests, cropland, grassland, wetlands, settlements, and other land)

[155]FAO http://www.fao.org/sustainable-development-goals/indicators/15.4.2/en/Retrieved December 05 2018

has been estimated. The estimates of the MGCI take into consideration the distribution of forest, grassland and cropland classes as per the formula:

MGCI= (Area cover by Cropland + Area cover by Forest + Area cover by Grassland) / (Total Mountain Area)

The calculated MGCI for Jamaica was 86%, which means that Jamaica's mountain areas are approximately 86% covered by vegetation (data validation pending). Jamaica is reported as having approximately 43.56% of its total area covered by mountains (FAO web portal).

14.3.3 Change in the Extent of Water-Related Ecosystems

Indicator 6.6.1 measures the "*change in the extent of watershed over time*". The Target set by SDG 6.6 is the protection and restoration of water-related ecosystems. These ecosystems include mountains, forests, wetlands, rivers, aquifers and lakes. The SDG Target date of 2020 is used to align with the Aichi Biodiversity targets of the Convention on Biological Diversity, although it is anticipated that efforts will continue past this date. The goal of clean water and sanitation (SDG 6) is closely linked to SDG #15 (life on land) and SDG #13 (climate action), as shown in the infographic below (Figure 58; UNEP 2018). This SOE presents available information on the status of watersheds, aquifers and wetlands.

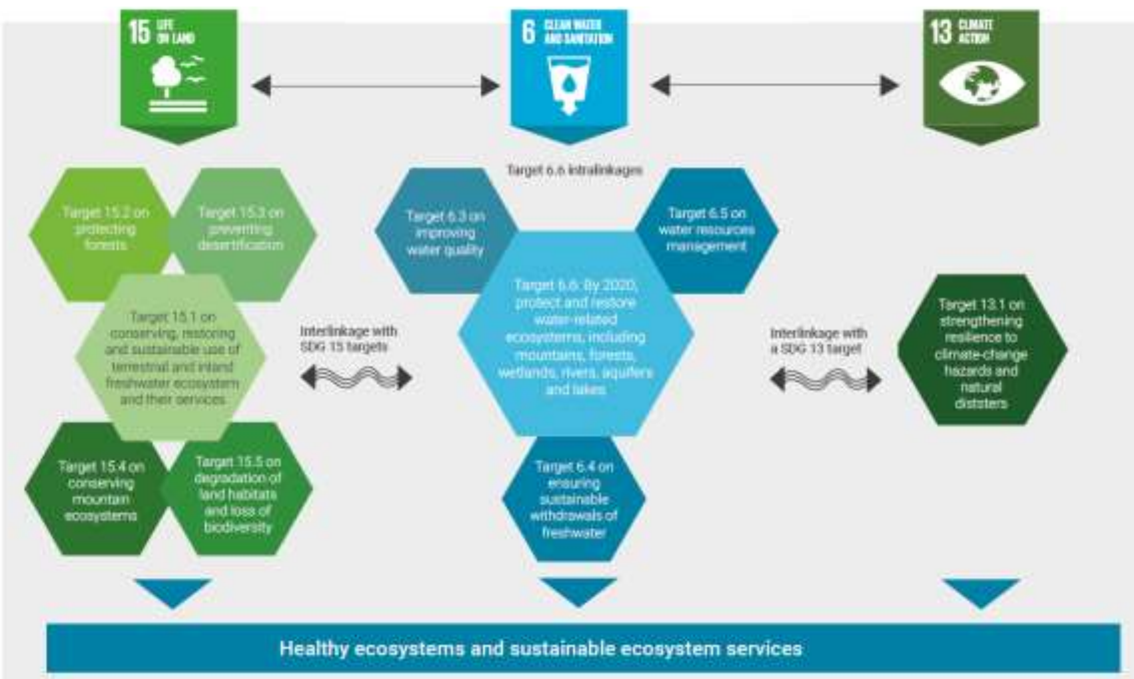


Figure 58 Linkages between SDG 6 and other SDGs (Reproduced from UNEP 2018)

Watershed Status

The NRCA, through a consultancy, developed a classification of Jamaica's 26 watershed management units (WMUs), in relation to the level of degradation. All 26 WMUs have been assessed as degraded to some extent (Figure 59) by the Global Environment Facility-Integrating Watershed and Coastal Area Management project.[156] In terms of relative proportion of land area, just over half (52%) of the total watershed area was classified as '*Least Degraded*'. These included nine of the 26 WMUs, including the two largest WMUs (Rio Bueno-White River and the Black River). Another seven WMUs (accounting for

[156]http://cep.unep.org/iwcam/media-centre/photo-gallery/demonstration-projects/jamaica/Map%20of%20Watersheds.png/view

12% of the total watershed area of Jamaica) were classified as "*Less Degraded,"* including the Great River and the Cabarita River. More than a third of the total watershed area in Jamaica was classified as either degraded (22%) or severely degraded (14%); these are generally located on the eastern side of the island. The most severely degraded WMUs included Rio Minho, Wagwater, Hope River and Yallahs.

Watershed degradation is an important driver to reduced river discharges, as loss of forest cover and increased road density are generally correlated with increased run-offs, hill slope instability (erosion and soil loss) and reduced river base flows. Impacts associated with watershed degradation are likely to be coupled with the impacts of climate change on river discharges, as increasing temperatures, higher drought risk, and increasing rainfall intensities may result in lower base flows as well.

The Land Degradation Neutrality Report (UNCCD 2018) produced a map showing changes in LULC overlaid with (declining) land productivity zones per watershed (reproduced as Figure 60); this was done relying largely on the ESA-CCI-LC dataset, v. 1.6.1[157]). Some of the more seriously degraded areas of Jamaica are in the southern coastal sections of the parishes of Clarendon, Manchester and St. Catherine and the worst areas are on the southern coastal border areas of Manchester and St. Elizabeth. Land degradation is likely to be the result of both climatic factors and human activity (UNCCD 2018). Some of these human activities include illegal housing (squatting), illegal logging for charcoal, bush fires and cutting of yam sticks.

[157] Forestry Department, written communication, 2019

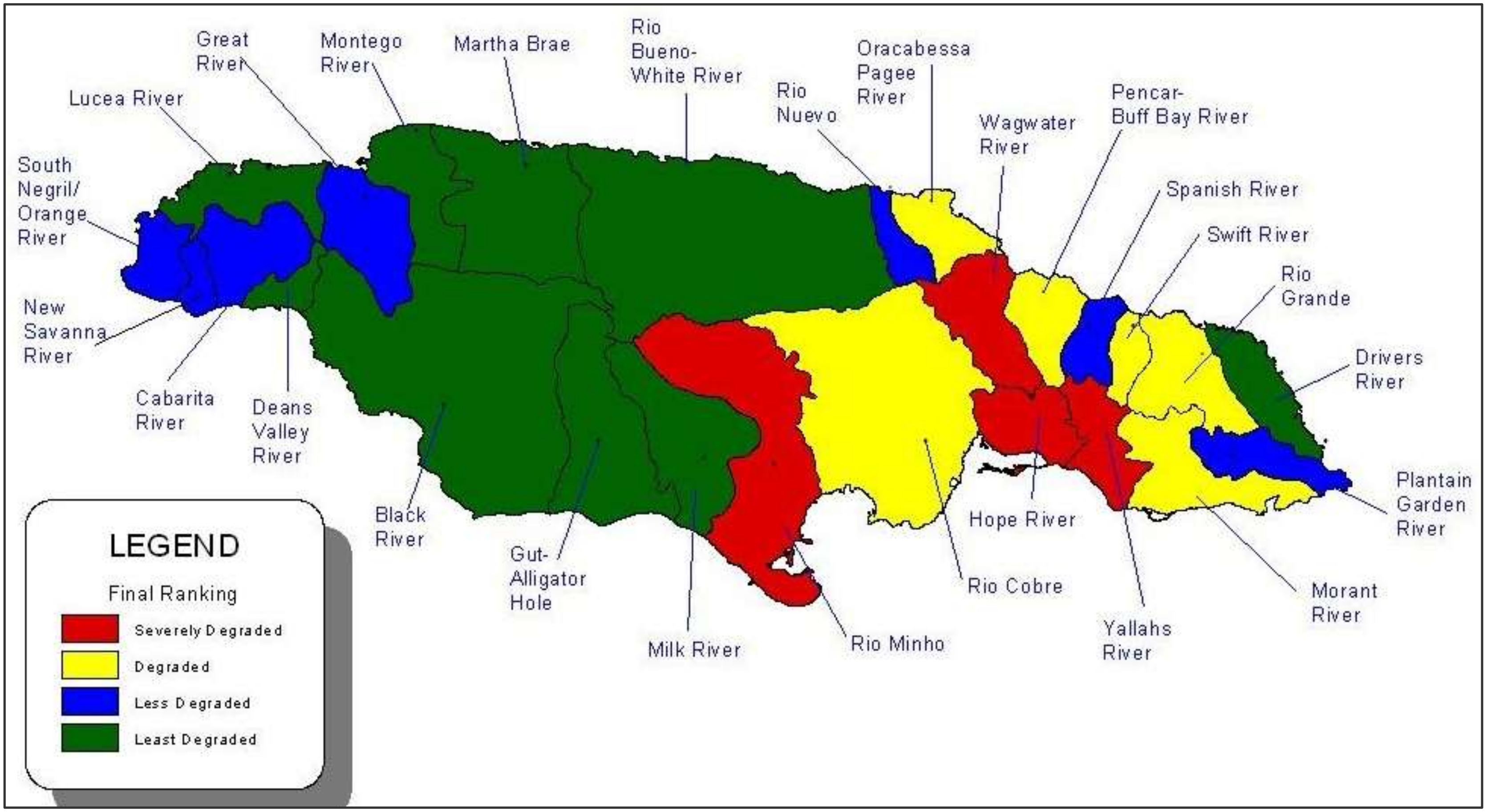


Figure 59 Level of degradation of Jamaica's WMUs (Reproduced from GEF-IWCAM website)

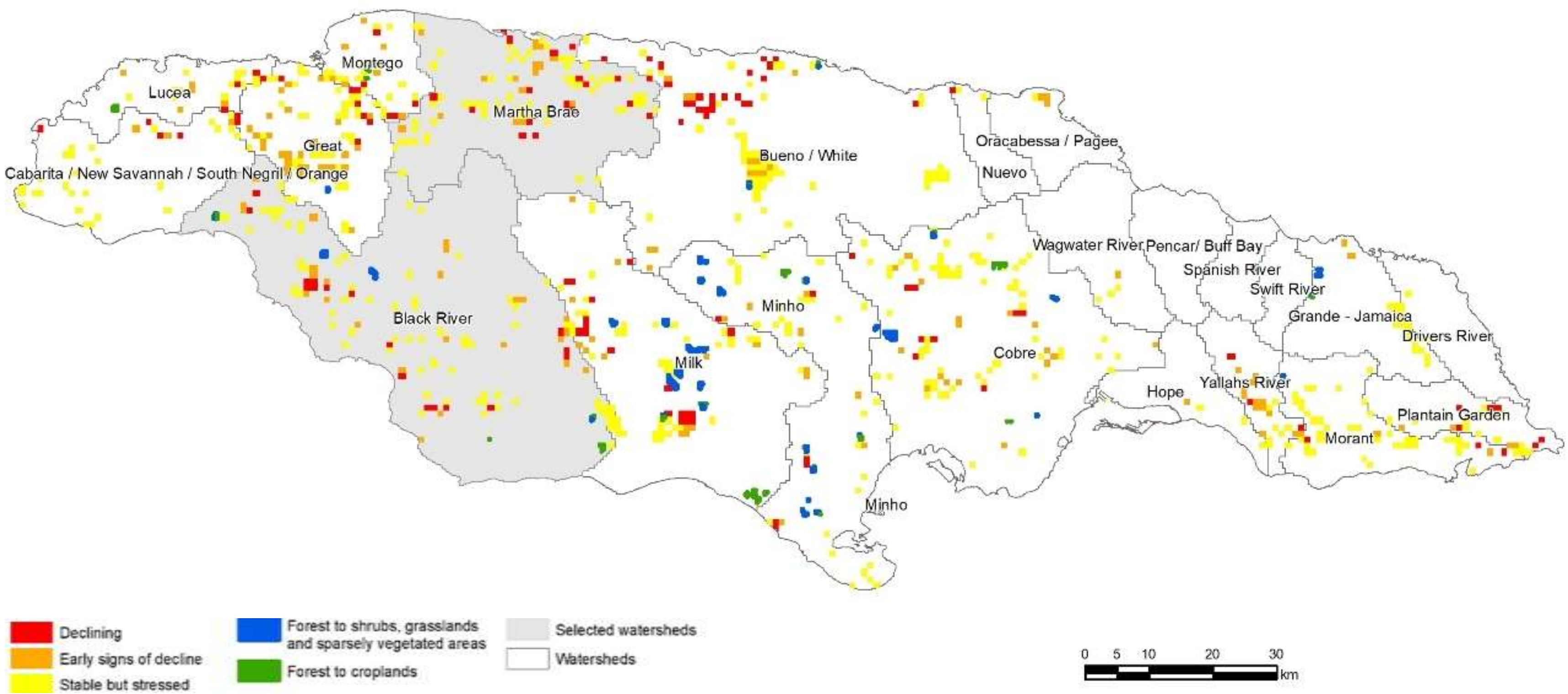


Figure 60 Overlay of land productivity values and LULC changes within watershed boundaries (Reproduced from the Land Degradation Report 2018)

Aquifer Status

Jamaica relies very heavily on groundwater from limestone and alluvium aquifers to sustain river base flows and supply water to many sectors. An estimated 84% of Jamaica's current water demand is met from groundwater resources contained mainly in limestone and alluvial aquifers (USACE, 2001). Groundwater accounts for an estimated 90% of the freshwater resources[158].During the review period the WRA undertook a preliminary classification of the island's aquifers using the DRASTIC rating system (USEPA, 1987) to rate the vulnerability of aquifers to pollution given location[159]. This system used the following parameters (with relative weightings in brackets), assuming that contaminants are flushed into the groundwater system from the surface by rainfall and have the mobility of water.

- Depth to groundwater (five)
- Impact of vadose zone (five)
- Recharge of aquifer (four)
- Aquifer media (three)
- Conductivity of the aquifer (three)
- Soil media (two)
- Slope (one)

This approach focuses on the natural attributes of the aquifer's location, and does not include risk factors, such as proximity to sources of pollution or intensity of use. The Preliminary Aquifer Vulnerability maps are reproduced as Figure 61. These maps use the same 26 WMUs used in relation to the watersheds.

The alluvial aquifers of Jamaica are mainly located on the southern side of the island, and include the Cabarita River, the Black River, the Rio Minho, the Rio Cobre, the Yallahs River and the Plantain Garden systems. On the northern side of the island there are smaller alluvial aquifers associated with the Martha Brae, Wagwater and Pencar-Buff Bay systems. Very high vulnerability areas are flagged as red and are found mainly in the highly populated coastal areas. With the exception of the Cabarita system (Westmoreland), the southern alluvial aquifers all have areas that are classified as being highly vulnerable. These areas are also more at risk because of saline intrusion arising from sea level rise associated with climate change, and over-pumping.

The vulnerability of the limestone aquifers is shown on the bottom map of Figure 61. Much more of the islands' groundwater resources are stored in limestone aquifers, compared to the alluvial aquifers. Although there are fewer areas that are classified as *Very High* vulnerability, there are relatively large areas that are classified as *High* vulnerability, including much of the Dry Harbour Mountains WMU and the Black River WMU.

Although there was insufficient data to quantify the relative proportion of the limestone and alluvial aquifers that are classified as high vulnerability etc., this work is an extremely important step towards more effective watershed management in Jamaica

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[158] WRA, written communication

[159] WRA, 2019, written communication

(a)

(b)

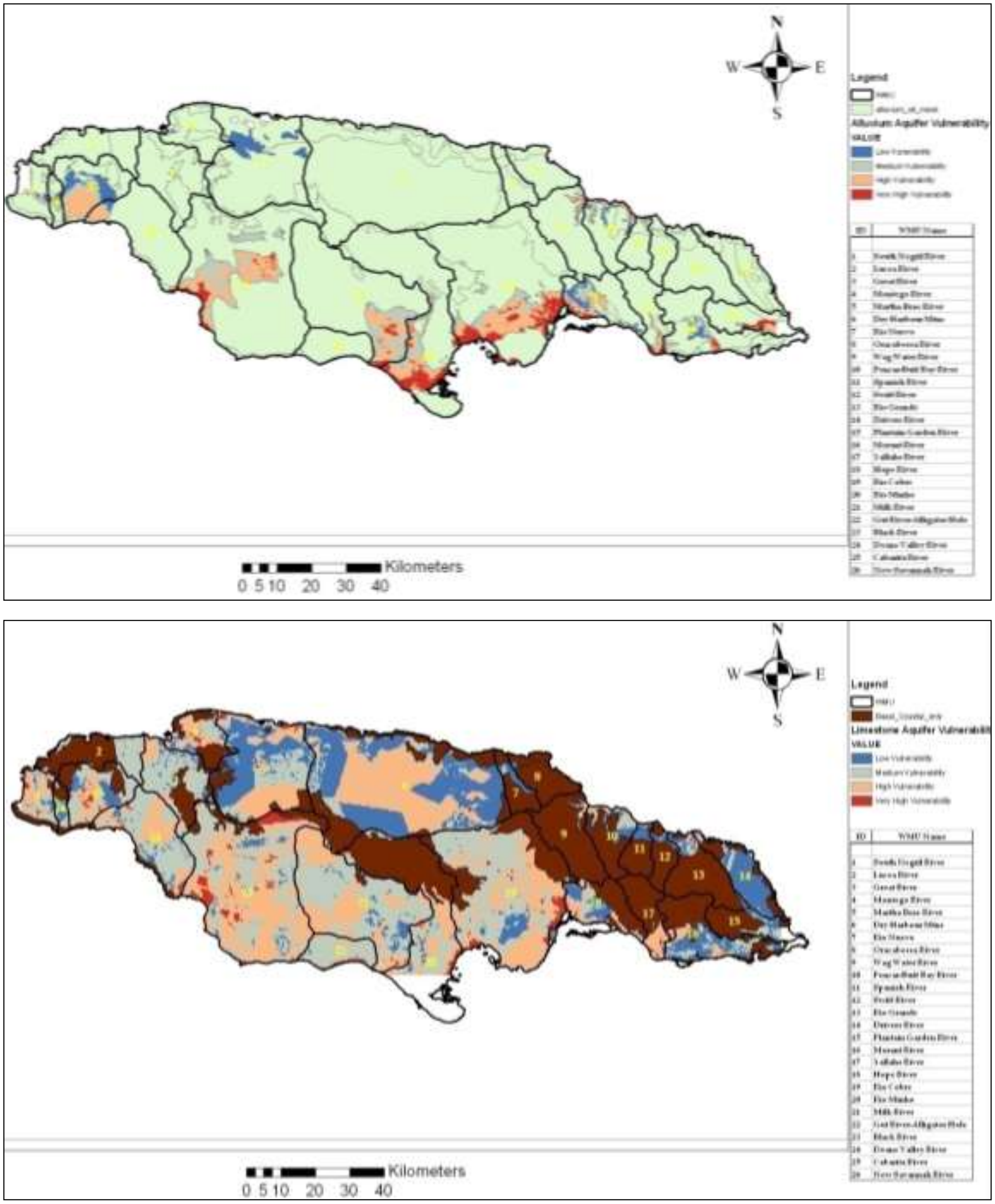

Figure 61 Limestone Aquifer Vulnerability for (a) Alluvial Aquifers and (b) Limestone Aquifers (Reproduced from WRA 2015)

Wetlands

Edaphic forests comprise vegetation that grows in waterlogged soils. Remnants of Swamp Forests (see **Figure 63**) are present in Jamaica (e.g. Negril Great Morass, Morant Point, Black River and in Savanna-la-mar; see Figure 62), and are characterized by *Symphonia globulifera* (hog gum), *Roystonea princeps* (royal palm) and other freshwater vegetation. The Forestry Department indicated that, between 1998 and 2013, Jamaica lost over 21.2 km^2 of Swamp Forest cover, leaving less than 1.23 km^2 remaining[160]. This loss is likely a result of reclamation of swampy areas for building and home construction.

Figure 62 Pond at Luidas Vale, St Catherine (Source: NEPA)

Mangrove forests are also a kind of edaphic species (growing in brackish water) and characterized by mangrove vegetation such as the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*) and buttonwood (*Conocarpus erectus*). The Forestry Department (2017) estimates that 82% of the remaining mangrove forests are located on the south coast of the island.

Table 52 is a preliminary list of wetlands (by parish, indicating area where available).It is estimated that there are ~97 km^2 of mangrove forest remaining in Jamaica; this figure does not include associated open water areas, and cannot be compared directly with the Ramsar sites, which account for 378.5km^2 of wetlands (including open water areas).

[160] It is possible that this figure is an underestimation as no high resolution mapping data have been collected. In the NFMCP the Forestry Department estimated that Swamp Forests are only found in Hanover and St Thomas (see Forestry Department 2017, page 34). However, swamp forests are known to occur in Clarendon, St Catherine, Westmoreland and other parishes.

Table 52 Preliminary List of Larger Named Wetlands in Jamaica[161]

North and West Coast	
St. Ann - Pear Tree Bottom - 0.8 km^2 **Trelawny** - Salt Marsh Swamp, Half Moon Bay & Hague 11 km^2 - Bush Cay – Florida Land Swamps	**Hanover/Westmoreland** - Great Morass, Negril - 24 km^2 - Cabarita Wetlands -2.4 km^2
South Coast	
Kingston - **Palisadoes Port Royal -75 km^2 *** **Portland Bight Wetlands and Cays - 245 km^2Ramsar Site (part of the coastal areas St Catherine and Clarendon)** - West Harbour Swamp 16 km^2 - Cockpit-Salt River -1.6 km^2 - Salt River Swamp - Carlisle Bay-Jackson Bay Swamps ~2 km^2 - Manatee Bay - 3.7 km^2 - Cabarita Swamp - 16 km^2 **Manchester** - Canoe Valley, 12 km^2	**St Catherine** - Kingston Harbour/Hunts Bay/Dawkins Pond -2 km^2 - Great Salt Pond and Flashes - 4.48 km^2 - Luidas Vale Ponds (freshwater karstic) - Amity Hall -4.8 km^2 - **Clarendon** - McCarry Base Swamp 12 km^2 - Mason River Protected Area, Bird Sanctuary and Ramsar Site (Clarendon/St. Ann) 0.8km^2(Freshwater inland wetland) **St. Elizabeth** - Black River Lower Morass, 60 km^2 * - Parrottee -Wallywash Pond - Great Pedro Pond
East Coast	
St Thomas - Great Morass - 16 km^2 - Cow Bay – 1.46 km^2 **St Mary** - Frontier Swamp	**Portland** - Turtle Crawle Swamp - Orange Bay Swamp - Hart Hill and Windsor Swamps - St. Margaret's Bay Swamp
**denotes Ramsar designated wetland*	

14.3.4 Proportion of Bodies of Water with Good Ambient Water Quality

SDG 6.3.2 is the **"**proportion of bodies of water with good ambient Water Quality" which, to be consistent with the previous SOE, is interpreted as the number of monitored stations meeting national biological oxygen demand (BOD), Nitrates (N), Phosphates (P) and faecal coliforms (FC) standards. This is an indicator which tracks the percentage of water bodies in a country with good ambient water quality. "Good" indicates an ambient water quality that does not damage ecosystem function and human health. Overall water quality is estimated, based on a core set of globally applicable parameters which evaluate major water quality impairments. For surface water, the parameters are dissolved oxygen, electrical conductivity, nitrogen, phosphorus and pH and for groundwater, the parameters are electrical conductivity, nitrate and pH. Table 53 shows Jamaica's National Ambient Water Quality Standards for freshwater.

[161] Areas sourced from NEPA: http://nepa.gov.jm/policies/draft/Mangroves%20and%20Coastal%20Wetland%20Protection/MANGROVE%20AND%20COASTAL%20WETLANDS%20PROTECTION%20annex.htmlRetrieved December 05 2018

Table 53 National Ambient Water Quality Standard – Freshwater (2009)[162]

Parameter	Measured as	Standard Range	Unit
Calcium	(Ca)	40.0-101.0	mg/L
Chloride	(Cl^-)	5.0- 20.0	mg/L
Magnesium	(Mg^{2+})	3.6- 27.0	mg/L
Nitrate	(NO_3^-)	0.1- 7.5	mg/L
Phosphate	(PO_4^{3-})	0.01 - 0.8	mg/L
Potassium	(K^+)	0.74- 5.0	mg/L
Silica	(SiO_2)	5.0- 39.0	mg/L
Sodium	(Na^+)	4.5- 12.0	mg/L
Sulphate	(SO_4^{2-})	3.0- 10.0	mg/L
Hardness	($CaCO_3$)	127.0-381.0	mg/L (measured as $CaCO_3$)
Biochemical Oxygen Demand	(O)	0.8- 1.7	mg/L
Total Dissolved Solids		120.0-300	mg/L
pH		7.00- 8.40	
Conductivity		150.0-600	µS/cm

One of the recommendations for reporting indicator 6.3.2 is to aggregate data by basin districts. As per indicator 6.6.1, Jamaica monitors water quality grouped into 26 watershed management units, this being analogous to a reporting basin district. This indicator provides an overview of the impact of certain types of pollution (including from diffuse sources not captured in indicator 6.3.1) and pollution reduction activities on ambient water quality, and is essential to describing the environmental status of freshwater systems. It enables an assessment of the impact of human development on ambient water quality, as well as the potential to obtain future ecosystem services from the water body, for example drinking water production and biodiversity.

Examination of the 2013-2016 ambient watershed water quality monitoring by NEPA shows that nitrates were within national standards in all but one WMU (Alligator Hole River), with 13 WMUs improving and eight deteriorating. The data show phosphates rising in 23 of 26 WMUs, with seven exceeding national standards; faecal coliforms were observed to be decreasing in 17 of 21 WMUs, with five exceeding the national standard; and nine WMUs with Biological Oxygen Demand (BOD) above the national standard and 11 WMUs with rising BOD concentrations. NO_3 and PO_4 data for 2015 are shown in the figures below.

WRA also monitors both surface and groundwater resources. Surface water was tested for chlorides, nitrates, sodium, sulphates and total dissolved solids. Available data for 2016 indicates that 43 of these stations are used for public water supplies. Two thirds of these are classified as having excellent/high quality water. Twelve were flagged as having deteriorating water quality:

1. Airy Castle, Saint Thomas
2. Pinnock Spring, Saint Andrew
3. Crooked River, Pumpkin, Clarendon
4. Cave River, Troy, Trelawny
5. Bullstrode Blue Hole, Westmoreland
6. Thickett River, Jerusalem Mountain, Westmoreland
7. Dean Valley, Carawina, Westmoreland
8. Cascade, Saint James

[162] https://www.nepa.gov.jm/standards/water_quality_standard_freshwater.pdf

9. Montpelier Spring, Saint James
10. Worchester, Saint James
11. Tangle River, Saint James
12. Mt. Zion Dam, Saint James

Only two were classified as having poor water quality and not meeting standards for drinking water quality: Kelly Spring in Kingston & Saint Andrew and God's Hole in Westmoreland. Other stations are also monitored for industrial and irrigation uses. Of these, none is classified as having deteriorating or poor water quality.

14.4 Ecosystem Services

The loss of forest cover has severe implications for terrestrial biodiversity, which is discussed in Chapter 16. Ecosystem services that would be adversely impacted by declines in status of terrestrial VECs (watersheds, aquifers and forest cover) include:

- Supporting services such as nutrient and water cycling, and soil formation; primary productivity; biodiversity and ecosystem resilience; habitat and food for endemic species;
- Regulatory Services:
  - Disaster risk reduction (flood, drought and soil erosion/sediment control) along with pollination and key carbon sequestration; and
  - Maintenance of water quality from natural filtration and water treatment, buffering of flood flows and erosion control;
- Provisioning services: clean and abundant freshwater for drinking, agricultural and industrial use, power generation and transport navigation; and
- Cultural services:
  - Science and education opportunities created by high endemism and biodiversity as well as watershed/forestry integrity; and
  - Recreational opportunities and tourism, health benefits.

Wetlands are major natural assets that provide a range of ecosystem services, including many of those mentioned above in addition to:

- Hazard risk reduction for lowland communities (through flood attenuation, shoreline protection). In 2017, World Wetlands Day was celebrated under theme of *Wetlands for Disaster Risk Reduction*,[163] recognizing the critical role played by Jamaica's wetlands in off-setting vulnerability to natural hazards (such as flooding and storm surges);
- Coastal water quality protection (though nutrient assimilation capacity, sediment intercepts); and
- Fish nursery functions.

Risk factors

- Watersheds (including groundwater), forests and freshwater-related ecosystems are threatened by human encroachment into the more mountainous areas of Jamaica, which were previously inaccessible. This may include development of roads or other linear structures (such as rights of way, transportation corridors, or pipelines) into upper catchments. Deforestation to facilitate mining, informal settlements and small-scale agriculture remains a major threat. Trees are also removed for fuel wood or charcoal burning, or for other purposes (e.g. scaffolding, yam sticks).

[163] http://www.forestry.gov.jm/node/343Retrieved December 03 2018

- Water quantity, groundwater recharge and river discharges are threatened by loss of forest cover, land use change to impervious surfaces, climate change and variability, particularly during extreme events (such as high intensity rainfall that results in increased surface run-off, and prolonged periods of low rainfall).
- Increasing temperatures and drying conditions are likely to result in increased evapo-transpiration (and lower amounts of stored water), shifts in bio-geographical ranges of some species, and general habitat degradation/fragmentation.
- Habitats are also under threat from natural hazards which may or may not be related to climate change, including flooding, droughts, hurricanes and wild-fires.
- Major threats to wetlands include sea level rise and drying-out due to climate change, wild fires, agricultural clearing, charcoal burning, invasive alien species and poaching of endemic species (e.g. bird-shooting, fishing), reclamation for roads, housing, tourism, illegal timber harvesting, as well as pollution (from agricultural, municipal and industrial effluents).
- Water quality is threatened by point-pollution contaminants, such as sewage pits and industrial waste discharge, as well more diffuse agricultural run-offs which contain high nutrient and pesticide loads.

14.5 Conclusions

One of the key aspects of this VEC is to examine the linkages between watersheds, land resources and major receiving water bodies. It is important to recognize that these indicators can also demonstrate the spatial linkages that connect watersheds to coastal and marine resources. Gathering data for these indicators requires a mixture of remote sensing and *in situ* monitoring approaches. A critical limitation of the data presented in this chapter is reliance on the 2013 land assessment survey produced by the Forestry Department, which is the latest available assessment. That assessment indicated that there was a minor net gain of forest cover over the 16-year period evaluation, although there were significant losses in terms of primary forest cover, with disturbing trends in the loss of DLFs, CBFs and swamp forests. Based on 16-year trends, it is estimated that there has been a loss of 47 km^2 of primary forest in the period 2014-2017. CBFs, DLFs, and swamp forests are especially threatened. MGCI indicates that Jamaica’s mountains are covered by ~86% vegetative cover. This is likely largely due to terrain which makes development in these areas challenging. These mountain regions are important refugia for endemic species, typically have high levels of biodiversity and are also important upper watersheds where the headwaters of many rivers are located.

Monitored water bodies generally have good water quality in terms of nitrates and phosphates.

15. Seas & Coasts

Scorecard 15: Seas & Coasts (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ASSESSMENT GRADE Condition / Trend	CONFIDENCE Grade	CONFIDENCE Trend	RISK
BEACHES	Erosion has been reported at all monitored sites.	UNCLEAR	2	2	High Risk Six
OFFSHORE CAYS AND BANKS	Based on 2014 data, general declines in coral reef health. South Cay SFPA coral reefs doing well.	NET LOSS / INSUFFICIENT DATA	3	1	Moderate Risk
OVERALL CORAL REEF HEALTH AT MONITORED SITES	The calculated Coral Reef Health Index (CRHI) for Jamaica was 2.3 indicating "poor" coral health.	POOR	2	3	High Risk Six
SEAGRASSES AND MANGROVES	Believed to be stable but no monitoring data available.	POOR	1	1	
FISH STOCKS	There is no data at country level for most commercially harvested species. Conch is currently the only species accounted for.	POOR	1	1	High Risk Six *(Not enough data to be conclusive)*
COASTAL WATER QUALITY	Majority of sites monitored for Nitrates and Phosphates were shown to be poor.	POOR	2	2	High Risk Seven

Photo: Boscobel Fish Sanctuary coral nursery outplantings, Jamaica by Natascia Tamburello, 2016. Used with permission.

15.2 Environmental Linkages

Marine and coastal resources are linked to key economic sectors, including tourism, fisheries and transportation. These resources are also under pressure as much of the urban population of Jamaica reside in proximity to the coast; a major issue related to this is water quality and 'floatables', which include improperly disposed plastics and other non-biodegradable materials that end up in the seas surrounding the island. It is important to remember that these marine and coastal resources, valued environmental components (VECs) lie downstream of watersheds, and are impacted by degradation of terrestrial resources (forestry, water, soils; discussed in Chapter 14); more importantly, many of these impacts increase cumulatively downstream, with increasing concentrations of pollutants moving towards the marine environment. Marine and coastal resources are also vulnerable to the effects of climate change, in particular higher water temperatures, ocean acidification, sea level rise and increasing intensity of extreme events (which combine to increase the risk of coastal flooding and more destructive storms).

Resources comprising the marine and coastal VEC include estuaries, harbours, shipping lanes, bays, wetlands (including mangroves), beaches, rocky shorelines, cays, seagrass beds, coral reefs and the broader Exclusive Economic Zone (EEZ) of Jamaica. To date, Jamaica's focus has largely been on data collection (and management) of the more accessible coastal areas and the Pedro Bank rather than comprehensive assessment of all resources within the EEZ.[164]Figure 63 shows the EEZ boundary and major banks and cays belonging to Jamaica. The total area of the EEZ is 257,047 km^2, and the area that is jointly managed with Colombia is 15,250 km^2.

[164] Jamaica's EEZ is 25 times the area of its land, therefore monitoring efforts are often concentrated on nearshore areas as a consequence of likely impacts from socio economic activities.

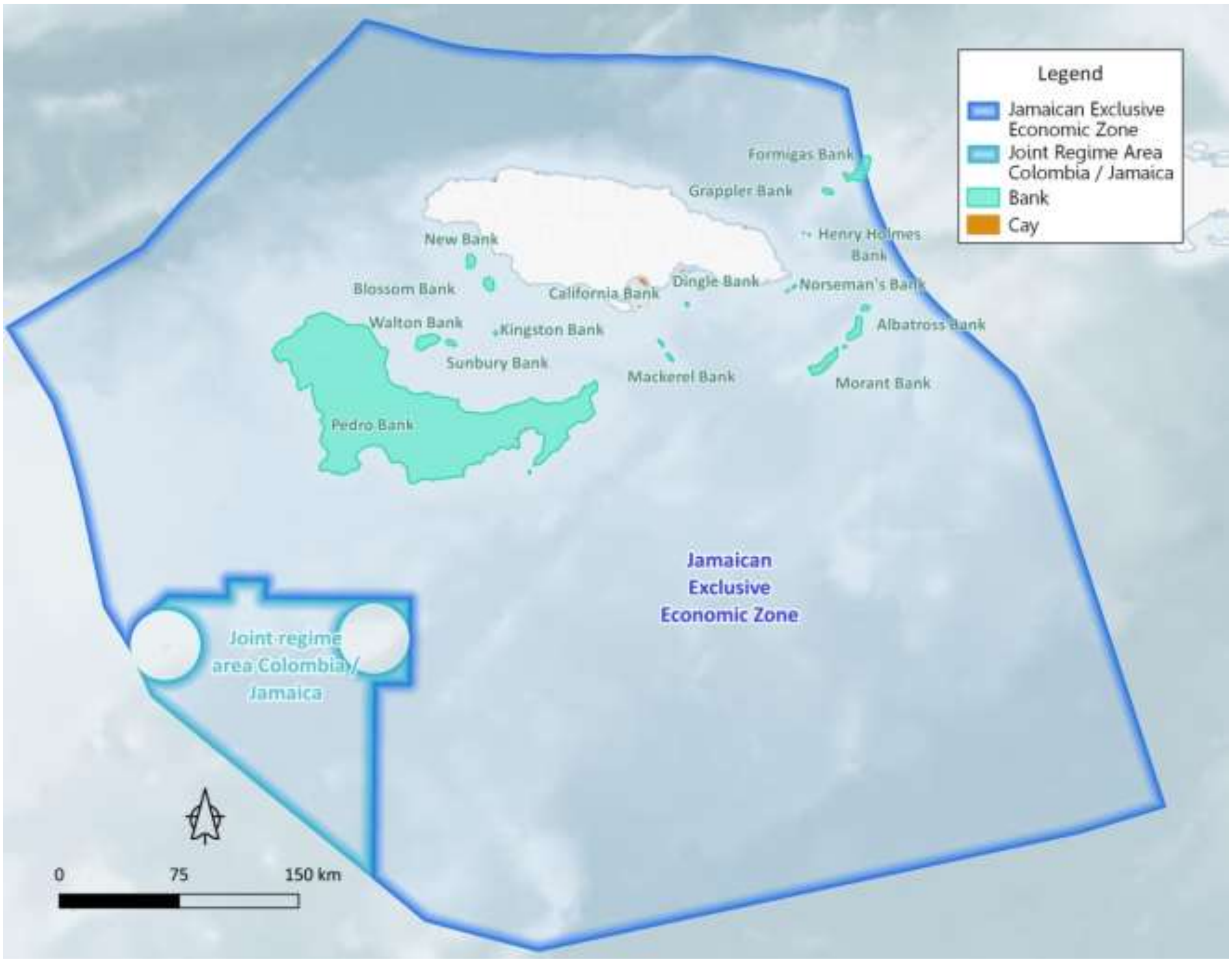

Figure 63 Jamaica's Exclusive Economic Zone (EEZ)

15.3 Indicator Trends and Patterns

15.3.1 Beaches

It is estimated that between 39% to 49% of Jamaica's shoreline can be classified as sandy beach (NEPA 2018c). During the review period the Beaches and Coastal Resources Committee of the Natural Resources Conservation Authority (NRCA) commenced work to create a web-based beach inventory,[165] listing the conditions at 43 popular bathing beaches around the island. Two-thirds (28) of these bathing beaches are white sand (bioclastic) beaches, and the remaining third (15) are mixed clastic-carbonate beaches. The mixed clastic-carbonate beaches are all located on the south coast (between Jackson Bay in Clarendon and Fort Charles in St. Elizabeth) and the east coast (Portland, St. Mary and St Thomas).

NEPA monitors several beaches in Jamaica, to determine their long-term stability. The stability of beaches is indicative of what is happening with:

[165] http://nepa.gov.jm/new/services_products/subsites/beach_guide/beaches/jackson_bay.php Retrieved December 03 2018

- Sediment supply (and the health of the systems that support that supply). White sand beaches comprising carbonate sediments made up of the shells of marine organisms, whereas brown or dark coloured beaches in Jamaica are typically made up of a combination of sediment brought to the coast by rivers, mixed with some marine material. The river bedloads are usually indicative of the dominant geology of the watershed drained by the river; and
- Climate change, which is causing sea level rise, increased variability in the frequency and intensity of storm events, as well as impacts on marine communities that contribute to beach sediment and serve to protect the shoreline from wave erosion. This also has implications for shoreline resilience and ability to recover from extreme events that cause damage and instability from time to time.

Chronic loss of shoreline can impact coastal buildings and infrastructure, fisheries landing sites and tourism activities. In addition, the instability of beaches can have an impact on inter-tidal habitats and nesting of marine turtles and shorebirds.

Turtle Nesting Beaches

Chapter 16 discusses biodiversity and the status of marine reptiles known to range in the Caribbean Sea. There are very few nesting beaches for leatherback sea turtles (*Dermochelys coriacea)*; and green turtles. Leatherbacks have been observed in recent times at Parottee and Billy's Bay St Elizabeth, while green turtles (*Chelonia mydas)* have been seen at Bush Cay, St James. The most critically endangered marine turtle species in the Caribbean, the hawksbill turtle (*Eretmochelys imbricata)* is actually the most commonly found nesting turtle in Jamaica (Figure 64). It should also be noted that several offshore cays (e.g. in the Portland Bight) are historically known as major turtle-nesting beaches.

Nesting season generally occurs between April and November, when beaches tend to be in a renewal process, and are more susceptible to erosion, due to hurricanes and tropical storms (hurricane seasons officially extends from June 1 to November 30 each year).Turtle hatching occurs approximately two months after nesting (Figure 65).

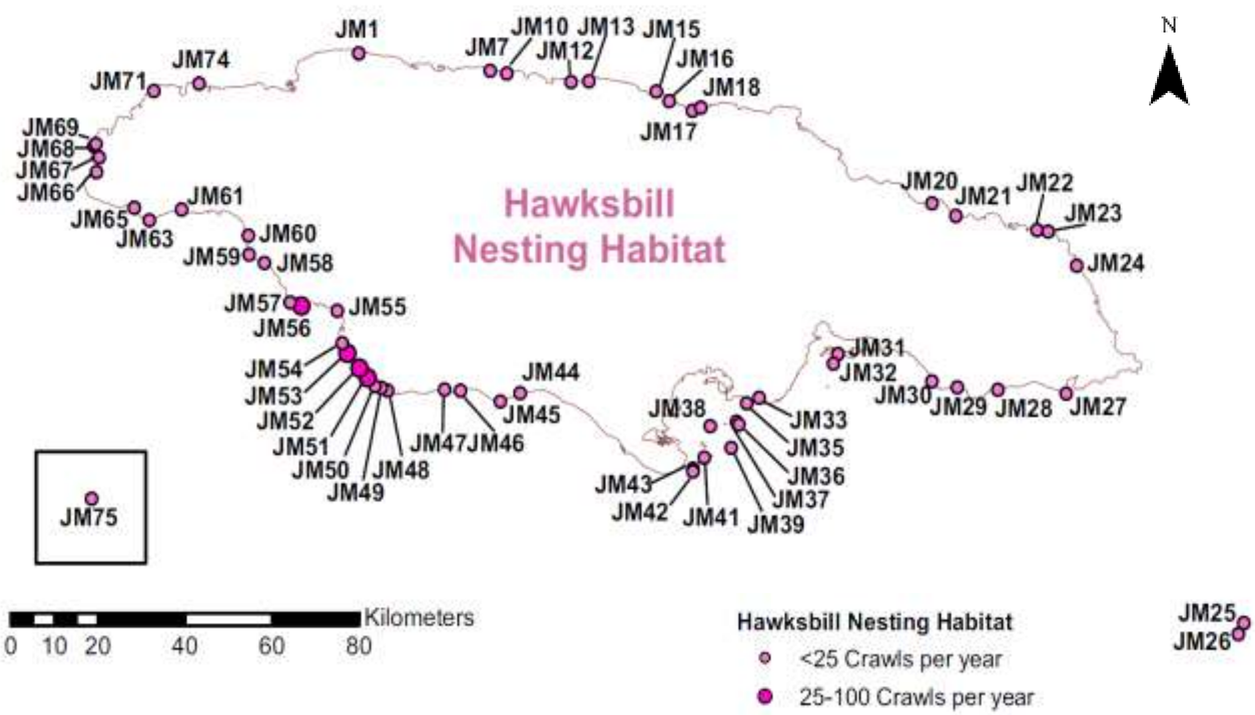

Figure 64 Known Hawksbill Nesting Beaches in Jamaica (Reproduced from Dow et al 2008; data provided by NEPA)

Figure 65 Turtle hatchlings headed for the sea for the first time, Jamaica Inn, Ocho Rios, (Photo: Annabelle Todd)

Available data on turtle nesting beaches were reported for 2014 (NEPA 2015), 2016 and 2017 [166]. The earlier report confirmed nesting activity at 32 of 59 beaches that were previously monitored as nesting sites (which is almost a third of the 2005 baseline of 150 turtle nesting sites). In 2016, NEPA monitored 45 beaches that were previously identified as nesting sites, and found only 27 to be active.

In the 2014 survey, the north and north-east coast (from St. Ann through St. Mary to Portland) had the highest number of active nesting sites (16). The south-west coast of Jamaica (Westmoreland through to St. Elizabeth and Manchester) collectively had 12 active nesting sites. Three active sites were also re-confirmed on the Pedro Cays.

The Palisadoes-Port Royal index site was monitored between September and November 2014, and it was found that there was a significant increase in the number of nests, compared to previous years, with 28 hawksbill turtle nests counted in 2014 compared to a quarter of that number in the previous year (2013). In the 2016 Survey, 29 hawksbill nests were recorded at this site; however in the 2017 survey of this index site only 19 nests were found.

Other nesting sites monitored in 2014 by non-governmental organizations (Bluefields Bay Fishermen's Friendly Society and the Oracabessa Foundation[167]) also showed an increase in the number of nests: 193

[166] (NEPA2018 written communication).

[167] ThNEPA, 2019, written communication is work was performed under an MOU with NRCA/NEPA, who provided funds for the work.

nests were recorded at Gibraltar Beach (Oracabessa), 42 (with hatchlings) at Farm and another eight nests with hatchlings at Whitehouse. NEPA also reported that the conversion of eggs to hatchlings had increased in 2014 (76% eggs hatched).

Turtle nesting sites are threatened by beach erosion during the main nesting months. It is expected that beach loss due to sea level rise may also be impacting nesting sites. Additionally, turtles are vulnerable to poaching (for their eggs, shells and meat). NEPA has indicated that poaching is particularly prevalent in Bluefields, Westmoreland[168]. Destruction of eggs by feral dogs was identified by NEPA (2015b) as a problem. The narrowing of beaches may also impact the ratio of males to females as gender is determined by nest temperature, with higher nest temperatures producing more females,[169] and impacting population dynamics in the longer term. As the beach narrows (with rising sea-level) more nests may be closer to the water and cooler, resulting in more males. Aside from distance from the sea, other factors can also affect local nest temperatures: lower cloudiness, less rainfall and rising ambient air temperatures have been linked to a higher female: male ratio.[170]

Beach Profiles

NEPA has conducted quarterly beach profile monitoring at six main beaches in Jamaica since 2000, and added a seventh beach (Hellshire, St. Catherine) in 2017. These data give a very general idea of changes in each beach, but are limited by the lack of information on the time of monitoring (only annual averages are given). In general, beach erosion and rebuilding cycles in Jamaica tend to be very seasonal, with pronounced winter erosion and summer recovery. Beach profile measurements are also likely to be strongly affected by time, since there is a relationship between a storm event and the system's ability to recover. It is assumed that the data from the monitored beaches are not affected by beach sediment removal or nourishment nor engineering structures that alter the ability of sediment to move naturally through the system. The following is a summary of the long-term trends that have been conjectured for the seven monitored beaches.

1. **Long Bay, Portland**: five sites have been monitored since 2007. This is an east-northeast facing beach in eastern Jamaica, and just over one km in length. Monitoring data indicates long-term erosion all along this beach. The single highest rate of erosion (57% loss in beach width) amongst monitored sites was noted at the Long Bay 2 station. Satellite imagery from June 2017 shows the maximum summer width of this beach is approximately 40 m (between the vegetation line and the high-water mark). Figure 66 illustrates the dramatic difference between the extent of the beach at one point from the March 2014 (after winter erosion cycle) and June 2017 (during summer accretion cycle). The difference between summer and winter profiles emphasizes the need to identify seasonal fluctuations as opposed to mean annual changes.

[168] NEPA, 2019, written communication

[169]http://www.seaturtle.org/mtn/archives/mtn128/mtn128p12.shtmlRetrieved December 03 2018

[170] See for example a 2018 report on green sea turtles in Australia, where the ratio of female to males was found to be 116:1. https://news.nationalgeographic.com/2018/01/australia-green-sea-turtles-turning-female-climate-change-raine-island-sex-temperature/Retrieved December 05 2018

Figure 66 Comparison of Winter (March 2014-top) and Summer (June 2017-bottom) beach extent for Long Bay, Portland.

2. **Burwood Beach, Trelawny**: two sites have been monitored since 2007. This is a north-northwest (NNW) facing carbonate beach. NEPA indicates a '*mild erosional trend*' with a net loss of approximately15% between 2007 and 2017.
3. **Negril, Westmoreland/Hanover:** 14 west-facing sites between Long Bay and Bloody Bay are currently monitored. This beach shows both accretion and erosion at various sites, with average net loss of less than 2% over the past decade.
4. **Bluefields Bay, Westmoreland**: two sites have been monitored since 2008. Bluefields Beach is a narrow (<10 m wide) west-southwest facing beach that is approximately 850 m long. A net gain of approximately 4% was observed at this beach over the monitoring period.
5. **Palisadoes-Port Royal, Kingston**: nine sites are monitored along the Palisadoes. This area is almost 10 km of beach, most of them south facing. In general, much of the beach is less than 30 metres at its maximum. Most of these increased in width, with the Port Royal site showing the highest levels of renewal. The sites with average net erosion showed about 20% change, and included Shipwreck beach (see Figure 67).

Figure 67 Comparison of Winter (December 2013- top) and Winter (January 2018- bottom) beach extent for Shipwreck Beach, Palisadoes.

6. **Jackson Bay, Clarendon**: two sites have been monitored since 2008. This is a south-southwest facing mixed sediment beach that is about 1.5 km long. Most of the beach backs on to an extensive wetland. In general, this beach is some 25 m wide at its maximum. According to NEPA, Jackson Bay has been experiencing chronic long-term erosion, with a 35.6% loss since 2008.
7. NEPA has recently added **Hellshire Beach, St Catherine** to its monitored beach stations. During the review period the beach experienced significant erosion. In 2014 average beach width was approximately seven m between the beach shacks and the high-water mark. From available satellite imagery (Figure 68), the beach width can be observed to have declined to <5 m by mid-2017, which was the beginning of a period of relatively rapid beach erosion in this area.

Figure 68 Comparison of Winter (March 2014- top) and Summer (June 2017- bottom) beach extent for Hellshire Beach

15.3.2 Status of Offshore Cays and Banks

Jamaica has many offshore cays and banks, particularly in its southern and eastern waters. There are 28 offshore islands and cays within the EEZ. These include Goat Island (Portland Bight, Clarendon), Navy Island (off Port Antonio), the Port Royal Cays (eight islands, including Gun Cay and Lime Cay) the Morant Cays, Emerald Island (off St. Thomas), Santamaria Island (off St. Mary), Pigeon Island (off Clarendon), Sandals Cay (privately owned by Sandals, off Montego Bay) and the Pedro Cays (Northeast Cay, Middle Cay, Southwest Cay and South Cay). Despite a small footprint (the combined area of offshore cays is approximately 7.3 km^2) these islands provide habitat for a diverse range of plants (Stoddart and Fosberg 1991), shorebirds and marine turtles. The Pedro Cays and Portland Rock are used as fishing bases, and provide habitat for seabird breeding colonies. The Pedro Cays include Middle Cay and Top Cay, where there are relatively large resident populations, with 348 and 140 persons living on these cays, respectively (Rhiney et al 2014). Very little recent environmental data are available on the status of these islands.

During the review period there has been more research focus on the Pedro Bank, which is the largest of Jamaica's 17 submarine plateaus (Figure 69). The Pedro Bank accounts for 7,591 km^2 or 80% of the combined area of Jamaica's marine banks (about 9,440 km^2). The Pedro Bank supports a range of marine ecosystems and is also very important to conch, lobster and finfish fisheries (Halcrow 1998, cited in Baldwin 2015).

A Marine Spatial Plan (Baldwin 2015) prepared for the Pedro Bank used data from 2014 satellite mapping (Purkis 2014, cited in Baldwin 2015) to estimate habitat areas (reproduced in Table 54).The dominant habitat/benthic cover on the Pedro Bank is microalgae (41.4%) and sand (34.1%). Coral reefs and seagrass cover account for the remaining 24.5%. Figure 72 above shows their location on the southwest margin of the Pedro Bank. In general, coral reefs account for a relatively small area.

Table 54 Key Marine Habitats – Pedro Bank (Source: Baldwin 2015)

Habitat Type	Area (km²)*	% total
Coral Reefs	1,388	18.3%
Seagrass	474	6.2%
Sand	2,590,	34.1%
Macroalgae	3,139	41.4%
Total	**7,591**	**100%**
* *estimated area shallower than 30 m isobath*		

The relative proportion of macroalgae and sand cover is a useful indicator of community disturbance. As part of the KSLOF Global Reef Expedition, Bruckner et al (2014) assessed 20 coral reef sites in March 2012, using a modified Atlantic and Gulf Rapid Reef Assessment protocol. They found that the macroalgal cover within the coral reef communities '*was relatively low, with only three sites having greater than 30% cover."*

Bruckner et al (2014) found that coral cover was generally low (<20%) and coral reef health ranged from critical to fair condition,[171] with the proportion of fleshy macroalgae coverage generally exceeding coral cover, and consistently low *Diadema* abundance.[172] In general, the ratio of fleshy macroalgae to live coral cover is a very good indicator of coral health in the Caribbean (Cortes 2019) with increasing levels of macroalgae being cumulatively indicative of environmental disturbance from human activities, disease, changes in community structure and climate change.

[171]They calculated the Reef Health Index (RHI) for each dive site using coral cover, coral disease prevalence, coral recruitment, macroalgal index, herbivorous fish index (parrotfish and surgeon fish only) and commercial fish abundance (grouper and snapper only).
[172]*Diadema antillarum* is a sea urchin that is very important to the health of coral reefs as it grazes on algae that would otherwise smother the reef; it may be considered a keystone species. http://www.healthyreefs.org/cms/healthy-reef-indicators/diadema-abundance/Retrieved December 05 2018

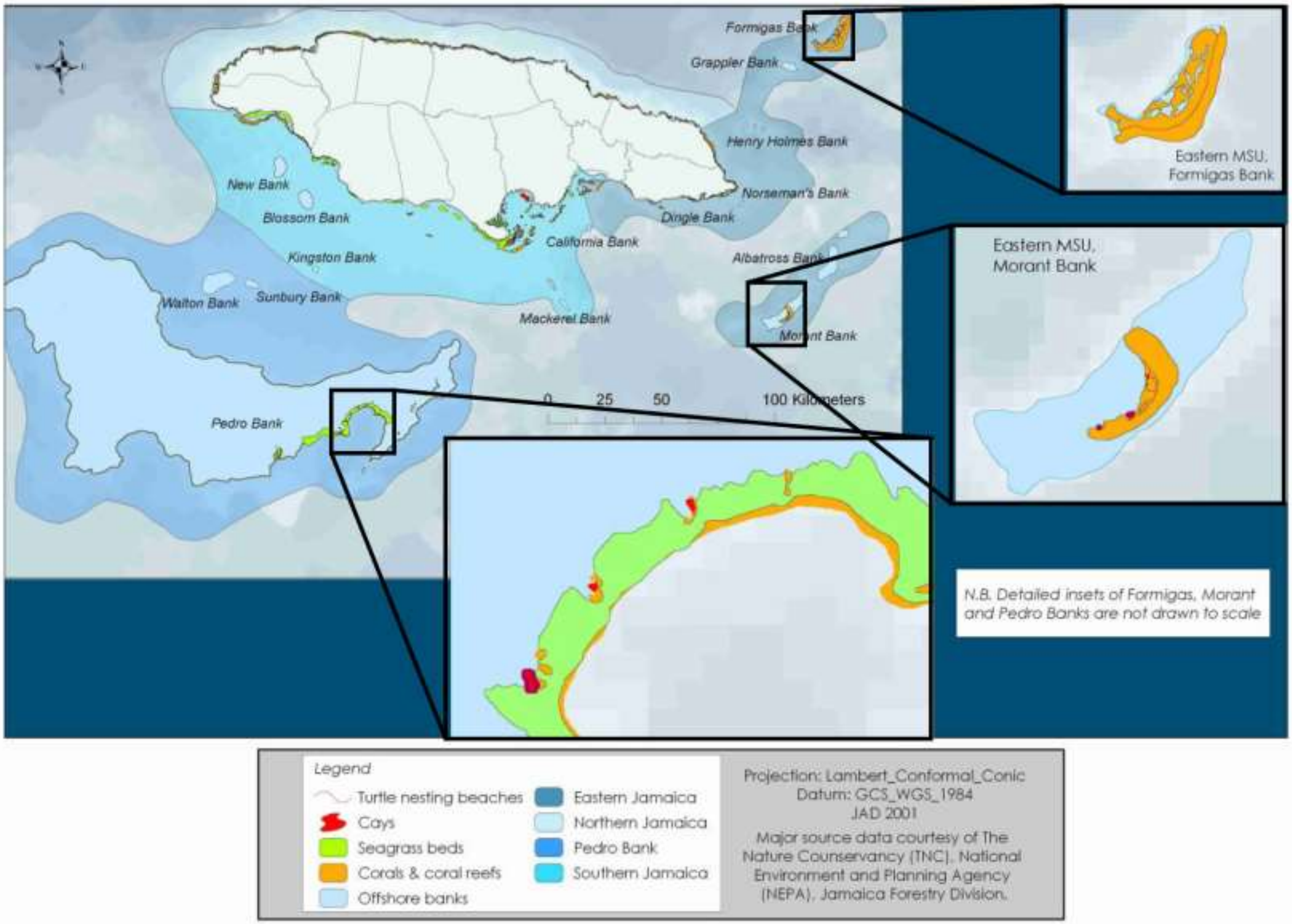

Figure 69Jamaican Offshore Banks (source: reproduced from Zenny 2006)

Despite this, there were some positive findings (Bruckner et al 2014):

- Very harmful fleshy algae like *Dictyota microdictyon* were completely absent and *Lobophora* occurred in low abundances;
- There was a low level (<20%) of partial mortality among stony corals on the bank (e.g. *Orbicella annularis).* This is very low compared to regional trends in the Caribbean (found by the KSLOF Global Reef Expedition surveys), which recorded 50% to 80% partial mortality in *O. annularis* and other larger corals; and
- The South West Cay Special Fishery Conservation Area (SW Cay SFCA) reportedly contained some of the healthiest coral reefs on the bank, with an extensive *Acropora palmata*framework and the largest healthy stand of *A. cervicornis* found anywhere on the bank. This is consistent with the findings of Purkis (2014, cited in Baldwin 2015) who estimated coral cover in the SW Cay SFCA was 37% (and macroalgae to be less than 1%).

Sea grasses account for 6% of the total area on the Pedro Bank, and are concentrated in the shallower areas of the eastern part of the bank. With the exception of the small area included in the SW Cay SFCA, there is no protected area encompassing/including seagrass beds on the Pedro Bank. Bruckner et al (2014) noted low species diversity (116 species) and low abundance (65 fish/100m^2) among the reef fish, with the population dominated by parrotfish. These authors also found that fish sizes were small, with general low biomass. They also noted a substantial decline in the abundance of surgeonfish from 2005 to 2012. More importantly, they found that there was a trend towards declining biomass with proximity to the fishing village.

15.3.3 Status of Benthic Ecosystems and Related Ecosystems

Coral Reefs

There are approximately 1,240 km² of coral reefs around Jamaica's coastline.[173] The 2017 Coral Reef Health Index (CRHI) Report includes assessments of 26 reef sites around Jamaica[174]. The CRHI measures the resilience of a reef by examining the ability of the reef community to maintain or restore structure and function and remain in an equivalent 'phase' as before events such as coral mortality. The reef index is determined by the integration of four key indicators: coral cover, macroalgal cover, herbivorous fish abundance and commercially important fish abundance. Aggregated index scores of the condition of the coral reef range from five (very good) to four (good), three (fair), two (poor) and one (critical). Over the years the CRHI has ranged from 2.1 to 2.4. The 2017 average CRHI of 2.3 means that the reefs in Jamaica continue to have a general ranking of 'poor'. A breakdown of the sites is given in

[173]https://www.icriforum.org/about-icri/members-networks/jamaicaRetrieved December 05 2018

[174]https://www.arcgis.com/apps/View/index.html?appid=a47e916b3ac540b0b15035dcb1a51057&extent=-78.6204,17.4906,-75.9836,18.7618Retrieved December 05 2018

Table 55 Summary of 2017 CRHI assessments .

Table 55 Summary of 2017 CRHI assessments

Rank	Sites
Fair (three)	• Hopewell, Hanover (one site) 3.8 • Boscobel SFCA, St. Mary (two sites) 3.1 average
Poor (two)	• Falmouth (three sites) 2.4 average • Ocho Rios Marine Protected Area (four sites) 2.4 average • Montego Bay Marine Park (three sites) 2.3 average • Negril Marine Park (four sites) 2.2 average • Discovery Bay SFCA (three sites) 2.1 average • Portland Bight Protected Area (one site) 2.0
Critical (one)	• Oracabessa Bay SFCA (three sites) 1.9 average • Palisadoes-Port Royal Protected Area (two sites) 1.8 average

Three of the 26 assessed sites were given a rating above three ("fair condition"), and all had live coral cover over 40%. All of the other locations had average CRHI scores below 2.4. It is noteworthy that, with the exception of the Boscobel SFCA, all other sites within protected areas were scored as either "poor" or "critical". The site with the lowest coral cover included South East Cay, Palisadoes – (2.6% coral).

Figure 70 shows additional CRHI trends between the last review period (2011-2013) and the current review period (2014-2017). Herbivorous fish biomass was marginally lower in 2017 when compared to 2013, while commercial fish biomass was slightly better in 2016/2017. Macro-algal cover did not show any sign of improvement in the review period, and appeared to be increasing in 2017 to over 30%. Although coral cover seemed to be increasing in the last review period, this change flat-lined in the current review period, remaining roughly at an average of about 20% for the assessed sites.

A review of sites that were assessed in both 2013 and 2017 indicates that there were improvements at sites in coral cover in Boscobel, Oracabessa, Montego Bay MP, Ocho Rios MP and Negril MP. It is also noteworthy that there were losses in coral cover in Falmouth (Relocation site one cover fell to 10.6% in 2017 from 25% in 2013), Discovery Bay sites (all three sites) and Drunkenman's Cay (Palisadoes). At Drunkenman's Cay, coral cover declined from 23% to about 12% between 2013 and 2017. As a group, the Palisadoes sites showed the lowest coral coverage. It must be remembered that these 26 monitored sites represent only a fraction of the total coral reefs of Jamaica. Figure 71 shows the extent of coral reefs around the island, indicating a general classification of the local threat level to these reefs. In general, almost all reefs fall into the very high to high threat level.

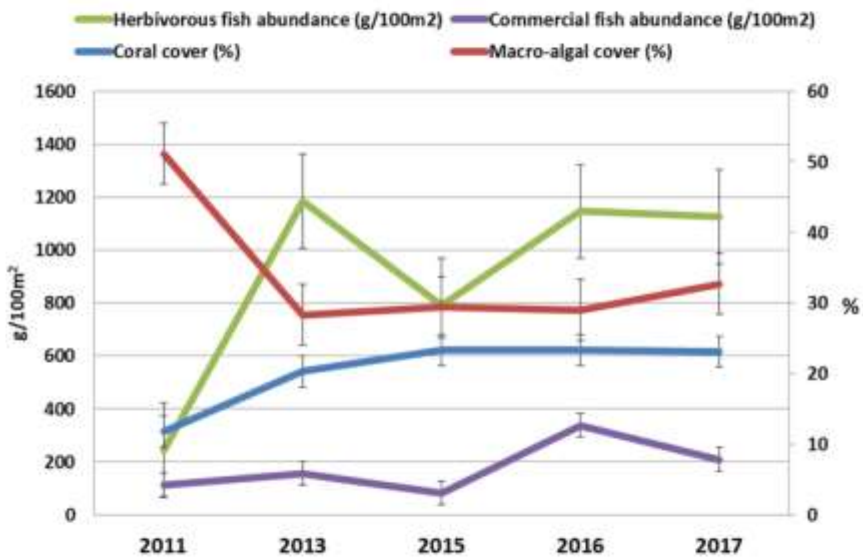

Figure 70 Trends in Key Coral Reef Health Indicators (2011-2017; Source: reproduced from NEPA 2018a Coral Reef Status)

Figure 71 Classification of Jamaica's coral reefs according to their integrated risk to local threats (overfishing, coastal development, watershed-based pollution, and marine-based pollution; Reproduced from WRI 2011)

Sea grasses and Mangroves

Seagrass meadows and mangroves are part of the Coastal Blue Carbon Ecosystems that work together with coral reefs to sustain a range of ecosystem services in the marine area. The term blue carbon[175] refers to the carbon that is sequestered in the biomass and sediments of coastal and marine ecosystems. Taking an integrated perspective, coral reefs, seagrass meadows and mangroves represent a major carbon sink in Jamaica that should be quantified and accounted for as national contributions to global carbon mitigation efforts.

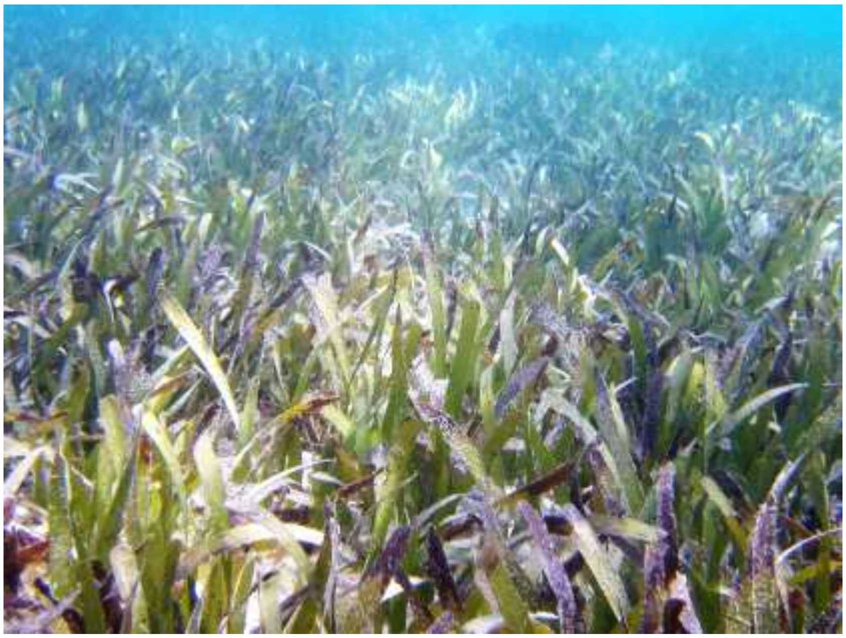

Figure 72 Thalassia meadow (Source: NEPA)

The dominant species comprising established native seagrass beds in Jamaica include *Thalassia testudinum*(Figure 72), *Syringodium filforme* and *Halodule wrightii.* Associated epiobionts, foraminifera, calcareous algae (e.g. *Halimeda opuntia*) and microbenthic infaunas (e.g. mollusks) are also integral components of the blue carbon system, and contribute the carbonate bioclastic sand comprising white sandy beaches.

Estimating seagrass, coral and mangrove coverage in Jamaica would be useful to establish the contribution to blue carbon. Unfortunately, while some level of coral and mangrove monitoring is done, very little information was available on status of seagrass beds during the review period. The Forestry Department estimated that there were 97.3 km^2 of mangroves, and that in the 16-year period preceding the review period, this land cover under this forest type had remained roughly the same. This may be due to NEPA's Permitting and Licensing System (NRCA Act) requiring a permit for modification of wetlands and the fact that developers encroaching on mangroves are required to replant (Figure 73).Additionally, the Forest Management Plan 2017, speaks to a 'no net loss' policy which calls for the replanting of mangroves to be impacted. The permits from the NRCA also require the planting of suitable wetland vegetation (mostly mangroves) or compensation for wetlands impacted by development.

Removal of sea grasses is also regulated, and replacement is required for any encroachments; it is likely that seagrass cover has also remained relatively stable.

[175] https://oceanservice.noaa.gov/facts/bluecarbon.htmlRetrieved December 11 2018

Figure 73 Mangrove Replanting Project (Source: NEPA)

15.3.4 Status of Fish Stocks

SDG indicator 14.4.1 *"proportion of fish stocks within biologically sustainable levels"* is designed to measure the sustainability of marine capture fisheries by their abundance.

A fish stock is classified as biologically sustainable if its abundance is sufficiently high to produce the maximum sustainable yield (MSY). In contrast, when abundance falls below the MSY level, the stock is considered biologically unsustainable. To determine stock abundance, one needs to carry out a stock assessment that uses fish catch statistics, fishing effort data and biological information and fit the data to a population dynamics model[176]. Stock assessments are technically demanding, but allow for effective management of the resource.

The Fisheries Division indicates that Jamaica's fisheries are managed using an ecosystem-based approach grouped by reef fisheries, offshore pelagics, conch, lobster, sea cucumber and others. Fisheries managers have further reported that "*whilst overfishing may be expressed as a concern and generally evidenced in the decrease[d] size of some species, there is not much evidence to conclude that this is a major threat to the industry*";and that the marine fish production has remained relatively stable throughout the years(Fisheries Division 2018).

[176]https://unstats.un.org/sdgs/metadata/files/Metadata-14-04-01.pdfRetrieved December 11 2018

In Jamaica's case, the data for this indicator for a wide range of commercial marine fisheries are not available. There is only one commercially harvested species subject to this level of monitoring: Queen Conch (*Strombus gigas*). The commercial fishery for Queen Conch is largely based on the Pedro Bank and is managed utilizing annual total allowable catch limits and individual non-transferable quota systems. The Fisheries Division has adopted a sustainable harvest strategy, which conservatively allows for harvest limits of 8% of the fishable biomass and a total allowable catch (TAC) no greater than 800 metric tons (mt) of 50% cleaned conch meat. For the period 2014 and 2015 it was reported that the TAC for Queen Conch was less than 500 mt.

The 2015 Queen Conch abundance survey on the Pedro Bank was conducted by the Fisheries Division in 2015, noting that:

- the highest concentrations were found in the shallow south-eastern section of the Pedro Bank where there are hard substrates (coral reefs, pavements and rubble).
- relatively high densities of conch associated with the macroalgae and seagrass meadows, which serve as nurseries for juvenile conch.
- Conch density was 394 conch/ha, with a total estimated biomass of 29,917 mt, with about 90% of this reported to be above the minimum harvest size (exploitable biomass). Conch density and biomass were therefore assessed to be at viable population levels that would allow for sustainable harvesting within limits. Existing (2015) harvesting pressure on the conch fisheries was not deemed to have a significant negative effect on the stock.

A more recent survey was conducted in 2018. Although it is recognized that 2018 data do not fall within the review period of this SOE, significant decline in conch stock occurred in the two last years of the review period (2016 and 2017), resulting in an estimated true exploitable biomass of conch in 2018 of ~3,561 mt. The calculated rate of loss of exploitable conch biomass for the review period after the 2015 survey is 7,781 mt per year, which is considered catastrophic for the population.

A preliminary stock assessment for sea cucumbers was conducted on the island shelf between October 2016 and July 2017(Flores, 2018). The most abundant species were *Holothuria mexicana*; *Isostichopus badionotus*; and *Actinopygia agassissi*. The highest densities were found offshore of St. Ann (mainly *H. mexicana*) and offshore of the Hellshire Hills in St. Catherine (mainly *I. badionotus*).*H. mexicana* were the most abundant species, particularly in the northern and western parishes; this species has a relatively low commercial value (Flores, 2018). *I. badionotus* appeared to be more common on the south side of the island between Manchester and St. Andrew; this species has an intermediate commercial value. *Actinopygia agassissi,* though generally classified as having an intermediate commercial value globally, has a relatively high price in Jamaica. All species commonly found in Jamaican waters are classified by the IUCN as "Least Concern" with wide distributions. Based on the data collected, the survey concluded that the Fisheries Division "*take immediate action to promote, disseminate and enforce strict regulations aimed at recovering the stocks of sea cucumbers on the island shelf."* Sea cucumbers are highly vulnerable to overfishing (Flores, 2018).

It is reported in the ESSJ (PIOJ 2018a) that marine fish production (including finfish, conch, lobster and shrimp) was generally lower between 2014 to 2016 (with average annual production of 12,424 tonnes) than it was in 2013 (14,263 tonnes). However, in 2017, marine fish production increased to 14,748 tonnes.

In 2017, at the monitored reef sites, the highest biomass for herbivorous fish was recorded at Round Hill, Hopewell (6,726 g/100 m^2) followed by Commander Reef, Oracabessa (3,305 g/100 m^2). The values for these are several orders of magnitude higher than for other sites, where the biomass ranged between 1,673 g/100 m^2 and 210 g/100 m^2, with an average of 813 g/100 m^2(excluding the two highest values – Round Hill and Commander Reef). Commercial fish biomass at the monitored reef sites ranged between 1,088 g/100 m^2 (Boscobel West) and 0 g/100 m^2at Sewage End (Ocho Rios), with an average of 150 g/100 m^2. In general, herbivorous species biomass exceeded commercial species biomass. Comparing biomasses recorded in 2015 with 2017, it was found that there were substantial declines in commercial target species at Boscobel West and Outer Bank, Oracabessa. Major improvements in this indicator were noted at the Negril MP, Montego MP and Round Hill sites.

15.3.5 Coastal Water Quality

Nearshore coastal water quality is primarily influenced by land-based sources of pollution from point and non-point sources. Over 200 water quality (WQ) stations located around the island are monitored for a range of ambient parameters, including bacteriological, biological and chemical characteristics. National standards have been established for various coastal water quality indicators: phosphates, nitrates, biological oxygen demand (BOD; an indicator of organic pollution), and faecal coliforms.

Coastal WQ stations are generally associated with major watersheds. Coastal WQ monitoring data were averaged for all available stations near the coastal areas of 32 drainage basins for the period 2014-2016. BOD values were the most elevated in the Cabarita River coastal WQ stations. The coastal areas of 14 of the 32 drainage basins had average BOD values exceeding the 1.16 mg/l BOD limit (NRCA standard) for the review period. Most of the stations that had BOD concentration averages below the NRCA upper threshold were located in the eastern side of the island: Plantain Gardens and Morant River (St, Thomas), Spanish River, Pencar - Buff Bay, Swift River (Portland) and Oracabessa - Pagee River, Rio Nuevo (St. Mary). Rio Bueno - White River (St. Ann) and New Savanna River (Westmoreland) also performed well in terms of average BOD values for the period (did not exceed the standard).

Nitrates and phosphates are key indicators of nutrient loads in coastal water. Too much input of nitrates or phosphates can result in eutrophication[177] and contribute to the growth of nutrient indicating (fleshy) algae in nearshore ecosystems. Averaged phosphate and nitrate levels exceeded national standards (0.003 mg/l and 0.014 mg/l respectively) in all cases for marine stations. The data indicate that over the 2014 -2016 period, the majority of the receiving coastal waters of the major watersheds had averages that exceeded the NRCA ambient standards for nitrates and phosphates, and therefore the coastal waters of Jamaica are considered to be of generally poor quality.

Averaged ambient pH levels ranged between 8.22 and 7.9, with four coastal WQ stations having average values below 8.0 (marine pH standard): Milk River, Lucea River, Wagwater River, and Cabarita River.

A suitable indicator that can reflect the extent of plastic pollution has not yet been developed. This sub-indicator refers to the modelled macro and micro plastics distribution in the ocean, where relative quantities of floating micro (<4.75mm in diameter) and macro (>4.75mm in diameter) plastics in large marine ecosystems are measured, based on a model of surface water circulation. Given the lack of a current indicator for (micro) plastic pollution[178] some suggested proxies for this indicator include: beach clean-up data, shipping density, coastal population density, and area of impermeable catchment i.e. urban areas with rapid run-off. In 2017, the Jamaica Environment Trust (JET) reported collecting 72.6 tons of garbage from just over 161 km of beach during their beach clean-up exercises. This compares to

[177] **Eutrophication**, the gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients in an aging aquatic ecosystem.

[178] https://unstats.un.org/sdgs/metadata/?Text=&Goal=14&Target=Retrieved December 11 2018

about 38.5 tons collected from a similar length of coastline in 2014[179], suggesting that for the beaches that were targeted in the review period, there was almost double the garbage collected in 2017 compared to 2014.

A partial record of environmental incidents in Jamaican waters (Table 56) suggests a reduction in pollution from 2015 to 2017, except for fish kills (20% increase).

Table 56 Number of environmental incidents in Jamaican waters (2015-2017; Source: NEPA 2018a)

Environmental Incident Type	2015	2016	2017
Oil spill	14	16	12
Fish kill	5	5	6
Improper waste disposal	1	1	1
Sewage discharge	6	7	6
Effluent discharge	2	3	1
Other spill	15	2	1
Total	43	34	27

15.4 Ecosystem Impacts

The valued environmental components included in this chapter include beaches, offshore banks and cays, coastal ecosystems (coral reefs-sea grasses-mangroves), fish stock and coastal water quality. In general, the NEPA monitored beaches all showed signs of instability. Long-term beach erosion occurs if seasonal accretion is less than seasonal or hazard-related erosion. Though it is likely that some beaches are more stable than those that are monitored, it is important to understand the ecosystem services provided by these beaches.

Beach ecosystem services include tourism potential and recreational opportunities for Jamaicans. Jamaica’s tourism sector is dominated by mass tourism that relies heavily on white sand beach resources on Jamaica`s north coast. The cost of beach erosion in Jamaica is best understood in terms of the cost of rehabilitating beaches that have undergone erosion. Rehabilitation can take the form of construction of groynes or breakwaters that protect the shoreline, and can also involve beach nourishment. Beach rehabilitation and shoreline protection may have high capital and environmental costs (for dredging of suitable sand or within the footprint of submarine structures).

In 2011, it was estimated[180] that it would cost approximately US$25 million to restore Long Bay beach in Negril which, at the time, was generating estimated annual revenues of approximately US$500 million. Beach erosion can also have costs associated with the loss of tourism. It is important to note that as sea-level rises, nearshore ecosystems begin to shift inland, resulting in damage to infrastructure and buildings that are constructed within the coastal zone. It may become increasingly costly to attempt to “hold the line.”

Loss of beaches can significantly impact marine turtle nesting, and have repercussions on the ecosystems services that are supported by critically endangered hawksbill turtle populations, which include maintaining the health of seagrass meadows and coral reefs. Hawksbill turtles selectively feed on sponges and maintain a balance in reef ecosystems (Teelucksingh et al 2010). Turtle nesting is also adversely impacted by feral dogs, cats, mongooses and poachers.

[179] http://internationalmarinedebrisconference.org/wp-content/uploads/2018/02/How-a-Beach-Cleanup-evolved-into-a-National-Public-Education-Campaign.pdf

[180] http://jamaica-gleaner.com/gleaner/20110814/lead/lead5.htmlRetrieved December 11 2018

Disruption of the coral reef ecosystems or the seagrass ecosystems can lead to a decline in carbonate (bioclastic) sediment production/supply, which in turn results in increased levels of beach erosion or more protracted recovery periods. Significant threats to beaches therefore include factors that put carbonate sediment supply at risk, including degradation of sediment producing ecosystems. Aside from change in the community structure of nearshore ecosystems (e.g. reef smothering or competition from invasive alien species, diseases, die-offs in sea urchin populations), changes in water quality are also a critical perturbation to the system. High nitrate loads result in the proliferation of fleshy macroalgae. In addition, elevated nitrate and phosphate levels (associated with land-based sources of pollution) have been shown to have an indirect adverse impact on net community calcification and dissolution in reefs by altering the water pH level (Silbiger et al 2018). This effect is likely to combine with ocean acidification (associated with higher rates of absorption of carbon dioxide from the atmosphere) to further alter water pH. The integrity of offshore ecosystems is not only important to sediment production in Jamaica, but also to protecting the shorelines from the effects of storms that may be increasing in intensity and frequency, as a result of a warming planet.

Poor water quality adversely impacts coastal stability, fisheries, tourism and human health. Additionally, low pH levels and periodically elevated suspended solids loads (which are correlated with rainfall intensity, and watershed degradation) also contribute to declining coastal water quality. Improper sewage disposal, high bather densities at specific times, and the use of animal manure as fertilizer in proximity to the shoreline can all contribute to elevated bacteria loads (particularly *Enterococci*), which can adversely impact human health and tourism. Agricultural run-offs from areas with high pesticide and fertilizer use or poor land use practices can also contribute to nutrient and sediment loads in freshwater and coastal ecosystems, and lead to elevated BOD levels. Incremental shifts in benthic communities from carbonate producers to fleshy macroalgae dominated systems are largely driven by declining coastal water quality.

A major threat to beaches and nearshore ecosystems that emerged in this review period is the *Sargassum*. *Sargassum* is a floating brown macroalgae that has increasingly impacted beaches in the Caribbean Sea, tourism and coastal fisheries since 2011. Mega-blooms of *Sargassum*, while generally believed to be stimulated by factors occurring at a global level (e.g. warming sea surface temperatures, Sahara dust fall) may also be locally exacerbated by nearshore nutrient loads. Stranded rotting *Sargassum*has had major unquantified deleterious impacts on beach sand (especially if the *Sargassum* must be mechanically removed), fishing activities, water quality (BOD specifically) and tourism.[181] During the review period, millions of dollars and hundreds of man-hours were spent by both Government and the private sector on removing *Sargassum* macroalgae from Jamaican beaches.

Nearshore ecosystems, offshore cays and marine banks also provide critical services that support the fisheries sector and supplement the food supply in Jamaica. Seagrass meadows and mangroves are important fish spawning areas that also serve to assimilate nutrients, produce carbonate sediment, and provide habitat and food for a range of marine species. These areas also form integral parts of the mangrove-seagrass-coral reef ecosystem which, when healthy and intact, serve as a buffer to protect shorelines from storms. Fish biomass in the coral reef ecosystems, in offshore banks and in the nearshore areas of the cays account for the majority of the island's artisanal fisheries. Demersal finfish species and invertebrates such as lobster and conch also rely on coral reefs for food and protection. The artisanal fisheries sub-sector creates diverse employment and contributes to food security. The major threats to the resource include habitat (and spawning area) degradation, declining water quality, over-

[181]https://essa.com/the-great-sargassum-disaster-of-2018/Retrieved December 11 2018

exploitation and invasive alien species (e.g. lionfish). In addition, poor fishing practices[182] like blast-fishing or abandonment of fish-traps (ghost-traps) remain significant causes of declining fish biomass.

In the Caribbean, seagrass meadows (and mangroves) have not received the same attention as the coral reefs, and their importance as a coastal habitat often was (and still is) ignored.

CARCOMP Network of Caribbean Marine Laboratories (1985-2007): History, Key Findings and Lessons Learned. (2019).

15.5 Conclusions

- **Beach erosion**. The beaches that are currently monitored by NEPA all show signs of either seasonal or long-term erosion. Scientific interpretation of the beach monitoring data requires additional information on the timing of data collection as well as other factors that might impact beach sediment supply and transportation dynamics, which are currently not included in the beach monitoring reports. Jamaica's beaches are important for tourism, domestic recreation, and fishing, and provide habitat for the critically endangered hawksbill turtles and other marine turtles.
- **Offshore cays and banks**. Coral reefs on the Pedro Cays were assessed in 2014. Coral cover was generally low (<20%) and coral health was ranked from critical to fair, with fleshy macroalgae exceeding coral cover and the presence of low levels of the grazing sea urchin *Diadema*. Some positive signs included low partial mortality in stony corals and healthy stands of *Acropora palmata*and *A. cervicornis*near South West Cay SFCA. It is likely that the coral reefs in this area are among the healthiest and unimpacted in Jamaican waters. In general benthic ecosystems around the other Pedro Cays were impacted by resident fishing communities, with the associated solid waste, sewage, overfishing and water quality issues resulting in declining biomass in the nearshore areas. No monitoring data or environmental surveys were available for other offshore banks and cays during the review period.
- ***Coastal Benthic Ecosystems.*** Although the monitoring methodologies applied for assessing coral reef health are generally of a high quality, the assessments are limited to only 26 sites around the island. Human and monetary resource constraints do not allow for a more extensive distribution of coral reef survey sites around the island. The poor coral reef health index rating continues to be a cause for concern. No monitoring data were available for seagrass meadows and mangroves, but these are believed to be relatively stable, due to strict enforcement of the no-net loss policy.
- ***Fish Stock.*** Surveys in the Pedro Cays in 2014 indicated declining reef fish biomass. Detailed data are available only for the Queen Conch stocks on the Pedro Bank, which are monitored routinely, in compliance with CITES obligations. The 2015 survey indicated an extremely healthy population. However, based on the near-collapse of the fishery (as indicated in the 2018 survey) it is assumed that decline in the stock occurred dramatically in the last two years of the review period (2016-2017).

[182] http://nepa.gov.jm/wwd2007/presentation/Destructive-Fishing-Practices.pdf Retrieved December 01 2018

16. Biodiversity

Scorecard 16: Biodiversity (2014 - 2017)

This scoresheet is intended to serve only as a visual chapter summary of the content that follows. For in-depth explanations of indicators, data and data sources please consult the contents of this chapter.

INDICATOR	SUMMARY	ASSESSMENT GRADE Condition / Trend	CONFIDENCE Grade	CONFIDENCE Trend	RISK
CHANGES TO THE RED LIST INDEX	No new species of plants added to the IUCN critically endangered (CR) or endangered (EN) list. Seven species of animals added to CR list including four reptiles and two bat species. 14 animal species added to the EN list, including 11 reptile species.	NET LOSS (Animals) IMPACT UNCERTAIN	3	3	Moderate Risk Five
CHANGE IN CONSERVATION STATUS OF ENDEMIC SPECIES	Key advances have been made with respect to iguana conservation with 20% increase in releases. Reclassification of some species status due to advances in genetic research and taxonomic revisions. 2014-2017 information needs to be updated.	STABLE	2	2	Moderate Risk Three
INVASIVE ALIEN SPECIES	There are currently 425 species of invasive plants and 125 invasive animal species listed in the Invasive Species Compendium. The lionfish continues to be a problem in Jamaican coral reef ecosystems.	NET LOSS	2	2	High Risk Six
BIODIVERSITY HABITAT INDEX	There has been an overall decline in the quality and integrity of forest habitats.	POOR / NET LOSS	2	2	High Risk Six

Photo: Various protected species of Jamaica, NEPA. Used with permission.

16.2 Environmental Linkages

Biological diversity, also referred to as biodiversity, is defined as the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which living organisms are part. This includes diversity within species, between species and among ecosystems (Convention on Biological Diversity). Biodiversity is not, in itself, generally considered to be a priority by the average Jamaican citizen. It is therefore important to expand the understanding of the link between ecosystem services which are reliant on biodiversity, and sustainable economic and social development (NEPA, 2016b).

Biodiversity is affected by key drivers and pressures that reduce or degrade land and marine habitats (e.g. mining or agriculture, roads or ports that introduce traffic). These drivers and pressures include the effects of climate change and natural hazards, which may be coupled with poaching and over-exploitation, pollution (including chemical pollution, as well as light and noise) and the introduction of invasive alien species. Changes in other major VECs examined in this report (Seas and Coasts, Land and Freshwater Resources, Air Quality and Environmental Health) also impact habitats and the resilience of species (particularly endemic species) to cope with drivers and pressures.

16.3 Indicator Trends and Patterns

The most recent updated National Strategy and Action Plan on Biological Diversity in Jamaica 2016-2021 (NBSAP) document reflects the current policy direction for Jamaica relating to achievement of the goals and targets established by the Convention on Biological Diversity – the Aichi Biodiversity Targets. The 2016 NBSAP adopts and endorses the Convention on Biological Diversity Aichi Targets for Jamaica, those that fall under Goal B (Reduce direct pressures on biodiversity loss and promote sustainable use). In respect of biodiversity status (rather than management responses), relevant targets include the following, which are to be accomplished in Jamaica by 2021[183]:

Target 5. the **rate of loss** of all natural habitats, including forests, is at least halved and, where feasible, brought close to zero, and degradation and fragmentation is significantly reduced;

Target 8. **pollution, including from excess nutrients and solid waste**, has been brought to levels that are not detrimental to ecosystem function and biodiversity;

Target 9. **invasive alien species** and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment;

Target 10. the multiple **anthropogenic pressures** on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

From previous chapters, it is apparent that Jamaica is not on track in respect of the rate of loss, pollution and anthropogenic pressures. This chapter reports on the status in respect of invasive alien species. The relevant environmental SDGs include response-related targets for biodiversity, rather than status indicators, and so are not relevant to this section of the SOE. Indicators of biodiversity status that have been selected for the 2017 SOE include four main indicators:

- Changes to the IUCN Red List (Endangered Species)

[183] https://www.cbd.int/countries/targets/?country=jm

- Endemic Species
- Status of Invasive Alien Species
- Biodiversity Habitat Index

16.3.1 Changes to the IUCN Red List

The International Union for the Conservation of Nature (IUCN) Red List compiles information to provide conservation classifications for endangered species. The IUCN Red List also provides information and analysis on the status, trends and threats to species in the interest of supporting biodiversity conservation at national, regional and global scales. The IUCN cautions that Red List statistics must be used with extreme care, as they can be subject to varying scientific effort as well as changes in understanding of a species' biology: changes to the Red List may not always reflect a true change in biodiversity status over time.

The conservation status of species listed by the IUCN for Jamaica reflects the global conservation status of species known to be present in Jamaica, and not necessarily the population of the species in the country. Moreover, it is further cautioned that changes in the global conservation status of these species do not reflect direct causes associated with specific local environmental pressures, particularly as it relates to non-endemic species. The conservation status of these IUCN Red-Listed species can allow conservation efforts to continue to prioritize and contribute to global efforts.

The IUCN Red List currently reports on 2201 species in Jamaica, including 564 species of plants and 1537 species of animals.

Table 57 shows the changes since 2013 in IUCN Red List monitored species.[184]

Table 57 IUCN Red List Changes in Plant and Animal Species between 2013 and 2017 (Source: IUCN)

IUCN Category	No. of Plant Species		No. of Animal Species		No. of Animal Species Added 2014-2017 by taxonomic group*			
	Total	Added 2014-2017	Total	Added 2014-2017	Mm	R	B	M
Extinct	2	0	3	3	2	0	1	0
Critically Endangered Species (CR)	41	0	22	7	2	4	1	0
Endangered Species (EN)	56	0	36	14	0	11	1	2
Vulnerable Species (VU)	118	5	52	20	1	2	5	12
Near Threatened (NT)	76	74	48	19	0	1	11	7
Total	**293**	**79**	**161**	**63**	**5**	**18**	**19**	**21**

**Mm – mammals; R- Reptiles; B – Birds; M –Marine Species*

[184] https://www.iucnredlist.org/search/list Retrieved December 11 2018

Plants

During the review period:

- CR/EN: 41 plant species remain on the Critically Endangered Species list and 56 on the Endangered Species list from earlier than 2014, but no new species were added to these categories.
- VU: Five forest species were added to the Vulnerable List: Spanish Cedar (*Cederla ordorata),* Wash Wood (*Jacquinia proctorii*), Wild Oil Nut (*Jatropha divaricata), Peperonia simplex* and *Varronia clarendonensis*. None of these are endemic to Jamaica.
- NT: Another 74 species were added to the Near Threatened IUCN listing.

Animals

In respect of animal species added to the list during 2014-2017:

- Four animal species are listed as **Extinct** in Jamaica. Half of these were added to the IUCN Red List *after 2013*: (1) the Jamaican Rice Rat (*Oryzomys antillarum*), in 2017[185] (2) the Caribbean Emerald (*Chlorostilbon elegans*), a bird listed as extinct in 2016 and (3) the Caribbean Monk Seal (*Neomonachus tropicalis*), listed as extinct in 2015. These species may have gone extinct many years before, and inclusion in this time period reflects the date of publication on the IUCN Red List, rather than the timing of actual extinction.
- Seven (7) animal species were added to the **Critically Endangered** (CR) list, all of which are endemic to Jamaica. One of these, the Jamaican Racer (*Hypsirhynchus ater*), is likely extinct.[186] The remaining species included two endemic bats, the Jamaican Greater Funnel-Eared Bat (*Natalus jamaicensis*) and the Jamaican Flower Bat (*Phyllonycteris aphylla*), three endemic reptiles (galliwasps) and one bird, the Jamaican Poorwill – (*Siphonorhis americana*). Endemic Critically Endangered species that were added in the review period are listed in Table 58.
- Fourteen (14) of the 36 animal species listed as **Endangered** (EN) in Jamaica were published on the IUCN list during the review period. These included 11 endemic reptiles, two fish species, the Whale Shark (*Rhincodon typus*) and the American Eel (*Anguilla rostrata*), and one endemic bird, the Jamaican blackbird (*Nesopsar nigerrimus*). Endemic Endangered species are listed in Table 58.
- Twenty (20) of the 52 animal species listed as **Vulnerable** (VU) were published on the IUCN list during the review period. These included:
    - Two species of reptiles: Loggerhead turtles (*Caretta caretta)* and Bromeliad Galliwasp (*Celestus fowleri*);
    - 12 fish species including the Oceanic Whitetip Shark (*Carcharhinus longimanus)* and the Silky Shark (*Carcharhinus falciformis);*
    - Five bird species including the endemic Black-billed Amazon Parrot (*Amazona agilis)*,the Yellow-billed Parrot (Amazona collaria), the West Indian Whistling Duck (*Dendrocygna arborea*), the Ring-tailed Pigeon (*Patagioenas caribaea*), and the Golden Swallow (*Tachycineta euchrysea*)[187]; and

[185] https://www.iucnredlist.org/species/136540/22388029Retrieved December 11 2018

[186] The Jamaica Environmental Country Profile (1987) indicated that the black racer snake was probably extinct.

[187] Note that the Golden Swallow has not been documented on the island since the mid 1980s and is widely believed to be extirpated. The only remaining population is therefore in the Dominican Republic.

    - One endemic bat species, the Jamaican Red Bat (*Lasirus degelidus*).

- Nineteen (19) of the 48 animal species listed as **Nearly Threatened** (NT) were published on the IUCN list during the review period. These included:
    - 11 bird species, including the endemic Jamaican Parakeet (*Eupsittula nana)* and the Blue Mountain Vireo (*Vireo osburni);*
    - Seven marine species; and
    - One reptile, the Jamaican Forest Sphaero (*Sphaerodactylus goniorhychus)*

Table 58 Endemic Animal Species that were classified as Critically Endangered or Endangered (2014-2017)

Species	**Common Name**
Endemic Critically Endangered	
Siphonorhis americana	Jamaican Poorwill
Natalus jamaicensis	Jamaican Greater Funnel-eared Bat
Celestus occiduus	Jamaica Giant Galliwasp
Phyllonycteris aphylla	Jamaican Flower Bat
Celestus microblepharis	Small-eyed Galliwasp
Celestus duquesneyi	Blue-tailed Galliwasp
Endemic Endangered	
Nesopsar nigerrimus	Jamaican Blackbird
Hypsirhynchus polylepis	Jamaican Long-tailed Racerlet
Sphaerodactylus semasiops	Cockpit Eyespot Sphaero
Celestus hewardi	Red-Spotted Galliwasp
Spondylurus fulgida	Jamaican Skink
Sphaerodactylus richardsoni	Northern Jamaica Banded Sphaero
Sphaerodactylus parkeri	Southern Jamaica Banded Sphaero
Sphaerodactylus oxyrhinus	Jamaican Sharp-nosed Sphaero
Sphaerodactylus dacnicolor	Jamaican Tailspot Sphaero
Celestus barbouri	Limestone Forest Galliwasp
Pholidoscelis dorsalis	Jamaica Ameiva
Celestus molesworthi	Portland Coast Galliwasp

For three categories of most concern (CR, EN and VU), there was a 37% increase in the number of species listed for the review period. Reptile species accounted for 17 of the 41 species (41%) added to the IUCN Red List categories, and fish accounted for another 14 (34%). Changes in the numbers of species published on the IUCN Red List are likely to be due to improved reporting as well as habitat loss and possibly the effects of climate change (NEPA 2018b). There is generally insufficient research on the causes of population declines in Jamaica. Habitat loss and degradation (due to land use changes and human encroachment into natural areas and pollution), over-exploitation of species, climate change and variability, and invasive alien species (e.g. predation of snakes and birds by the mongoose, or competition from lionfish) are likely to play a critical role in the changes being experienced by ecologically sensitive populations.

The IUCN Red List is a means of tracking the potential for extinction or loss of a species in a particular area. Loss of species results in a decline in overall biodiversity, and ultimately a decline in the availability of ecosystem services provided by biodiversity. Conserving habitat for plants and animals allows for the maintenance of biodiversity. Changes in the conservation status (on the IUCN Red List) of endemic species are also very closely linked to habitat conservation concerns and development pressure within Jamaica.

16.3.2 Endemic Species

Jamaica has a high level of endemic species and the country's forests are the main repositories of terrestrial biodiversity. The 2016 NBSAP report highlighted the following statistics regarding Jamaica's native[188] species:

- **Flora**: over 3,000 vascular plant species including 600 species of ferns, 316 endemic trees, 26 endemic species of bromeliads, 227 native species of orchids of which 26% are endemic. There are also 15 native species of cacti (four are endemic).Changes in species numbers include a revision in the number of indigenous seed plants where recent studies revealed that there are approximately 3,175 species in Jamaica (of which 32.4% are endemic compared to a 27.9% level of endemism reported in 2009).
- **Fauna**: 21 native species of bats (five are endemic), and 67 native species of land birds (30 are endemic), 136 species of butterflies (including 37 endemic species[189]), 106 known bird species (31 of which are native to Jamaica and are migratory)[190]. Nine (9) native species of grapsid crabs all of which are endemic. Similarly, all 21 native species of frogs are endemic. There are 29 species of native lizards of which 28 are endemic. The list also includes other reptiles including nine endemic species of snakes (NBSAP 2016).

The Jamaican Iguana recovery programme involves the removal of invasive predators (mongoose, wild pigs and feral dogs and cats). While conservation efforts have been showing some success, major threats to the iguana persist; the iguana is still currently listed as Critically Endangered on the IUCN Red List. There have been improvements seen for some key charismatic endemic species, including an apparent increase in the number of the critically-endangered Jamaican Iguana (*Cyclura collei* shown in Figure 74). The main conservation approach for the Jamaican Iguana is a recovery programme, targeted releases into the wild and predator control, which was implemented after the rediscovery of the species in 1990 by a hunter.Nesting data for the period 2013-2017 showed that the number of actively nesting females in the wild ranged between 41 - 53 over the five-year period (NEPA 2018b).

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[188]A native species is one that occurs naturally rather than as a result of accidental or deliberate introduction into that ecosystem by humans. It can be indigenous or endemic.

[189]https://www.cockpitcountry.com/Butterflies%20CC.html

[190] Avibase indicates that there are 325 species of birds in Jamaica, 29 of which are endemic. https://avibase.bsc-eoc.org/checklist.jsp?region=JM&list=howardmoore

Figure 74 Jamaican Iguana (Cyclura collei; Source: NEPA)

16.3.3 Invasive Alien Species (IAS)

No specific indicator has yet been developed to monitor overall trends in respect of invasive alien species (IAS). However, for the purposes of this SOE, a qualitative overview of the status of known IAS in Jamaica is presented. Invasion by alien species occurs as a result of transportation (intentional or accidental on incoming vessels or imported biological materials) as well as changes in climatic conditions and vector pathways (e.g. currents or wind systems, the removal of barriers). IAS represents the second most significant threat to biodiversity, ranked second only to habitat destruction,[191] and are considered more damaging than environmental pollution.

Full data sheets on invasive alien species impacting Jamaica have been listed on the Invasive alien species Compendium (Simberloff 2000). These include 425 species of invasive plants. Five highly invasive plants affecting native Jamaica flora biodiversity are listed below:

1. Bamboo (*Bambusa vulgaris*): *B. vulgaris* culms and branches root very readily, forming monospecific stands along river banks, roadsides and in open ground. In Jamaica, the spread has been so great that entire forests have been colonized by bamboo and are now classified as 'bamboo forests.'
2. White Ginger Lily (*Hedychium coronarium*): This plant species has been found to be invasive in shallow water systems, along streams, in waterlogged areas and in very moist areas of high

[191] Simberloff, D. 2000. Introduced Species: the threat to biodiversity and what can be done. http://www.actionbioscience.org/biodiversity/simberloff.htmlRetrieved January 29 2019

elevation in the tropics and subtropics. Once established it is difficult to control as it reproduces vegetatively and is able to withstand a wide variety of climatic conditions.

3. The Australian Paper Bark Tree (*Melaleuca quinquenervia*): This plant has been widely introduced in the tropics as an ornamental plant, escaping and colonizing these areas as the plants seed profusely. In Jamaica, this plant is restricted to wetland areas, but is found to be highly invasive there, particularly in the Black River morass.
4. The Mock Orange (*Pittosporum undulatum*) and Wynne Grass (*Melinus minutiflora*) have taken over large areas on the periphery of the Blue and John Crow Mountains National Park (NEPA 2016).

An estimated 125 animal species are also listed on this database. It includes 82 species of arthropods, eight nematodes, five mollusks and one cnidarian species, as well as 29 vertebrates (12 of which are fish species and five are birds). This includes very common animals like goats, cats, dogs, pigs and rats, as well as the American Bullfrog (*Lithobates catesbeianus*), the Brown Anole Lizard (*Anolis sagrei*) and the Javan Mongoose (*Herpestes javanicus*).

In the review period, it was anecdotally reported that the mongoose (*Herpestes javanicus*) population has increased. The mongoose is a major threat to ground nesting birds and reptiles, particularly the endemic Jamaican Boa and the critically endangered Jamaican Iguana; it is thought to be responsible for the extinction of five endemic species in Jamaica (NEPA 2016).

Two important and recent invasive alien species are the White-tailed Deer (*Odocoileus virginianus*) and the Lionfish (*Pterois volitans*). The White-tailed Deer has impacted ecosystems and rural communities in Portland (NEPA 2016). The Lionfish has also been recognized as having a significant adverse impact on coral reef ecosystems. A significant concern with the Lionfish is that it feeds on commercially important species like the spiny lobster as well as herbivorous fish which remove macroalgae from reefs. The Lionfish is thought to be responsible for major declines in fish biomass in Jamaican reefs (Ballew et al 2016).

16.3.4 Biodiversity Habitat Index

The Biodiversity Habitat Index (BHI) uses biologically-scaled environmental mapping and modelling to generate rigorous and cost-effective estimates of the potential impacts of habitat loss, degradation and fragmentation on retention of terrestrial biodiversity globally, from remotely-sensed forest change and land-cover change datasets.

The BHI does this by linking remotely sensed forest change and land-cover change data sets to recent advances in biodiversity informatics, ecological meta-analysis, and macro-ecological modelling. The BHI was designed specifically as an indicator for measuring and reporting progress in relation to the Convention on Biological Diversity's Aichi Target 5.

However, no national Biodiversity Habitat Indices were available for this assessment. An online BHI calculator developed by the Group on Earth Observations Biodiversity Observation Network[192] (GEO BON) could potentially be used to generate BHI estimates for Jamaican forest cover and local bird diversity. It is unclear if Jamaican conservation agencies have systematically used this tool for tracking changes in species habitat composition. Jamaica however has a wealth of related information (Forestry Department, NEPA), including projects that have studied land use change that could be used to contribute to the BHI.

[192]http://geobon.org/ Retrieved December 11 2018

Jamaica's 5th National Convention on Biological Diversity Report and Jamaica NBSAP (2016-2021) identified changes in biodiversity due to anthropogenic disturbance of biodiversity by way of habitat degradation. The report showed that there has been an overall decline in the quality of forests. Despite a net increase in forest cover of 0.4% per annum between 1998 and 2013, there were reductions in the Broadleaf and Open Dry forest classifications of 0.2 and 7.2 per cent per annum respectively (NEPA 2016). Estimates of increases in forest cover are likely due to timber plantations and possible reversion of 'ruinate' agricultural estates to secondary forest. Other impacts to habitat can be attributed to multimillion-dollar infrastructure investments including multi-lane highways. These projects required significant clearing of forest cover; even in ecologically sensitive areas such as mangrove and dry limestone forest (5th National Report; NEPA 2015a).

The BHI is closely linked to habitat integrity, which also affects the IUCN conservation status of species, and the ability of endemic species to compete with invasive alien species.

16.4 Ecosystem Services

Jamaica's biodiversity is highlighted by the diversity in endemic species as well as the integrity and diversity of their ecosystems (including ecosystem functions and interactions of terrestrial, coastal, and marine areas). Jamaica has been described[193] as the most bio-endemic island in the Caribbean, ranking 5th among islands of the world with unique species. Biodiversity losses in Jamaica are major losses for planetary biodiversity and are irreversible.

Ecosystem services provided by diverse functional habitats include a range of natural capital including physical assets (e.g. habitat structure and extent) and flows (e.g. provision of food and medicines, regulation of climate, pollination, decomposition). In general, these services provided by biotic components of the ecosystem are fragile and depletable. Ecosystem instability, collapse or loss of keystone species can affect the capacity of ecosystems to deliver ecosystems services traditionally relied on by Jamaicans. Change in conservation status is a proxy for biodiversity health and would be most reflected in impacts to cultural and education ecosystem services (e.g. academic research, national heritage). Losses or gains in endemic species could also impact recreational ecosystem services. For example, the recovery of charismatic species (e.g., Jamaican Iguana, Jamaican Coney, Yellow-Billed Parrots – see Figure 75) could result in increased ecotourism opportunities such as wild life and bird watching.

While it is relatively easy to understand how a coral reef might protect beaches that humans need, and therefore be ascribed monetary value, it is more challenging and complex to derive the monetary (or other form of) value provided by a particular endangered bat species living in a specific cave in Jamaica. Broader ecosystem services can be affected with changes in biodiversity status. Valued ecosystem services like integrated pest management, pollination and other agricultural (provisioning) services can be affected by changes in diversity or to local abundance of crucial invertebrates and arthropods like bats, bees, and snakes.

Many argue that biodiversity conservation is important for its own sake, and should not necessarily require the justification of human valuation. However, there are several important points to note about the value provided by rich and complex biological systems (European Commission, 2015):

- Loss of biodiversity may result in reduced efficiency in ecosystem functioning (including biomass production, decomposition/soil formation and nutrient cycling). This can impact carbon sink

[193] http://www.ipsnews.net/2012/05/jamaicas-rich-biodiversity-faces-multiple-threats/Retrieved December 15 2018

efficiencies, climate, and nutrient loadings in ecosystems where the link to human needs is obvious (e.g. coral reefs).

- In general, studies show that ecosystems are more resilient and stable at higher biodiversity levels, where there are functional redundancies (i.e. a range of species or habitats providing the same function). Furthermore, genetic diversity *within species* is the basis of "survival of the fittest" and allows species to cope with and adapt (evolve) in response to long-term environmental changes.

Threats to biodiversity include drivers of environmental change such as climate change, land use/land cover (LULC) changes associated with encroachment of human activities into natural habitat areas (e.g. through agriculture, road developments, deforestation) and pollution (e.g. pesticides, air emissions, waste disposal). Invasive alien species (including diseases) are a major risk to the stability of native ecosystems through predation, competition, diseases.

Figure 75 Yellow-Billed Parrots (Photo: W. Sutherland)

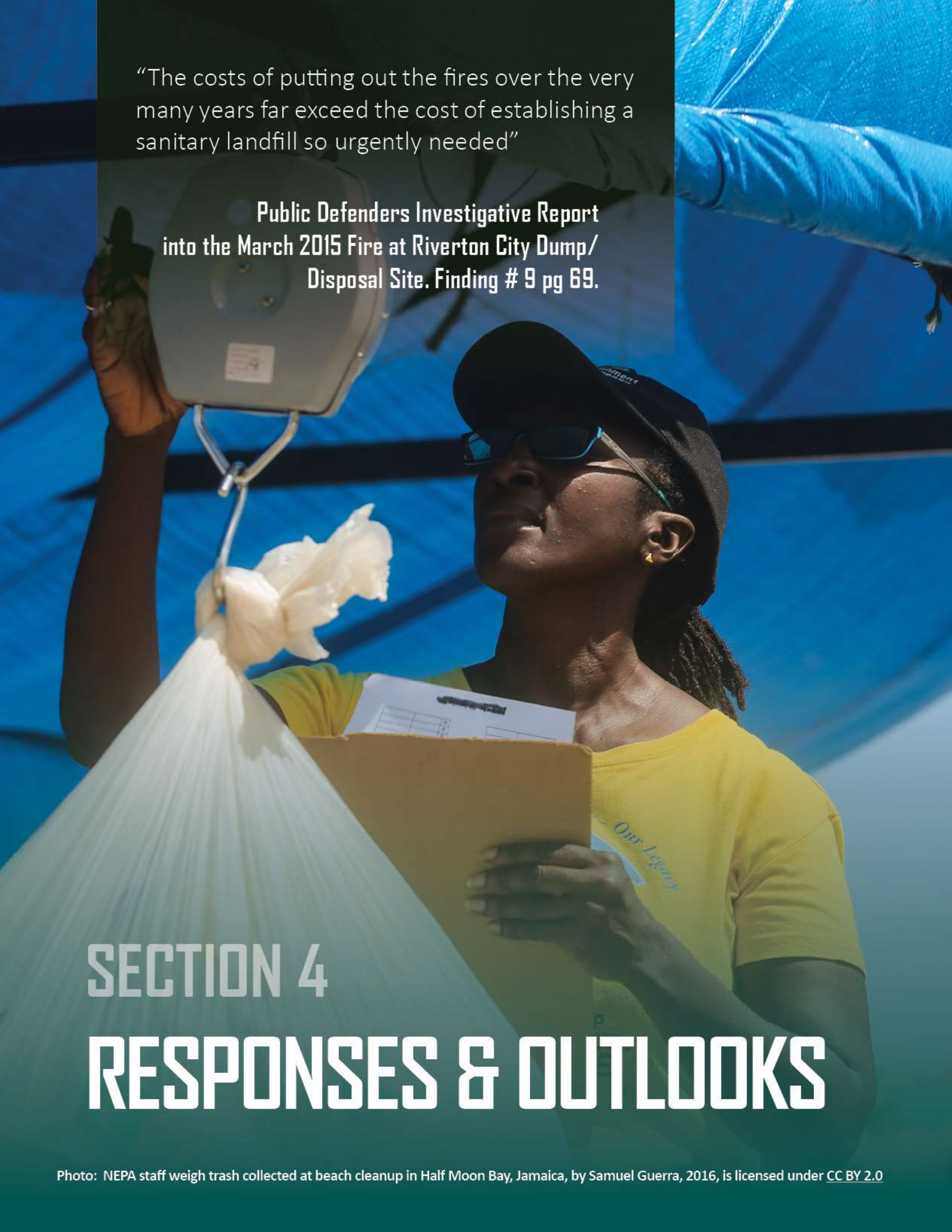
16.5 Conclusions

- ***Changes to the Red List Index.*** The IUCN has increased the number of animal species listed as critically endangered or endangered during the review period, including several endemic species with very limited range in Jamaica. Reptile species accounted for 41% of the additions to these two classes of concern. To conserve these species, it will be necessary to understand the specific threats to their habitats.

- ***Change in conservation status of endemic species.*** Analysis of the information shows that there is a notable focus on charismatic endemics (e.g. the Jamaican Iguana). Many other endemic species lack sufficient data to make valid science-based conservation decisions. Conservation of endemics is often closely linked to preservation of their habitat and, as such, this is a sub-indicator that feeds into SDG 15.5.1. Frequent and consistent monitoring of endemics may be cost prohibitive so the GoJ may need to rely on proxies (e.g. habitat status) that reflect a suite of sub indicators that can inform SDG 15.5.

- ***Invasive Alien Species (IAS).*** There are hundreds of introduced species in Jamaica. There is insufficient monitoring of IAS to determine the extent of specific changes in review period. Species in Jamaica for several decades have been noted to expand in range and numbers (e.g. bamboo, lionfish and mongoose) and require special management strategies to prevent major impacts on core biodiversity areas.

- ***Biodiversity Habitat Index (BHI).***As a companion to the IUCN Red List, Jamaica needs to update and report on a Biodiversity Habitat Index. Achieving this may be limited by resources and access to relevant remotely sensed data. Addressing these gaps should include incorporating current remote sensing data, identifying existing capacity gaps, and seeking the necessary partnerships to address these gaps. If collected properly, this indicator could serve as a powerful proxy for satisfying SDG 15 (Life on Land). Given the very close correlation between habitat and biodiversity it is logical that resources be directed to fulfilling the data requirements for this indicator. It is also important to consider ways to also incorporate information on coastal biodiversity that may be captured under the SDG 14 targets and indicators (i.e. conserve and sustainably use the oceans, seas and marine resources for sustainable development).



> "The costs of putting out the fires over the very many years far exceed the cost of establishing a sanitary landfill so urgently needed"
>
> **Public Defenders Investigative Report into the March 2015 Fire at Riverton City Dump/ Disposal Site. Finding # 9 pg 69.**

SECTION 4
RESPONSES & OUTLOOKS

Photo: NEPA staff weigh trash collected at beach cleanup in Half Moon Bay, Jamaica, by Samuel Guerra, 2016, is licensed under CC BY 2.0

17. Responses

17.1 Overview

This chapter examines the effectiveness of interventions or responses that have been implemented over the review period to counteract adverse environmental change and the consequences of this change for humans. Using the DPSIR framework, Responses are herein defined as human interventions that:

- Seek to sustainably maintain ecosystem services that are critical to human well-being;
- Recognize gaps or oversights that allowed impacts to occur;
- Reflect social and economic priorities and mandates;
- Are designed to restore ecosystem services/functioning; mitigate exposure to environmental impacts or adapt to impacts (or build coping capacity);
- Involve plans, policies, laws, institutional capacity as well science and technology (research programming); and
- Have clear criteria for selection/implementation, that are:
    - Environmentally sustainable;
    - Technically feasible;
    - Economically viable;
    - Socially desirable;
    - Legally permissible; and
    - Administratively achievable within the set time frame.

Response (management) indicators that satisfy these criteria typically include five main types:

1. Political will, which is embodied in the decision-making. This is translated into action through allocation of resources necessary for implementation. A reliable proxy indicator of political will is therefore financial support for environmental programming at the national (Parliamentary) level. Based on available data, the most reliable data set is presented in the PIOJ's Economic and Social Surveys of Jamaica (ESSJ), which estimate the annual budgetary allocations for specific selected environmental management and related programmes, using a standardized approach.
2. The kinds of projects to which funding is applied is an indicator of priorities set by the NEPA, environmental managers and other scientists. While the task of accounting for total expenditure on the multitude of international, private, public and institutional (research) environmental programming (and investment) may lie beyond the scope of this SOE, it is possible to identify some of the major environmental programming directions and projects as a general indication of environmental priorities that obtained over the review period.
3. Another representation of political will to implement is reflected by the enactment of legal mechanisms that facilitate the satisfaction of obligations in respect of multi-lateral environmental agreements or improve legislative and regulatory controls on development activities and environmental conservation. These may include new judicial acts, repeals of ineffective acts, updates to existing acts, or the promulgation of outstanding regulations provided for legislation. It also includes national and physical plans and policies.
4. **Governance and administrative provisions** to facilitate project implementation, priority-setting, or improvements in operational level controls on environmental degradation or achievement of goals is another general indicator of responses. NEPA and the various other

regulatory and advisory ministries, departments and agencies with some jurisdiction for land development and planning (as well as pollution control and waste management) control these drivers/pressures of environmental degradation through the permitting and licensing system (PLS) as well as development orders, spatial plans, and other measures.

5. **The protection given to fragile or threatened habitats and species through coordinated planning (conservation effort)** over the review period is considered a reliable indicator of the importance and severity of threats that face these habitats and species. The national system of protected areas is a critical management response to enable conservation of biodiversity and endangered species and to protect threatened habitats. A key indicator is the expansion or contraction in spatial coverage, in terms of protected status, that is afforded to specific habitats or environmental systems between review periods.

Each of these five main areas is discussed in this chapter, using available data for the review period. However, it must be cautioned at the outset that, while management indicators may allow for some degree of assessment of the response to environmental concerns, it cannot be assumed that meeting a management target automatically signals a reversal of a negative trend in loss of ecosystem services or improvement in the condition of a particular VEC. Reasonable performance in any one of these indicators does not necessarily result in significant improvements if there are other challenges to effectiveness. While indicative of collective will to change the pathway in the DPSIR model, none of these five response types adequately allows for an assessment of the effectiveness of the management responses.

Ultimately, improvement in conditions of the VEC and associated ecosystem services (i.e. States and Impacts, as described in the previous section) is the best indicator of the effectiveness of management, underlining the potential usefulness of employing consistent indicators within the DPSIR framework in each SOE report. Moreover, the assessment of changes in States of VECs and Impacts on the availability of ecosystem services requires *scientific* collection of data and proper statistical evaluation of these data, and some level of consistency (comparability) between review periods. Some of the data sets that have been used in this SOE failed to meet tests for verifiability, representativeness (spatial and temporal coverage), conformity to standard methods, completeness (lack of gaps) and sufficient understanding of the systems involved (cause-effect pathways). It is hoped that the framing and groundwork established in this SOE will provide a basis for improvements in the next one.

17.2 Response Indicators

17.2.1 Financial Support for Environmental Protection (2014-2017)

The PIOJ (2014b, 2015, 2016b, 2017b) collates estimates and standardizes budgetary allocations (BAs) for environmental management and related programmes on an annual basis in its ESSJ Reports. The data presented next rely heavily on the PIOJ reporting of BAs, which includes seven main categories:

- Environmental protection, which includes allocations to NEPA, environmental management and meteorological services under the MEGJC, and the Ministry of Local Government and Community Development (MLGCD). It is assumed that this includes allocations to the Environmental Risk and Climate Change Divisions of MEGJC;
- Waste management, which is assumed to include budgetary allocations to the NSWMA and other entities involved in waste management (NWC);
- Forestry, which is assumed to include budgetary allocations to the Forestry Department;

- Disaster management, which includes allocations to the Office of Disaster Preparedness and Emergency Management; disaster management for flood mitigation including road repairs and river training, and Emergency Management of the Ministry of Health;
- Fire protection, which is assumed to include budgetary allocations to the Jamaica Fire Brigade;
- Land resources management, which reflects allocations for Land-use Planning and Development (including Squatter Management); Rural Development (survey, land administration, settlement and land reform), and Area Development;
- Water resources management, which is assumed to include budgetary allocations primarily to the WRA.

BAs include capital as well as recurrent expenditures required by the agencies involved, which would be driven largely by internal budget requests that are sent forward for inclusion in the annual national budget. Consequently, these allocations represent adjusted budgetary requests.

Figure 76 shows the changes in BAs over the review period. In the 2013/2014 budget, expenditure on the PIOJ-selected environmental management and related programmes (EM budget) represented 2.2% of the total national budget. This was increased to 2.6% in the 2014/2015 budget, and has remained, on average, at that level over the review period.

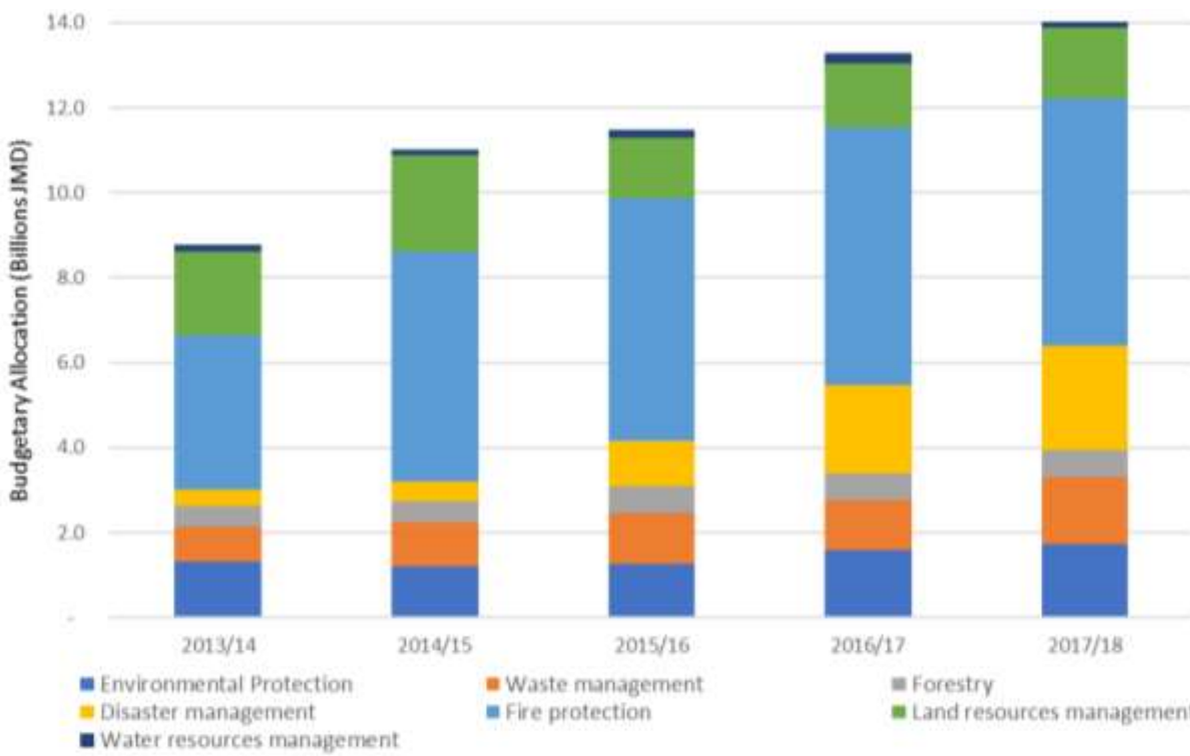


Figure 76Total BAs for Selected Environmental Management & Related Programmes (2013/2014 to 2017/2018; Source: reproduced from PIOJ)

Although there was a 61% increase in environmental expenditure between the 2013/2014 budget (J$8.8 billion) and the 2017/2018 budget (J$14.2 billion), the total national budget was increased by only 40% during the same period, suggesting an increase in the proportion of the overall budget allocated to environmental spending. Over the review period, the most notable increase in allocation was to the area of disaster management, which increased from J$0.4 billion in 2013/14 to J$2.5 billion in 2017/2018. All major programmes showed growth in budgetary allocations except land management, which declined by 20% (coloured in green in Figure 76).

Figure 77 shows the breakdown of BAs to the seven selected programmes in the 2017/2018 national budget. The largest allocation is given to fire protection which, when combined with disaster management, accounts for 58% of the BA for environmental programmes.

Environmental protection received 12.2% of the allocation for environmental management (J$1.73 billion) in 2017/2018. Land resources management, although receiving a shrinking budget for most of the period, accounted for the next largest expenditure (11.7%). The BA for waste management doubled in the review period (from J$0.8 billion to J$1.6 billion), increasing the relative proportion received by this programme to 11% of the total EM budget, and putting it almost on par with environmental protection. The allocations to forestry and water resources management were considerably smaller (4.5% and 2.1% respectively in 2017/2018).A relatively tiny proportion of the EM budget goes to this area on funding for protected area planning.

It is cautioned that these allocations reflect a compromise between adjusted budget requests from the receiving agencies and Government priorities. It is expected that the actual expenditures (cost of executing capital projects and meeting recurrent costs, a factor of the size of the agency) may differ from the BAs. In addition, multi-national (international), institutional and private sector funding of environmental programmes are not included in this assessment.

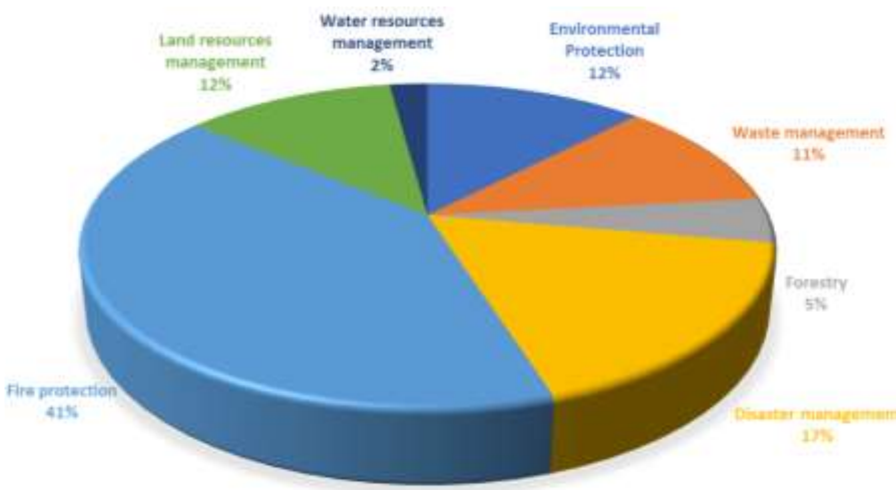


Figure 77 Breakdown of Budgetary Allocations for EM Budget (2017/2018; Source: reproduced from PIOJ)

Given its economic challenges and fiscal limitations, the GoJ is forced to prioritize its spending, resulting in inadequate support for the conservation of biodiversity and the environment.[194] Restricted budgets and public sector reforms have resulted in the rapid decline of single-source income from the national treasury to support protected area management (Myers and Edwards 2018). A major gap, as it relates to protected areas, is the continued failure to source the funding needed to carry out the mandates of the National Protected Areas System.

The **Financial Sustainability Plan for the Protected Areas System of Jamaica** serves to guide an integrated process to ensure long-term and stable funding for the Jamaican Protected Areas System (JPAS). It will be integrated into the PASMP. The plan is based on a comprehensive view of costs and

[194]NEPA's budgetary allocation also supports the execution of Planning and Development activities.

benefits, ensuring that those who bear protected area costs are recognized and adequately compensated, and that those who benefit from protected areas make a fair contribution to their maintenance. This plan was prepared in 2009 and covers the period 2010–2020. The 2012 project document highlighted four eligible trust funds for consideration of a consolidated national fund. These were:

1. Jamaica National Parks Trust Fund
2. Forest Conservation Fund
3. Environmental Foundation of Jamaica[195]
4. Tourism Enhancement Fund

A number of possible sources of funds were identified in the Financial Sustainability Report of the PASMP such as: GoJ budgetary allocations; tourism fees; debt swaps; personal donations/sponsorship programmes (including the Jamaican Diaspora); corporate social responsibility programmes/sponsorship and dedicated fund-raising from special events. The Sustainable Financing Plan for Jamaica's System of Protected Areas 2010-2020 (2009) also identified payment for ecosystem services as a mechanism for funding Jamaica's system.

The **National Conservation Trust Fund of Jamaica (NCTFJ) Limited** was incorporated under the Companies Act in 2014. The purpose of this trust fund is to assist in supporting the long-term sustainability of Jamaica's national system of protected areas by providing financial support for planning, management, research, public safety, law enforcement, facilities management, infrastructure, training, interpretation, public education, restoration, rehabilitation, enhancement, monitoring and other needs and activities that contribute substantially to the conservation, protection and maintenance of the protected area system. The fund is expected to support operational and capital development (new facilities) and capital maintenance projects (reconstruction and replacement) for both government and non-government entities, based on a submission and evaluation process similar to the Tourism Enhancement Fund (TEF) process. This fund is managed and directed by the Board of the NCTFJ. The completion of a resource mobilization strategy (Myers and Edwards 2018) was a key task that should assist in achieving their sustainable financing goals. Attention will be given to further funding of the NCTFJ for protected areas management and to the development of other funding sources, including through foundations at the national level.

There is currently no annual breakdown of current sources of funding for protected areas or conservation efforts, nor is there a department that is dedicated to keeping track of this information. It is difficult to assess the amount of funding allocated for the environment in general and, specifically towards protected areas and conservation. However, there is a general perception that these sources have been decreasing over the years (Galindo 2009) with a shift in focus towards climate change adaptation and disaster risk reduction.

The **Caribbean Biodiversity Fund** (CBF) is a regional environmental fund established in 2012 to provide a sustainable flow of resources for the conservation, protection and maintenance of biodiversity in the Caribbean. The CBF mobilizes resources and channels support to partner with National Conservation Trust Funds (NCTFs) and directly to selected national and regional projects. Jamaica's current CBF status is as a participating country, with its national fund nominated. A pre-financing agreement was signed in June 2017. One output of the project "S*trengthening the Operational and Financial Sustainability of the National Protected Area System(NPAS)" Project* was the development of management and business plans for eight protected areas which are all at differing stages of development (NEPA 2018d). The slow

[195] The Environmental Foundation of Jamaica was merged with the Forest Conservation Fund in 2015. The official name is the Environmental Foundation of Jamaica.

pace of implementation of sustainable financing mechanisms including full operationalization of the NCTFJ means that the ability to achieve Vision 2030 and SDGs continues to be stymied.

Recent international obligations, such as the Programme of Work on Protected Areas of the Convention on Biological Diversity provide guidance on funding protected areas and how cross-agency management can occur at the national level.

17.2.2 Major Environmental Projects (2014-2017)

The following represents a brief synopsis of major environmental projects that were undertaken during the review period. This list is intended to be illustrative and comprehensive.

Environmental Protection

- The **Integrated Management of the Yallahs/Hope River Watershed Management Area** project is funded by the Global Environment Facility (GEF) and the Inter-American Development Bank (IADB). The project, which commenced in 2016, sought to reduce environmental pressure on these eastern watersheds. Similar projects that take a community-based approach to watershed management to address climate change impact have been implemented in the **Rio Grande Watershed**.
- The **Integrated Water, Land and Ecosystem Management in Caribbean Small Island Developing States (IWECO[196]) project,** coordinated by NEPA and supported by GEF and UNEP, commenced in 2016 and seeks to contribute to the conservation of ecosystems that are of global significance and to the development of sustainable livelihoods.
- **Cocoa Pollinators Research Project** (2015) facilitates the understanding of natural ecosystem services (specifically pollinator midges) that support cocoa production, and may help with their conservation.
- **The Peckham Bamboo Pre-Processing Project:** With funding from the Organization of American States, and support from the PIOJ and Bureau of Standards Jamaica, MICAF undertook this project through its Community Renewal Programme (MICAF 2017). The project aims for Jamaica to be producing and exporting at least one bamboo bi-product (bamboo charcoal) by 2018. It involved 40 hectares of land being put into bamboo cultivation. Bamboo is a very fast-growing grass that has a wide range of uses. It is an invasive alien species that has encroached into forested lands.
- **The boundaries of Cockpit Country Proposed Protected Area** were researched during the review period and finalized in late 2017. Cockpit Country is an ecologically sensitive broadleaf forest region which hosts a range of endemic species[197]. Establishment of this boundary is a step towards protecting the area from development of mining operations.
- Completion of the "**Mitigating the Threat of Invasive Alien Species within the Insular Caribbean**" Project in 2014, with research contributions from the University of the West Indies on freshwater species along with assessment by NEPA. This project included:
    - Control of the invasive alien Lionfish through the "***Eat It To Beat It***" Campaign, which involved training fishermen to safely capture the fish and prepare it for consumption. Anecdotal evidence (fishermen and diver reports) suggest that sightings and catch of lionfish are declining;
    - Research on the impact of the invasive alien plant *Alpinia allughas* on the biodiversity of the Lower Black River Morass Ramsar site; and

[196] http://www.cep.unep.org/gef-iweco-1/gef-iwecoRetrieved December 15 2018

[197] Windsor Research Centre: https://www.cockpitcountry.com/Forestnative.htmlRetrieved December 15 2018

  - Research on regeneration of the swamp forest and treatment for the invasive alien species Paperbark Tree (*Melaleuca quinquenervia*).
- An output of this project was the completion of the National Invasive Aliens Species Strategy and Action Plan in 2013[198], substantive implementation of which occurred during the review period and beyond (2014 -2020).
- Strengthening the Operational and Financial Sustainability of the National Protected Area System (NPAS Project; GEF/UNDP; 2012–2017). This was a major project that was aimed at rationalizing and increasing the viability of the national protected areas system.

Environmental Resilience Through Poverty Reduction and Alternative Livelihoods

- **Biodiversity Restoration in the Portland Bight Protected Area through Community Engagement**: towards protecting communities, infrastructure, livelihoods and biodiversity in the Portland Ridge area (GEF Small Grants/UNDP). This project commenced at the end of 2017. It seeks to restore and protect areas of dry limestone forest on Portland Ridge, where several IUCN listed species are known to range.
- **Capacity Building for Forest Conservation and Sustainable Livelihoods Project**-involving the Blue and John Crow Mountains National Park, implemented by the JCDT (2014).
- **Promoting Biodiversity Conservation through Medicinal Plant Production for Knowledge Management and Alternative Livelihood** (GEF Small Grants/UNDP; 2014–2017). This project focused on forested areas in the Bull Head Mountain, Teak Pen Mountain and Mocho Mountain ranges in Clarendon, and was implemented by the Clarendon Parish Development Committee Benevolent Society.
- **Project to Improve Livelihoods in the Portmore Causeway Fishing Village** (2014) supported the improvement of the livelihoods of persons operating in the Portmore Causeway Fishing Village.
- **Conserving Biodiversity while Generating Sustainable livelihoods through the Sawyers Restoration** project (2014). This project also involved development of an **Eco-Tourism Plan**, (2014–2016) with Sawyers Local Forest Management Committee.
- **Enhancing the Resilience of the Agriculture Sector and Coastal Areas for Livelihoods Protection and Food Security** (MICAF/Adaptation Fund; 2014-2017).
- **Climate Resilience in the Fisheries Project** (MICAF/Adaptation Fund; 2015– 2021) [199]seeks to enhance community-based climate resilience in fishing communities through climate-smart adaptation, diversification and viable alternative livelihoods as means of bolstering sustainability.
- **Advancing Food Security by Creating Alternative Livelihood with the use of Energy Efficient Technology in the Rural Community of Mafoota** (GEF Small Grants/UNDP2015) was implemented by the Mafoota Agricultural Cooperative Society Ltd.
- **Protecting the Natural Ecosystems and Preventing Land Degradation while sustaining Livelihoods through Apiculture** (UNDP 2014–2016) in the community of Content[200].
- **Transforming Lives Through Renewable Energy and Youth Empowerment in Majesty Gardens** (GEF/UNDP/Environmental Health Foundation 2014–2016). This project was implemented through the establishment of a multi-agency steering committee comprising representatives from the Caribbean Maritime Institute, PIOJ, JPS, St Andrew Settlement, St Andrew Parish

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[198]http://www.ciasnet.org/wp-content/uploads/2014/06/NIASSAP_FINAL.pdfRetrieved December 15 2018

[199]http://www.micaf.gov.jm/content/capital-projects

[200]https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=22490

Church, the Social Development Commission, MSTEM and the Environmental Health Foundation.

- **Jamaica REDD+ Reef to Landscape Project** (UNEP/Green Climate Fund 2016-2017) developed alternative livelihoods in vulnerable communities to increase resilience of land, freshwater and coastal ecosystems.

Climate Change & Disaster Risk Reduction

- The Adaptation Fund- financed **Enhancing the Resilience of the Agriculture Sector and Coastal Areas for Livelihoods Protection and Food Security** programme continued in 2014. Achievements in 2014 and 2015 included installation of water technologies (rainwater harvesting, drip irrigation, water filtration system), training in land management practices, storm surge modelling, environmental impact assessment of hard shoreline structures and publication of the Climate Risk Atlas for Negril (ODPEM, 2015).
- Approval of the US$17.9 million **Adaptation Programme and Financing Mechanism** for the Pilot Programme on Climate Resilience **(PPCR)** kick-started activities to boost sectoral adaptive capacity (agriculture, tourism), climate-resilient watershed management and financing of adaptation measures by community-based organizations (e.g. soil conservation, reforestation, waste management) and micro, small and medium-sized enterprises through grants and preferential loans. A total of 51 grants and 11 loans were approved in 2017.
- Efforts by the **Climate Studies Group-Mona** at the University of West Indies to produce downscaled global and regional climate outputs, undertake trend analysis and develop a tropical storm simulation tool.
- The **Jamaica Community Based Landslide Risk Reduction Project**, completed in 2015, provided an evidence-based toolkit for vulnerability reduction, using the well-tested Management of Slope Stability in Communities (MoSSiC) methodology, and completed drainage and infrastructure works in three urban communities and one rural.
- The **Improving Climate Resilience for Sustainable Management of Natural Resources and Disaster Risk Reduction in Mocho** project (2014-2017) was a US$300,000 investment to rehabilitate catchment areas by lessening environmental impact through improved disaster risk management, agricultural techniques and land management practices.

Cross-cutting Information Services

- The **Improving Climate Data and Information Management Project** (US$6.8 million grant) under the preparation phase of the PPCR facilitated the generation of mid-term climate scenarios for Jamaica (i.e. the 2040s), with a special focus on the Rio Minho and Rio Bueno-White River watersheds, and generation of updated downscaled climate projections to the year 2100. This project also improved Jamaica's weather observation and forecasting capacity through procurement of automatic weather stations, tide gauges, equipment and supplies to upgrade real-time stream, flow and rainfall measurement, and back-up generators to support the operations of the Meteorological Service Jamaica and the Water Resources Authority during hazard events. Completion of the **2015 State of the Jamaican Climate Report** in 2017 was made possible through this project. It represents the most up-to-date study on observed and projected climate change in the island.
- The **Improvement of Emergency Communication System Project**, initiated in 2017 and funded through a J$1.6 billion grant from the Government of Japan, supports development of an inter-agency communications platform, procurement of equipment critical to response efforts in key locations and installation of early warning sirens at 15 locations island-wide.

- The European Union supported the upgrade of an **Early Flood Warning System for the Rio Cobre Watershed in 2017**. The objectives of the project are to increase the monitoring equipment density by procuring four stream gauging stations and six rainfall intensity stations and to recalibrate the flood discharge rate of the Watershed Management Unit, which is critical to improving the flood management system of the Rio Cobre.
- **Activation of the National Emergency Response Geographic Information Systems Team (NERGIST)**, in response to the outbreak of bush fires in East Rural St. Andrew (2015), flash flooding and landslides in Portland and St. Mary (2016), damage incurred by Turks and Caicos Islands (TCI) from Hurricane Irma (2017) and extensive flooding in Montego Bay, St. James (2017). NERGRIST was launched in 2014 as part of the Disaster Risk Reduction Framework (2012-2015), administered through the ODPEM and partners.
- Improvements in the availability, accessibility and sharing of Jamaica's **geospatial data for DRM**, such as the development of the Geospatial Damage Assessment Tool for the NERGIST, a Chikungunya web application to track reported cases and identify potential breeding sites, the Chemical Hazard Emergency Management Services Map Application.

Institutional Research

- The **University of Technology** (UTECH) undertook major research on climate change impact as well as sustainable tourism (e.g. Sinclair-Maragh 2017) during the review period. UTECH researchers also received significant funding to develop mitigation measures to document dolphin/fisheries interactions; the project made recommendations for mitigating the effects of dolphins on the artisanal fisheries.
- **The University of the West Indies Life Sciences Department** reported on-going research and publications in the following major areas:[201]
    - The critically endangered Jamaican Iguana (Jamaica's largest invertebrate). A 2014 paper estimated the total remaining population of about 200 iguanas to be restricted to the Hellshire Hills (part of the Portland Bight Protected Area). Conservation work involved collaboration with the San Diego Zoo (Wilson et al 2016).
    - Threatened frog species and their management (Holmes et al 2015).
    - Environmental impact on tropical montane forests and wetlands from various drivers and pressures including climate change and variability, anthropogenic pressure, storms and other abiotic factors (e.g. Holmes et al 2015; Luke et al 2016; Prospere et al 2016a).
    - An important paper (Prospereet al 2016b) characterized the remnant swamp forest (Black River Lower Morass; BRLM) and associated threats (including the invasive plant *Alpinia allughas* and anthropogenic impacts) and concluded that "*If effective conservation and management does not come to the BRLM, the remaining swamp forest fragments appear doomed to further degradation and will soon disappear altogether".*
- **The Northern Caribbean University (NCU)** indicated on-going research into wind turbines, land-slope, water-harvesting, pesticides impact and watershed protection using tree crops.[202]

[201] This is not a comprehensive list UWI Life Sciences publications in the review period, which comprised ~30 publications in international peer reviewed journals.

- [202] (NCU, written communication, 2018).

- **The Scientific Research Council (SRC)** reported that between 2014-2017: [203]
    - Supplied 42 anaerobic wastewater treatment systems to various public and private sector entities, which is estimated to have treated about 2.05 million litres per day of sewage.
    - Supported NEPA in testing wastewater effluents for several wastewater discharge licensees.
    - Continued research into germ plasma maintenance and conservation. The goal of this is to ensure conservation, production and distribution of plants of economic value to the agro-productive and health sectors. There has been some focus in this review period on endemic medicinal plants such as *Malpighi proctorii* and *Turnera campaniflora* and the endemic orchids *Epidendrum ramosum, Dichaea glauca* and *Pleurothallis sp*.
- The **International Centre for Environmental and Nuclear Sciences (ICENS)** located at the Mona Campus, University of the West Indies has continued research into the natural geochemistry of the island, and the production of geochemical maps. Research into naturally occurring **cadmium** is of concern because at elevated concentrations it is considered a contaminant and can accumulate in food and export crops. ICENS also conducted research that supports the correlation of aluminium and iron found in bauxitic/*terra rossa* soils with rare earth elements as well as toxic elements like cadmium and arsenic.
- The **Jamaica Bauxite Institute** has partnered with researchers to evaluate the feasibility of extracting rare earth elements (lanthanides) from the red mud produced by alumina processing. These rare earth minerals (e.g. Scandium, Cerium and Dysprosium) are used in the electronic industry. Jamaican bauxite residue reportedly (Vind et al 2018) has a very high concentration of lanthanides (up to 2500 mg/kg). It is unclear what progress has been made since the initial pilot testing which was completed in 2015. Various other uses for the residue have been explored, including bricks, and cement (Evans 2016). Barriers to reuse include possible leaching of heavy metals (mainly chromium), radioactivity, and alkalinity (pH above 11.5 is considered hazardous).

Development Control

- NWC received partial funding in 2016 from the US Trade and Development Agency for technical assistance for the **Energy Efficiency and Renewable Energy Project** at the NWC, which is designed to aid in reducing electricity costs.
- During the review period, the NWC continued investment in its **Rural Water Supply Project**, which commenced in 2008.
- **Energy Efficiency and Conservation Project- EECP** (IADB/GoJ): This project is a public sector building retrofit and energy cost-cutting initiative that aims to increase energy efficiencies, save energy (in terms of kWh/year), reduce energy expense, and as well as public sector carbon emissions. The cumulative savings (between January 2013 to December 2017) under the EECP, is US$1.8 Million and include overall reductions of:
    - 5,663,463 kWh of electricity
    - 4,509 tonnes of CO2 emission
    - 3,506 barrels of imported oil
- **Energy Security and Efficiency Enhancement** 2011-2017: This project supports the National Energy Policy goal, for all Jamaicans to use energy wisely. The project facilitates Jamaica's

- (written communication, SRC 2018), SRC:

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participation in the Clean Development Mechanism (CDM). Under the CDM, Jamaican emission-reduction projects can earn certified emission reduction credits, which can be traded to industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. Aside from strengthening governance and compliance mechanisms, the programme also supports private sector investments in energy efficiency and renewables. This project indirectly contributed to US$1.6 billion investment in the energy sector including investments in:

- Two natural gas import and storage infrastructure;
- Two LNG power plants;
- Conversion of a 114 MW of diesel-fired power plant to use natural gas;
- Renewables capacity expansion: two wind farms, two solar plants, and a hydro plant; and
- Several loan beneficiaries in the micro, small, and medium size enterprise sector valued at US$5.38M.

- **JPS** (2017 Annual Report) [204]reported a range of new initiatives to reduce reliance on fossil fuels, including:
    - A new 190 MW natural gas power plant with its joint venture partner, the South Jamaica Power Company. This more modern plant will replace the Old Harbour Power plant;
    - A 94 MW natural plant in central Jamaica operated by New Fortress South Power Holdings;
    - A 37 MW solar power plant operated by Eight Rivers Energy Company;
    - The launch of 24.5 hybrid energy storage project to facilitate inputs from renewables and ensure grid stability and reliability.
- The Petroleum Corporation of Jamaica implemented its **Deployment of Renewable Energy and Energy Efficiency in the Public Sector** and the EECP in 2016.
- The **Rural Economic Development Initiative** (2010-2017) built capacity for sustainable agriculture through infrastructure development (e.g. greenhouses, drip irrigation) and facilitation of the adoption of improved practice and technology for 4,325 small farmers.
- **The Participatory Slum Upgrading Programme** is a regional programme of UN-HABITAT which was initiated in collaboration with the African, Caribbean and Pacific (ACP) Group of States and the European Commission. Jamaica participated in Phase One of the project (which focused on Rapid Urban Sector Profiling). Phase Two was launched in 2015, resulting in the following outputs:
    - Citywide slum situational analysis;
    - Policy regulatory review;
    - Adaptation of the international guidelines on decentralization and access to basic services for all;
    - City-wide slum upgrading strategy;
    - Resource mobilization; and
    - Concept notes/ development reports.
- **Coffee Leaf Rust Early Warning Project** (2016). This project utilizes climate information to help reduce risk factors associated with Coffee Leaf Rust, and has the potential to help farmers adopt adaptations to changing climatic conditions that are conducive to Coffee Leaf Rust.
- **Jamaica Banana Accompanying Measures** (2015). The objectives of this project were to improve resilience and productivity of banana small farmers (and strengthen linkages between farmers and markets.

[204] (2017 Annual Report)

- The **Environmental and Social Management Framework** (Jones 2017) is a component of the on-going Pilot Programme for Climate Resilience (PPCR) which seeks to provide support for management of environmental impacts associated with the PPCR. The PPCR and the Fisheries Division place high emphasis on protected area management, ecosystem-based approaches and long-term wild capture sustainability.
- MICAF maintains agricultural germplasm for sweet potato, cassava, fruit trees, citrus, cocoa. Animal genetic resources (semen and livestock) are conserved in respect of dairy and cattle, goats and sheep, and pigs.
- The Ministry of Transport and Mining received technical support from UNDP and the ACP-EU to complete the 2017 **Baseline Assessment of Development Minerals in Jamaica** (Lewis et al 2017). This programme aims to improve management of development minerals (industrial minerals, construction materials, dimension stones and semi-precious stones) in Jamaica).
- The GOJ issued the **National Coastal Management and Beach Restoration Guidelines for Jamaica** (2017), with support from the World Bank, ACP-EU Natural Disaster Risk Reduction Programme. These guidelines integrate the 1995 NRCA Guidelines for the Planning, Construction and Maintenance of Facilities for Enhancement and Protection of Shorelines and the 2010 Draft Guidelines for the Relocation and Restoration of Jamaica's Coastal Resources: Corals, Sea grasses and Mangroves. The 2017 Guidelines focuses on mainstreaming climate risk reduction, and identifying techniques to increase coastal resilience.

Waste Management and Pollution Control

- PHASE 1 of the **Global Fuel Economy Initiative** (GFEI) was completed during the review period (2015-2017). Jamaica is the only country in the Caribbean with an active GFEI project,[205] which promotes the use of cleaner and more efficient fuels. This project included development of a vehicle emissions baseline and national reports on existing motor vehicle and fuel policies and regulations. The programme analyses data on the national fleet and vehicular CO_2 emissions, and has produced several policy recommendations including the drafting of the National Vehicle Emissions Standards which passed the House of Representatives in early 2018.
- Evaluating **Discovery Bay Inshore Coastal Water Quality Project** (2017) to improve capacity for Environmental Management (GEF Initiative).
- NWC commenced design work for major distribution infrastructure: Hounslow to Parottee, Essex Valley (St Elizabeth) and Bogue Village to Ramble Hall (St James), as well as sewage infrastructure at Norwood (St James) and Tawes Pen STP (reconfiguration). Most sewerage projects in 2016/2017 were undertaken in KSA/St Catherine.

17.2.3 Legal Mechanisms (2014-2017)

The following is a brief synopsis of major changes to national framework of environmental legislation, regulations, standards, plans and policies that were made during the review period.

Policies

- The **Draft National Watershed Policy** was updated in 2015.
- The **Orchid Policy** (2014) aims to conserve Jamaica's endemic orchid species and their habitats.

[205] https://jis.gov.jm/jamaica-praised-for-work-to-reduce-motor-vehicle-emissions/ Retrieved October 28 2018

- The **National Forest Policy** (2016) provides the framework for changes to implementation of key management strategies. This includes regulating privately owned land as well as establishment of land trusts for vulnerable broadleaf forests.
- Cabinet approved the development of the **Wildlife Trade Policy** (Forestry Department and NEPA) in August 2017. This policy will institute a system to ensure sustainable use and regulation of wildlife trade in Jamaica in the context of Jamaica's obligations to the international Convention on International Trade in Endangered Species of Fauna and Flora (CITES).
- During the review period, substantive work was done on the **Draft National Fisheries Policy** (issued in 2018).
- The Draft **Cays Management Policy** (2015) is designed to protect the ecological integrity of Jamaica's cays and their associated ecosystems. This includes a Marine Spatial Plan for The Pedro Bank developed by The Nature Conservancy. This policy is not yet complete.
- Cabinet and Parliamentary approval of the **Climate Change Policy Framework for Jamaica** given in 2015. This Framework supports attainment of *Vision 2013 Jamaica* by protecting Jamaica's sectoral and development goals from the risks of climate change. It provides guiding principles and an institutional mechanism to enable the development, coordination and implementation of actions at all levels to address climate change impacts. It includes six strategic planks through which to accelerate action, including climate finance; research, development and knowledge management; regional and international engagement and participation; public participation; better governance; and mainstreaming of climate change considerations in planning and protection of Jamaica's ecosystems.
- The **Revised Water Sector Policy (WSP)** was presented to Cabinet in 2017 to substantively revise the 2004 WSP. The revised WSP recommended that 85% of Jamaica be designated as Utility Service Areas, where water is supplied mainly by the NWC using a least-cost approach.[206] The remaining 15% of the island will be supplied by the Rural Water Supply Ltd., which will not use this least cost approach.
- During the review period work was done to update the 1997 **National Land Policy**. The policy establishes a framework for efficient planning, management and sustainable development of land. The policy document was not yet issued at the end of 2017.
- The **National Minerals Policy (NMP)** was submitted to Cabinet in 2017. The NMP identifies environmental performance indicators for the sector, including tailings management, energy use and GHG emissions. The policy states:

  > ***"Mineral exploitation in areas protected under different legislations and equivalent to the World Conservation Union's (IUCN) categories I and II, as outlined in the Policy for the National System of Protected Areas, will not be undertaken, unless mandated by Cabinet. If exploitation is undertaken in these areas, it will be important to ensure that the impact assessment of any such decisions fully reflect the economic cost of the minerals to be sterilized, and the natural resources and eco-systems of the protected areas that might be affected."***

- Specific goals that are identified in the NMP address issues related to Vision 2030 Jamaica NDP (Goal 1) sustainability, (Goal 3) environment, health and safety and socio-economic effects, as well as business environment, training and research, and economic benefit optimization. These are described in Table 59.

[206] https://jis.gov.jm/cabinet-decision-pending-revised-water-sector-policy/Retrieved October 28 2018

Table 59 Minerals Policy Areas of Emphasis relevant to the SOE

Goal 1: Sustainability	Goal 3: Environment
• Securing adequate, affordable and reliable energy sources. • Encouraging use of cleaner technology. • Creation of Mineral Development Zones. (MDZ) linked to other development plans • Management of mineral resources through effective land management, orderly extraction and use of tailings.	• Development of comprehensive approach to ensure that land and marine space consider economic development needs as well as protection of watersheds, water resources, forests and other natural assets. • Waste management and recovery. • Mine rehabilitation and closure work. • Community relations through community-based committees. • Introduction of mandatory integrated social-economic and environmental plans and enforcement of Life of Mine plans.

- The Squatter Management Unit continued to lay the groundwork for the development of the **National Squatter Management Policy and Implementation Plan** during the period under review. This included a review of available literature on squatting and planning recommendations that could be applied to Jamaica. Two squatter sites on Crown lands were upgraded and regularized during the review period. Planning, design and preliminary infrastructural works are on-going on 10 other sites. [207]
- The **Agricultural Land Use Policy** (MICAF) was at the Green Paper stage (public *consultation) by March 2018. This policy is intended to "guide proper administration and management of land for sustainable use that will foster agricultural growth, encourage opportunities for investment and income generation, satisfy the demand for lands for agricultural production, re-generate livelihoods for farming communities, and promote overall economic development of the country."*[208]
- The **National Organic Agriculture Policy** (MICAF) is currently being prepared. This policy is expected to position Jamaica to take advantage of market opportunities for organic produce and reduce the importation and consumption of pesticides and inorganic fertilizers which create adverse environmental impacts.
- The **National Seed Policy and Plan** (MICAF) is at Cabinet approval stage, and will facilitate the establishment of a sustainable seed system which will assure accessibility of high-quality seed to farmers at affordable costs. It is intended to bolster efforts towards sustainable agriculture, biodiversity and national food security.
- The **National Community Tourism Policy and Strategy** was launched in 2015. Its main goal is to formalize and incentivize community-based tourism options for the international market. This type of tourism is expected to align with the Natural Resource and Environmental Management Sector Plan of Jamaica's Vision 2030 and contributes to improve natural resources management and the sustainable use of natural resources.

- [207] (Squatter Management Unit 2018, written communication).

[208] https://cabinet.gov.jm/wp-content/uploads/2018/06/GOJ-Policy-Development-Programme-Update-at-March-2018-web-version.pdf Retrieved October 27 2018

- The **Emissions Policy Framework** for Jamaica (promulgated by the Ministry of Economic Growth and Job Creation – MEGJC) is being prepared, and will address and guide management of emissions from agricultural by-products.
- The **National Policy for the Environmentally Sound Management of Hazardous Wastes** (Green Paper) was issued in December 2017.[209]
- The **National Policy Poverty and National Poverty Reduction Programme** (NPP/NPRP) was approved by Parliament in 2017 in support of the eradication of extreme poverty by 2022. One of the eight guiding principles adopted by the NPP/NPRP is the need for sustainable development approaches that recognize the importance of environmentally sustainable livelihoods. The policy specifically identifies the promotion of environmental stewardship, risk reduction associated with disasters and climate change... In particular, the NPP/NPPR identifies the need for river training, watershed rehabilitation, slope stabilization, among other initiatives, as a means of reducing vulnerability and increasing livelihood sustainability.
- **National Policy on Environmental Management Systems** (EMS; 2017). This policy is intended to support Jamaica's path towards a sustainable green economy. An EMS is defined as "*part of the management system used to manage environmental aspects, fulfil compliance obligations and address risks and opportunities".* This policy seeks to promote use of EMS in the private and public sector.

Plans and Management Strategies

- The 2017 **National Forest Management and Conservation Plan** was developed in order to streamline relevant policies impacting forests. One of the goals includes reversing the loss of forest biodiversity through conservation.
- Development and revision of **protected area management plans:** the Palisadoes-Port Royal (2015); the Mason River Protected Area (2014); Proposed Black River Protected Area Business Plan, 2016; Discovery Bay Special Fishery Conservation Area Business Plan, Revised 2017; Montego Bay Marine Park Business Plan, Amended 2017; Ocho Rios Marine Park Protected Area Business Plan 2016; Blue and John Crow Mountains National Park and World Heritage Site Business Plan 2016-2020; Gourie Recreational Area Business Plan; Seville Heritage Park; Business Plan; Ocho Rios Marine Park Protected Area Management Plan 2015-2020;Montego Bay Marine Park Management Plan 2017-2022; Negril Marine Park Management Plan 2017-2022; and Pedro Cays Business Plan 2016
- The **Protected Areas System Master Plan** (PASMP) addresses the full range of national protected areas including landscapes, fresh water ecosystems, seascape and natural and cultural heritage. The PASMP covers a five-year period 2013–2017 and presents guidelines to establish and manage a comprehensive network of Protected Areas to be co-managed by four government agencies: NEPA, the Jamaica National Heritage Trust (JNHT), the Forestry Department and Fisheries Division of the Ministry of Agriculture. The PASMP's goals respond to the gaps and challenges that currently exist in protected areas management.
- The PASMP is consistent with many Jamaican policies and plans, including the Policy for Jamaica's System of Protected Areas (1997), the National Strategy and Action Plan on Biological Diversity in Jamaica (2016) and Vision 2030 Jamaica: National Development Plan (2009). It is also an important framework to guide and support the implementation of selected national and sectoral strategies including:

[209] http://nepa.gov.jm/new/legal_matters/policies_standards/docs/policy/2018august_national_hazardous_wastes_policy.pdf Retrieved October 28 2018

  - The Medium-Term Socio-Economic Policy Framework 2012 – 15.
  - The Strategic Forest Management Plan 2010 – 2014.
  - The Master Plan for Sustainable Tourism Development (2002).
  - The Culture, Creative Industries and Values Sector Plan of Vision 2030.
- **The Pedro Bank Marine Spatial Plan (MSP)** was completed in 2017 by the Nature Conservancy Jamaica as part of NEPA's NPAS project with funding from GEF and UNDP. This MSP was designed as a multi-use zonation plan for the Pedro Bank to guide sustainable marine resources use and identify suitable areas that could be declared as national protected areas.
- **Zoning Plans:**
  - **Final Draft Coral Spring–Mountain Spring Zoning Plan 2017-2022** (2014-2019): This area contains the largest contiguous area of dry limestone forest along the north coast of Jamaica. More than 90% of the protected area is privately owned;[210]
  - **The Draft Ocho Rios Marine Park Protected Area Zoning Plan 2015-2020** (2015); and
  - **Draft Palisadoes-Port Royal Protected Area Zoning Plan 2014-2019**(2013)
- In 2017 it was announced that J$5 million was allocated for the update of the **Water Resources Development Master Plan** and of the **Water Allocation Policy Strategy**. To date this updated plan has not been published.
- NEPA completed drafting of the **Jamaica National Settlement Strategy** (2nd draft) in March 2017. This strategy identifies "*strong well-developed urban centres and sustainable rural areas,*" as critical elements to guide spatial planning and provides a strategic direction for the management of growth, investment and resources.
- **The National Strategy and Action Plan on Biological Diversity in Jamaica** (NBSAP) (NEPA 2016). The goals of the plan are summarized in Table 60.

Table 60 National Strategy and Action Plan on Biological Diversity in Jamaica: Strategic Goals

	Strategic Goal
A	By 2021, *to address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society*. This includes awareness building, mainstreaming into planning, removal of harmful subsidies, and sustainable production and consumption patterns.
B	By 2021, to reduce direct pressures on biodiversity loss and promote sustainable use. This goal includes sustainable harvesting and management, pollution control, management of invasive alien species, and minimization of anthropogenic impacts on ecosystems that are particularly vulnerable to climate change impacts.
C	By 2021, to improve the status of ecosystems by safeguarding ecosystems, species and genetic diversity. This also sets the AICHI target of protecting 17% of land areas and 10% marine areas by 2020.
D	By 2020, to enhance the benefits to all from biodiversity and ecosystem services. This goal recognizes the importance of essential services provided by ecosystems, and requires resilience enhancement.
E	Enhance the implementation through participatory planning, knowledge management and capacity building. Specifically, by 2019 Jamaica has developed a national strategic plan for biodiversity, and has commenced its implementation in an effective and participatory manner. It also speaks to respect of traditional knowledge of local communities, knowledge transfer and mobilization of financial resources.

- The **National Spatial Plan** has progressed since 2013. The GoJ secured funding for the preparation of seven technical background papers towards the National Spatial Plan from the Inter-American Development Bank (IDB) through the Pilot Programme for Climate Resilience (PPCR) Project and the Foundations for Competitiveness and Growth Project being implemented

[210] http://nepa.gov.jm/csmszp/draft-zoning-plan.pdf Retrieved October 27 2018

by the PIOJ in collaboration with the Jamaica Promotions Corporation (JAMPRO) and the Development Bank of Jamaica. The objectives the NSP include optimization of use of land and other natural resources by providing a framework for making sustainable location choices. Expected outputs include a situation analysis of spatial development and the National Settlement Strategy in Jamaica; identification of development scenarios outlining alternative strategies to reach ***Vision 2030 Jamaica*** goals; assessment of key economic sectors; and implementation of an Action Plan.

- The Invasive Alien Species Working Group (The Endangered Species (Protection, Conservation and Regulation of Trade) prepared a **Management Strategy of Green Iguana Plan**.
- Implementation of the Jamaica **Renewable Energy Nationally Appropriate Mitigation Action** (NAMA), which underpins Jamaica's global commitment to expand electricity generation from renewable sources.
- Approval of the **National Chemical Emergency Response Protocol** in 2014 and development of the **Draft National Chemical Emergency Risk Management Plan** in 2015, which outlines an approach to the sound management of hazardous chemicals in Jamaica.
- Ratification by the Prime Minister of the **National Oil Spill Plan** in 2014, to support coordination of oil spills management and response procedures across government and non-government stakeholders. It provides for oil spill response in Jamaica's territorial waters and its adjoining near and offshore Contiguous Zone and Economic Exclusive Zone.
- **Mass Rescue Operations (MRO) Contingency Plan 2015.** This plan is tiered (parish, national, and international) and was developed to respond in the event of a major passenger ship or aviation incident in Jamaica's marine or air space. Stakeholders included the Maritime Authority, Jamaica Defence Force, Ministry of Health, Jamaica Civil Aviation Authority, Port Authority of Jamaica, Airports Authority of Jamaica, Jamaica Constabulary Force, Parish Disaster Committees and other agencies.
- By the end of 2017 NEPA completed the drafting of **Development Orders** for all parishes in Jamaica. These new Development Orders address sustainable planning issues such as population growth, waste management, transportation and encroachment into environmentally sensitive areas.[211] The Development Orders apply to planning permissions for developments within parish/local government jurisdictions, in consultation with relevant national regulatory authorities.
- **Local Sustainable Development Plans** (LSDP). An LSDP is a tool used to guide the Local Authority in managing the orderly development of the parish. LSDPs are most urgently needed for the areas where rapid urbanization is occurring, specifically St, James and Kingston and St, Andrew. The Local Planning Authorities prepared LSDPs for various parishes, which are at different stages: LSDPs for Trelawny, Clarendon and St, Elizabeth were completed during the review period, making four out 14 completed by 2017.
- In 2016 MEGJC, through UNEP, published the National strategy and action plan for sustainable consumption and production in Jamaica (SCP Action Plan), which was entitled "**The Green Economy Scoping Study for Jamaica (**UNEP 2016a**).**"[212]Completion of this plan is a key SDG indicator, and places Jamaica amongst the 71 countries that have completed similar plans. The plan is intended to support Vision 2030 Jamaica NDP by providing 10-year targets to be mainstreamed into the national policy framework for key sectors: agriculture, construction,

[211]http://www.jamaicaobserver.com/latestnews/NEPA_on_track_with_provisional_development_orders?profile=1?profile=1Retrieved October 27 2018

[212]http://www.oneplanetnetwork.org/resource/national-strategy-and-action-plan-sustainable-consumption-and-production-jamaicaRetrieved October 27 2018

energy, tourism and water. The SCP Action Plan outlines the main "green" policy directions for the construction industry. Progress toward these is outlined in Table 61.

Table 61 Progress Towards Policy Goals for the Construction Industry

Policy Goal	Progress to Date
National Building Act (NBA) and New Building Code of Jamaica (NBCJ) Codes and standards that mandate green construction practices	NBA was gazetted in early 2018,[213] and replaced the Parish Council and KSAC building act. It also provided for the establishment of the NBCJ as regulations made under the Act (Section 14), which will be administered by the Bureau of Standards Jamaica. Section 62 provides for regulations in respect of water harvesting, energy efficiency, renewable energy and conservation. The NBA and Code are expected to improve energy efficiency of buildings and improve waste management. It is expected that the code will also address hazard standards, squatting and adequacy of dwellings for occupancy.[214] Significant progress towards completion of the NBCJ was made in 2018.
Green Building Rating System	The Leadership in Energy and Environmental Design (LEED) is a US rating system that has been widely adopted, and represents the international standard for green building rating systems. There is a growing number of LEED certified architects practising in Jamaica. Jamaica's first LEED certified building was completed in 2015 (Marriott Courtyard Hotel New Kingston). LEED has not been officially adopted in Jamaica.
Development Orders and other planning guidelines to reflect sustainable planning principles	NEPA completed the drafting of Development Orders for all parishes. These address key sustainable planning issues. Three parish Local Sustainable Development Plans (LSDPs) have been completed, making the number of completed LSDPs four out of 14.

- **National Food & Nutrition Security Action Plan**, which has Cabinet Approval. This plan will enable goal setting to improve food and nutrition security, and ultimately advance the SDGs of combating poverty and hunger at a national level.

Acts

- Promulgation of Jamaica's **Disaster Risk Management (DRM) Act, 2015** (2015), a key legal instrument to enable disaster management and clarify emergency response measures, including disaster relief funding and mandatory evacuations. It empowers ODPEM to declare Disaster Areas and Especially Vulnerable Areas.
- **The Agricultural Loan Societies and Approved Organizations Act, 2017** (2017) has been approved by Legislative Committee. This Bill is intended to facilitate small farmers' access to credit, which would improve capacity to implement more efficient and sustainable practices.
- During the review period, substantive groundwork was done on the **Fisheries Act**, which was finalized in 2018. It is intended to repeal the existing Fishing Industry Act, with the goal of improving overall management of the industry. Poaching, as well as unreported and unregulated fishing is a problem on offshore banks and in Jamaica's wider EEZ. The declaration of SFCAs has been integrated into the updated policy and these no take areas are expected to improve fish populations that support commercial fisheries.

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[213] https://japarliament.gov.jm/attachments/article/339/The%20Building%20Act,%202018.pdfRetrieved October 27 2018

[214] http://jamaica-gleaner.com/article/news/20180701/jamaica-enact-new-building-code-minimise-damage-disasters Retrieved October 27 2018

Regulations

- The Draft **Natural Resources (Protected Areas) Regulations** (2017) is aimed at controlling threats to protected area resources. The Regulations would apply to protected areas established under Section 5 (1) (b) of the Natural Resources Conservation Authority Act.
- The **Endangered Species (Protection, Conservation and Regulation of Trade) (Amendment of Schedules) Order, 2015 amended the First, Second, Third and Fourth Schedules of the Act,** specifies the fees structure of CITES permits and certificates.
- The **Endangered Species (Protection, Conservation and Regulation of Trade) (Establishment of National Export Quota (*Strombus gigas*)) Regulations**, 2016 and 2017 were enacted. They established the national export quota for Queen Conch (*Strombus gigas*) at 450,000 kilograms.
- **Amendment to the Natural Resources Conservation (Permits and Licence) Regulations** in 2015 to broaden the categories of enterprises, construction and development activities requiring environmental approvals.

National Standards, Manuals & Guidelines

- The **Hillside Development Manual for Jamaica**[215] was launched in 2014 by the Mines and Geology Division. It recognizes that 70% of Jamaica's lands are located on hilly terrain, and that the major bauxite mines are located in karstic limestone terrain. Mined out bauxite lands are often rehabilitated and used for forestry, farming, housing, or community use which requires infilling, compaction and grading of the disturbed areas. The manual advises that sinkholes, which are likely important to groundwater recharge and flood control, should not be filled. It also established guidelines for quarrying and rehabilitation.
- The **National Quality Infrastructure (NQI)** has been developed by MICAF to facilitate expansion of trade of locally manufactured goods; by ensuring international quality standards are met. A key piece of legislation that was enacted as part of the NQI is the Nuclear Safety and Radiation Act (2015) which provides for the establishment of a regulatory body (the Hazardous Substances Regulatory Authority) for activities relating to radioactive material.NEPA **developed the revised Motor Vehicle Emissions Standards**in 2015.[216] These standards establish maximum levels of THC (total hydrocarbon exhaust emissions), NMHC (non-methane hydrocarbon exhaust emissions), CO, NO_x (nitrogen oxides) and PM (particulate materials) for imported vehicles The Motor Vehicle Emissions Standards are to be promulgated under the Road Traffic Act.

Accession to International Environmental Agreements and Associated Reporting

- The **Paris Agreement** under the UNFCCC was effected in November 2016, with **Jamaica as a signatory. Jamaica r**atified the agreement in 2017.
- Global adoption of the **Sendai Framework for Disaster Risk Reduction** 2015–2030 at the Third UN World Conferencein Sendai, Japan in 2015. The Sendai Framework is the successor instrument to the Hyogo Framework. The Sendai Framework recognizes the unique challenges and needs of Small Island Developing States.
- Jamaica ratified the **Amendment to the Basel Convention** on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Ban Amendment) in November 2015. The 2015 amendment bans the import of hazardous waste from members of the Organisation of Economic Corporation and Development (OECD), the European Commission and Liechtenstein.

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[215] http://www.mgd.gov.jm/about-us/discover-mgd/documents/development-manual/hillside-development-manual.htmlRetrieved October 27 2018

[216] http://nepa.gov.jm/new/legal_matters/policies_standards/docs/standards/motor_vehicle_exhaust_emission_standards.pdf Retrieved October 27 2018

- Jamaica acceded to the **Minamata Convention on Mercury** in July 2017thereby committing to prevent trade and manufacture of particular products containing mercury and to regulate mercury emissions and waste.
- Accession by Jamaica in 2015 to the **Protocol Concerning Pollution from Land-Based Sources and Activities** (the LBS Protocol), which aims to support implementation of Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention) through management, monitoring and research.
- Submission of Jamaica's **Intended Nationally Determined Contribution** (INDC) to the UNFCCC in 2015, outlining the country's proposed contribution to cutting global emissions. Focused on the energy sector, the INDC amounts to a 7.8% reduction in GHG emissions by 2030 compared to business-as-usual emissions. Attainment of this target is predicated on implementation of the National Energy Policy 2009-2030 and renewable energy projects underway.[217] The INDC also noted priority sectors for adaptation: tourism, agriculture, fisheries, forestry, water, energy, industry, human settlements and coastal resources, marine resources, human health, transportation, waste management, education, finance and disaster risk reduction and response management.
- Completion of the GHG inventory in 2015 for five sectors, covering the period 2006-2012, and Cabinet approval and submission of **Jamaica's first Biennial Update Report** (BUR)to the UNFCCC in 2016. The creation of a national database for GHG emission inventories will aid in preparations of future BURs.
- Preparations of inputs toward Jamaica's **Third National Communication** to the UNFCCC were well underway in 2017, including completion of climate change vulnerability and adaptation assessment studies for human health, agriculture, water resources, coastal resources and tourism.

17.2.4 Governance and Administrative Provisions (2014-2017)

Permitting and Licensing

Natural resource exploitation, land development and the environmental footprints of these are regulated by NEPA through its permitting and licencing system (PLS). Under the Natural Resources Conservation (Permit & Licences System) NEPA processes various applications, which are classified as direct or indirect applications.[218] In 2014/2015 NEPA processed within the required timeframe (55 to 60 days) ~71% of the 1915 applications processed, compared to 2016/2017, when 64% of 2061 applications were processed within the target timeframe.

[217] Government of Jamaica (2015). Intended Nationally Determined Contribution of Jamaica Communicated to the UNFCCC.

[218] Direct applications are defined as applications on which the final decision/recommendation is made by NEPA, NRCA and/or the TCPA and include environmental permits, environmental licences, beach licences, planning (TCPA) and enquiries. Indirect applications are applications for which recommendations are provided by NEPA to the local authorities and include subdivisions (less than 10 lots), subdivisions (over ten lots) and planning (non TCPA).

Table 62 Permits, Licences and Approvals Issued by NEPA during the Review Period

Type	Number issued in review period	Average Annual Number issued
CITES[219] Permits	656	164
Discharge Licences (NRCA Wastewater and Sewage Regulations, 2013) *	591	148
Air Pollutant Discharge Licences	21	5
Environmental Permits	379	95
Beach Licences	202	51
Environmental Licences	2,263	566
Planning and Subdivision Approvals	2,303	576
Permits to Export and Transit Hazardous Waste	27	7
Total	**6442**	**1610 (average)**
* (excludes 2017 data) – 39 of the 591 were issued to trade effluent treatment facilities		

- During the review period the total number of enforcement actions taken by NEPA increased from 904 in 2014 to 1,278 to 2017. In 2017, 94% of these consisted of onsite breach/warning notices and warning letters, intended to steer the licencee back to compliance. Legal actions available to NEPA include:
    - Enforcement Notices;
    - Cessation Orders;
    - Stop Notices;
    - Notice of Intention to Suspend;
    - Notice of Intention to Revoke;
    - Suspension Notice;
    - Onsite Breach/ Warning Notice;
    - Warning Letters;
    - New Court Matters;
    - Notices Under the Air Quality and Wastewater Regulations;
- In 2015 the **Forestry Department System of permits and licences** was implemented, whereby permits are required for the removal of timber and forest produce, road use, fires, or transportation/use of power saws. Forestry licences are required for the operation of sawmills and trade or storage of locally purchased lumber. The **Sawmilling Licensing Registration Programme** was established in September 2014. Persons involved in production, trade or storage of lumber are required to obtain an operating permit and be registered under this programme.

New Programmes

- NEPA expanded the **Jamaica Ambient Air Quality Monitoring Programme** (JAAQMP), which calls for reporting[220] of air pollution incidents and ambient air quality. The JAAQMP received funding for an upgraded programme in the review period, which resulted in the expansion of the monitoring network. Expansion of the network into urban areas outside of the KSA was limited in the review period.
- In 2016 Jamaica produced its **First Mercury Inventory** with support from the Caribbean project "*Mercury Storage and Disposal Project*".

[219] CITES refers to the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Endangered species includes any animal or plant species threatened with extinction which are or likely to be affected by trade' or whose survival is unlikely if any factor which threatens its extinction continues to operate.

[220]http://nepa.gov.jm/new/services_products/subsites/air_quality/reports.phpRetrieved October 27 2018

- **NEPA produced the Pollutant Release and Transfer Registry** which provides information on the movement of waste generated by licensed or permitted facilities from source to disposal point (in the air, land or sea).
- In the past few years several small **Waste Recycling Plants** have become established in Jamaica. These include Jamaica Recycles, Kurbriton Jamaica Ltd., 360 Recycle Manufacturing Ltd, Recycling Partners of Jamaica Ltd and Gravita. Recycling Partners of Jamaica Ltd is a GoJ partnership (MEGJC) with the Wisynco Group Ltd., Pepsi Cola Jamaica, Grace Food & Services Ltd. Jamaica Beverages Ltd, Lasco Manufacturing Ltd, Trade Winds Citrus Ltd. and Seprod. The focus of the company is to divert plastics bottles from the environment and landfills for recycling. Jamaica's first PET (polyethylene terephthalate) recycling plant started operations in July 2017 by Gravita, a multi-national company with headquarters in India and over 25 years experience in the recycling business and operations in 18 countries across the globe. Gravita Jamaica Ltd manufactures PET flakes and has an annual capacity of 4,800 metric tons (mt) per year. PET is the plastic resin used to make most plastic bottles (e.g. soft drink bottles). In 2017, the company processed 1,518 mt of PET, with ~40% of that being clear plastics. In 2018, recycled PET flakes production was 1,988 mt, a lower monthly rate than in 2017 (165 mt/ month in 2018; 253 mt/ month in 2017), with the same proportion of clear plastics. The success of this operation will rely on Jamaicans sorting plastic bottles from other wastes.

New Government Bodies with an Environmental or Social Mandate

- Since 2013, the GoJ has increased the profile of climate change issues, assigning the portfolio to the **Climate Change Division** (CCD) established under the Ministry of Water, Land, Environment and Climate Change (MWLECC) up until 2016 and the Ministry of Economic Growth and Job Creation (MEGJC) thereafter. The CCD is responsible for Jamaica's obligations as a Party to the UNFCCC. The CCD coordinates and facilitates climate action (adaptation and GHG mitigation) nationally, regionally and internationally (MEGJC 2018b) and is the National Designated Authority to accede to the Green Climate Fund (PIOJ 2016b). Other agencies with key roles in advancing climate action and risk management include the Meteorological Office of Jamaica, the ODPEM, PIOJ and NEPA. PIOJ is the country's National Implementing Entity to the Adaptation Fund.
- **Cannabis Licensing Authority (CLA)** was established in 2015. The licensing system allows for three tiers of cultivation licences [221](one acre, one to five acres, and over five acres). Illegal commercial ganja cultivation is likely to have caused forest fragmentation, habitat loss, stream modification and soil erosion in the past; moving forward with decriminalized cultivation, it will be necessary to develop an understanding of the likely environmental impact of this crop.
- The Bureau of Women's Affairs was changed to the **Bureau of Gender Affairs** in 2016. The Bureau places renewed emphasis on mainstreaming the National Policy for Gender Equity (approved in 2011).

[221]http://cla.org.jm/application/types-licences Retrieved October 27 2018

Partnerships

- NEPA has signed Memoranda of Understanding with several organizations during the review period, including:
    - The Scientific Research Council (SRC) signed in 2015[222] to conserve endemic plants and protect biodiversity. The SRC agreed to focus on:
        - protecting endemic plants using tissue culture;
        - maintaining an in vitro germ plasma for genetically identical planting materials;
        - propagating endemic and endangered plants for introduction into the wild;
        - exploring the development of molecular diagnostic tools to identify and characterize plants that are endemic to Jamaica.
    - **Institute of Jamaica** for implementation of a project to control the invasive fern *Dicranopteris pectinata* and stock two acres of the Mason River Botanical Station/Protected Area with native plant species.
    - **University of Technology TECH** (2014) to cooperate and share information on natural resource management and spatial planning.
    - **Northern Caribbean University (NCU)** in 2015 became the third university to partner with NEPA to protect the environment.
- Launch of the **Climate Change Focal Point Network** in 2014, comprising representatives from selected Jamaican Government Ministries, departments and agencies and, in time, from sub-national governments, civil society groups and the private sector. Recognizing the cross-cutting nature of climate change, the purpose of this network is to coordinate implementation of respective climate change activities, advance mainstreaming of climate change in policies, plans and programmes and contribute to monitoring and reporting of activities (McIntosh 2014).
- Establishment of seven **National Committees** and ratification of the **National Disaster Risk Management Council** chaired by the Prime Minister in 2017, which provide oversight and execute functions and responsibilities in the DRM Act.
- Launch of the **National Emergency Response Geographic Information Systems Team** (NERGIST) in 2014. NERGIST is a team of GIS experts trained to capture and map damage data, contributing to such efforts as post-disaster damage assessments.
- The Ministry of Foreign Affairs and Trade (MFAFT) has embarked on a policy of strengthening the links between the **Diaspora** and Jamaica, fostering collaborative task forces for crime prevention, agriculture, youth and female empowerment, and immigration.

17.2.5 Protected Area Planning (2014-2017)

Jamaica has made commitments to implement the Convention on Biological Diversity Strategic Plan for Biodiversity 2011-2020 and achieving Aichi Biodiversity including Target 11:

> ***"By 2020, at least 17% of terrestrial and inland water areas and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape."***

[222] http://www.jamaicaobserver.com/news/src--nepa-sign-mou-to-protect-endemic-plants_19098136 Retrieved October 27 2018

The Protected Areas System Master Plan estimated that 18% of the land area and 15% of the Jamaica's waters were under some form of protection in 2012 (Table 63 lists these sites). The Protected Planet data clearing house[223] includes 140 protected areas in Jamaica, with about 1,760 km^2 of the land and about1,860 km^2 of the marine area protected (16% and 1% respectively). However, it cautioned that not all of the protected areas in Jamaica are being "*effectively and equitably managed*" (Aichi Biodiversity Target 11). The main benefit of protected area designation is that these areas are given some level of protection from formal and planned anthropogenic development pressure. A good example of this in the review period is the Goat Islands (Box 12). Specific protected areas[224] that were designated in the review period include:

1. **Nationally Designated Sites**

   a) **Special Fishery Conservation Areas** (SFCAs) declared since 2013 include: East Portland, Boscobel East and West St. Mary and White River (St. Mary), which are added to the 14 existing SFCAs. No data are available on the spatial extent of these new SFCAs.

   b) **Natural and Cultural/Historic Sites**
      - **Charles Town Maroon Site (near Buff Bay, Portland)** (23/04/2015): The settlement emerged around 1754 and was identified as Crawford Town.
      - **Scotts Hall Maroon Site (St. Mary)** (3/04/2015): Scotts Hall is known for producing Captain Davy, the maroon responsible for the murder of the rebel leader, Tacky, in 1760.
      -

   - **2. Internationally Designated Sites:**
      - **Blue and John Crow Mountains Cultural Heritage Site** (2015): This is the only UNESCO World Heritage Site that has been inscribed in Jamaica. The site includes extensive areas of intact closed broadleaf forest and disturbed broadleaf forest, high levels of biodiversity and endemism as well as the heritage sites for the Maroons and Taino native people, and includes the Nanny Town Heritage Route. It comprises 262 km^2 at elevations ranging from 850 m to 2,256 m above mean sea level. Another 285 km^2 form a buffer zone. The site is home to the largest butterfly in the western hemisphere (Jamaican Swallowtail *Papilio homerus*) and over 200 endemic species. This designation will facilitate protection of the area from mining and agricultural encroachments. Factors impacting the property in 2017 and 2016 included wildfires, forestry, recreation, invasive alien species, land conversion, mining, agricultural encroachment and climate change. This site is also a National Park[225] and AZE site (see below).

   -

- It should be noted that there are other globally recognized sites in Jamaica such as the IUCN Alliance for
- Zero Extinction[226] (AZE) Sites which includes the following:
   - **Blue and John Crow Mountains** is the largest of Jamaica's AZE Sites (2017), hosting a significant number of globally endangered species, including:
      - Plant species: Blue Mountain Yacca(*Podocarpus urbanii*)(CR- endemic), *Eugenia kellyana* and *Psychotria danceri*;

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[223] https://www.protectedplanet.net/country/JMRetrieved October 27 2018

[224] JNHT designated a total of 22 new heritage sites. These include buildings, statues and monuments which are not listed here as protected sites.

[225] https://whc.unesco.org/en/list/1356 Retrieved October 27 2018

[226] http://zeroextinction.org/site-identification/2018-global-aze-map/ (Retrieved October 27 2018) - these are sites that have been globally assessed by the IUCN as sites that must be effectively protected if the most threatened species are to survive.

- Endemic Frog species: Arntully Robber Frog (*Eleutherodactylus orcutti*[227])and the Jamaican Peak Frog (*E. alticola)*;
- Bird species: Jamaican Petrel (*Pterodroma caribbaea*)(CR - endemic*)*, Bicknell's Thrush (*Catharus bicknellii)*, the Jamaican Blackbird (*Nesopsar nigerrimus) (*EN - endemic*)*; the Yellow-billed Parrot (*Amazona collaria)*(VU – endemic), and Black-billed Parrot (*Amazona agilis)* (VU – endemic); and
- Mammal species: Brown's Hutia (a small rodent) (*Geocapromys brownii)* with a population restricted to John Crow Mountains *(*EN - endemic*)*.

- **Cockpit Country**(2017): Contains entire remaining populations of the Endangered plant species *Pseudorhipsalis alata*, and two Critically Endangered frog species *Eleutherodactylus griphus* and *Eleutherodactylus sisyphodemus* within an area of ~713 km^2(Figure 78).
- **Point Hill** (2017): Contains entire remaining population of the Critically Endangered Jamaican Greater Funnel-Eared Bat (*Natalus jamaicensis)* within an area of 53 km^2.
- **Hellshire Hills** (2017): Contains entire remaining population of Jamaican Iguana (*Cyclura collei)* within an area of 104 km^2.
- **Portland Ridge** (2017): The entire remaining population of the Critically Endangered frog species *Eleutherodactylus cavernicola* (Figure 79) is severely restricted within the roughly 475 km^2 of this protected area.

[227] There is some speculation that this species may have become extinct as a result of the disease chytridiomycosis, which is spread by the fungus *Batrachochytrium dendrobatidis*https://www.cockpitcountry.com/ChytridIntro.html. This disease represents a major threat to Jamaica's amphibians.

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Figure 78 Cockpit Country Proposed Protected Area

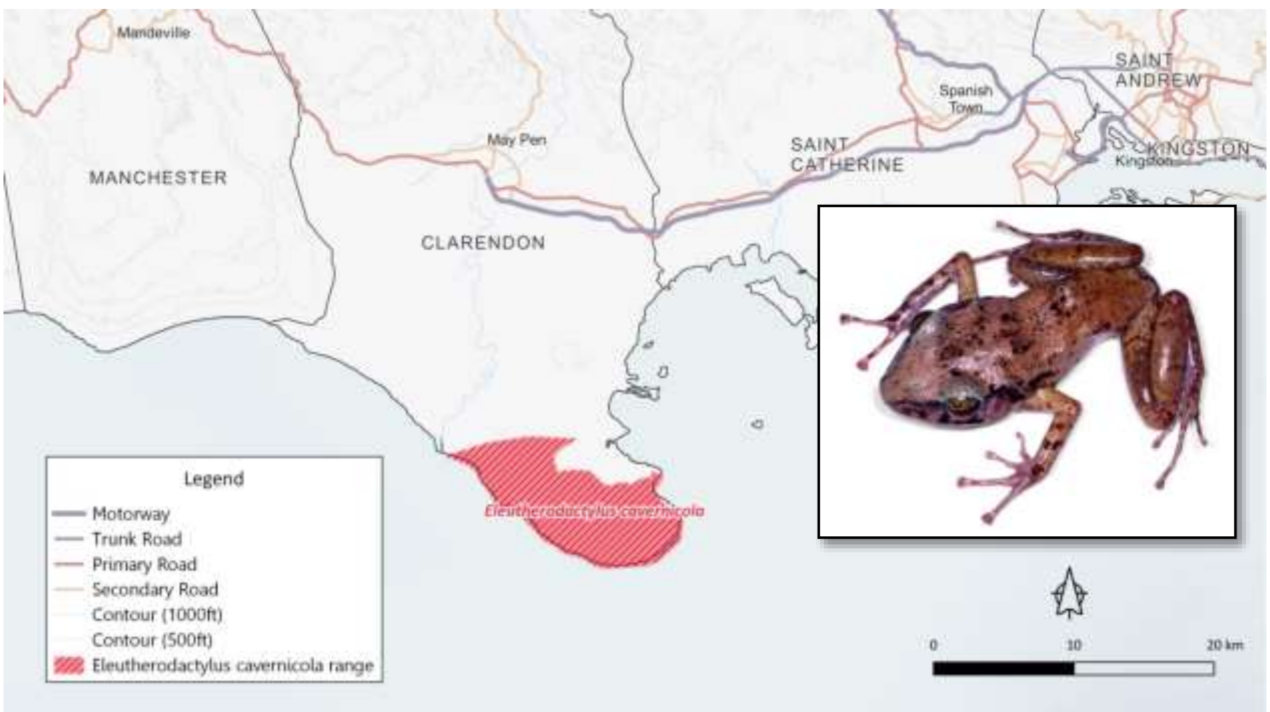

Figure 79Eleutherodactylus cavernicola range (Photo Credit: Blair Hedges)

Great Goat Island (~1.9 km^2) and **Little Goat Island** (~0.6 km^2) are offshore cays within the Portland Bight Protected Area.

"*Despite being protected under four laws and containing two forest reserves, six game sanctuaries, and three fish sanctuaries, the government announced in August (2013) that it was engaged in negotiations to sell Goat Islands .... to build a massive transhipment port and associated logistics hub – right in the heart of the Portland Bight Protected Area*" (Robin Moore[228], Fellow at the International League of Conservation Photographers, National Geographic, 2014). The development proposal that was put forward to develop the Goat Islands would have involved reclamation of the shallow marine area connecting the island to the mainland, and extensive clearance of natural habitats on the island and surrounding sea, with billions of USD in Chinese investments.

Through the *"Save Goat Islands"* campaign, NGOs such as the Jamaica Environmental Trust and the Caribbean Coastal Area Management Foundation, along with concerned members of the community and researchers like Dr. Byron Wilson and Dr. David Smith, raised opposition to the development of these islands, citing the need to conserve the islands' habitat. The IUCN officially submitted a letter appealing to the Government of Jamaica to reconsider development of this area, citing the ecological services provided by Goat Islands as a major fisheries nursery for commercial species like snapper, grunt, lobster, shrimp and oysters, as well as its ecotourism potential.

Following the change of government in 2016, the UDC and the NEPA announced plans to establish Goat Islands as a Wild Life Sanctuary for endemic and endangered species – including the critically endangered Jamaican Iguana (*Cyclura collei*). These agencies currently co-manage the sanctuary, and have indicated the intention to have it designated as Jamaica's first biosphere site under the UNESCO Biosphere Programme[229].The Goat Islands fall within the boundaries of the Portland Bight Protected Area (Natural Resources Conservation Authority Act) and the Amity Hall Game Sanctuary (Wild Life Protection Act). The establishment of Goat Islands as a Wild Life Sanctuary was not implemented as of the end 2017. A management plan is to be prepared.

Box 12Goat Islands (Planet Labs, 2019)

[228] https://blog.nationalgeographic.org/2014/04/22/saving-goat-islands-jamaica/Retrieved October 27 2018

[229] NEPA, written communication, 2019

Table 63 Inventory of Protected Areas in Jamaica (2017)

Forest Reserves	National & Marine Parks, Environmental Protection Area, Protected Areas and Game Sanctuaries/ Reserves[230]	Protected National Heritage Sites	Special Fishery Conservation Areas (SFCAs)[231]	World Heritage Site/Ramsar Sites and Other
• Bogue • Bull Head • Cedar Valley • Chepstowe • Chesterfield • Citron Valley • Cockpit Country *** • Content II • Dolphin Head • Dover • Dromilly Block "A" • Fort Stewart - Block "A" • Fyffe and Rankine • Garlands Block "A" • Garlands Block "B" • Garlands Block "C" • Greenock • Harker's Hall • Hyde Block "A" • Hyde Hall Mountain • Industry Field-Rowkamp • Jericho Block "A" • Jericho Block "B" • Jericho Block "D" • Jericho Block "E" • John Anderson • Kellets-Camperdown • Kildare • Lancaster • Lover's Leap • New Forest • Mount Diablo • Peace River • Peak Bay Block "A" • Peak Bay Block "B" • Peckham • Pencar • Shuna • Smithfield • Spring Garden • Spring Vale • St. Faith's - Block "G" • Troja • Troy Block "A" • Windsor Lodge	**National Parks** • Blue & John Crow Mountains **Marine Parks** • Montego Bay • Negril **Environmental Protection Areas** • Negril **Protected Areas** • Coral Spring-Mountain Spring • Ocho Rios Marine Park • Portland Bight • Mason River • Palisadoes-Port Royal **Game Sanctuaries/Game Reserves**[232] • Alligator Pond/Gut River/Canoe Valley • Amity Hall • Black River Upper Morass • Black River Lower Morass • Bogue Lagoon Creek • Cabarita Point • Fairy Hill • Glistening Waters • Holland Bay Great Morass • Knapdale • Long Island • Mason River Savanna • Negril Great Morass • Parottee Great Morass • Portmore and Greater Portmore • Reigate • Stanmore Hill • West Harbour-Peake Bay	**Heritage Sites[233] (not including mineral spas, towns, monuments and buildings):** • Cinchona Botanical Gardens • Hope Botanical Gardens • Castleton Botanical Gardens • Bath Botanical Gardens • Hollywell National Park • Long Mountain • Blue Mountain • Seville Heritage Park • Pedro Bank • Orange Park	• Alligator Head • Bird Cay /South West Cay • Bluefields Bay • Bogue Islands Lagoon • Boscobel Oracabessa Bay • Bowden • Discovery Bay • Galleon Harbour • Galleon St Elizabeth • Montego Bay Point • Orange Bay • Oracabessa Bay • Port Morant Harbour Lagoon • Salt Harbour • Three Bays • Whitehouse • White River	**UNESCO World Heritage Site** Blue and John Crow Mountains **Ramsar Sites** • Black River Lower Morass • Palisadoes/Port Royal • Portland Bight Wetland and Cays • Mason River **Other***** • Blue and John Crow Mountains • Cockpit Country • Hellshire Hills • Point Hill • Portland Ridge & Bight
[234]***Alliance for Zero Extinction/IUCN Site				

[230]http://nepa.gov.jm/new/services_products/publications/docs/hunters_handbook_2017.pdfRetrieved December 27 2018
[231]http://www.micaf.gov.jm/sites/default/files/Special_Fisheries_Conservation_areas.pdf Retrieved December 27 2018
[232]http://nepa.gov.jm/new/services_products/publications/docs/hunters_handbook_2017.pdfRetrieved December 27 2018
[233]http://jnht.com/Retrieved December 27 2018
[234]https://whc.unesco.org/en/statesparties/jm/documents/ Retrieved December 27 2018

17.3 Conclusions

In general, very little official funding is allocated in the 2017 national budget for environmental protection (~2.6% or J$14.2 billion). This figure is a useful statistic to examine priorities and changes over the years. The 2017/2018 budget allocation equates to J$5,200 (US$40)/person/annum allocated for the broad category environmental management (EM). While this is a major improvement from the previous review period (an increase of ~61%), where ~J$3,230 /person/annum was allocated in the national budget for EM, this is still considered very low, particularly when it is taken into account that 58% of that goes towards disaster and fire risk reduction. Subtracting disaster and fire risk reduction, Jamaica currently allocates environmental protection of ~J$2,185 (or US$17 person/year for this purpose. There appears to be a general reliance on external (donor) funding to cover the environmental protection and conservation efforts.

The biggest concern with the current status of budget allocations for EM is the very low level of funding that is allocated towards waste management, especially in light of the major deficiencies in the quality and quantity of municipal service provision and the severity of environmental impact associated with improper waste management (ranging from air quality, to water and soil pollution and solid waste). Although the national waste management budget has almost doubled in the review period (from J$0.82 billion in 2013/2014 to J$1.57 billion in 2017), this allocates less than J$575 /person/annum to deal with waste.

More than half of Jamaica's population currently live in concentrated urban areas (see Chapter2.3.2). The estimated proportion of the urban population living in sub-standard housing with poor access to services like sewerage and solid waste collection is ~61% (Chapter 7.3.1), and expected to increase as more people from rural areas migrate to towns. Waste collection and disposal services are not keeping up with increasing waste generation (Chapter 7.3.6), particularly in the urban areas where there is major potential adverse impact from flooding (through choking of gullies), poor air quality, coastal pollution (through pathways for non-biodegradable waste entering rivers and the marine environment) as well as environmental health issues related to persistence of conditions conducive to vector breeding. Chapter 7.3.6 only touches on some of cumulative environmental effects associated with the disparity between available solid waste management and the scale of the demand for these services. When the problems with solid waste management are coupled with the issues related to sewage treatment facing municipal corporations the environmental concerns can be considered a significant crisis that cannot be addressed by the current level of spending on waste management. This crisis looms larger, when one examines the relatively fewer donor-driven project initiatives that augment national expenditure for waste management. Waste management should be considered on par with disaster management.

It is not recommended that conclusions be drawn from the list of major projects that have been included (Chapter 17.2.2), as these do not necessarily reflect national priorities in respect of environmental protection, and may reflect larger international or donor agency mandates or specific research interests. An example of this is the growing climate-change or energy efficiency-related programming, for which millions of US dollars have been allocated. The NPAS project is one of the larger and more significant projects directly geared to improving delivery of environmental protection capacity. During the review period there are also a number of projects that highlight the growing importance of information services and data-driven decision support tools. Institutions such as Jamaica's three universities (UWI, UTECH and NCU) and the SRC focused on critical areas such as fragile habitats, endangered endemic species and anthropogenic drivers (such as waste management and agriculture).

Another key direction that was noted in projects undertaken in the review period was a focus on alternative livelihoods. In particular, the Biodiversity Restoration in the Portland Bight Protected Area, through the Community Engagement Project, focused on protecting VECs by dealing with poverty in communities and focusing on livelihoods in the Portland Ridge area. A number of other projects focused on providing basic community needs and alternative livelihoods (e.g. two projects on Water Harvesting and Enhancing Sustainable Livelihoods Projects, PIOJ, 2018). Groundwork was also laid for the launch of the 2018 National Policy on Poverty, which also focuses on livelihoods.

Numerous legal mechanisms were completed or commenced during the review period. National policies addressing critical environmental management gaps such as climate change, offshore cays, minerals development, squatter settlements, poverty reduction and hazardous waste were introduced during the review period. Several national plans and strategies with environmental implications were introduced or revised. These covered topics including protected areas, water resources, spatial planning (including development orders and local sustainable development plans), biodiversity and species conservation, renewables and emergency management. Benchmark pieces of legislation included the new Fisheries Act and the Disaster Risk Management Act (2015). Major milestones in the international arena included accession to the Paris Agreement (climate change), the Minamata Convention (Mercury), the LBS Protocol and adoption of the Sendai Framework for Disaster Risk Reduction.

In terms of the administrative/operational controls of environmental management, NEPA issued, on average, 1,610 legal controls (including permits, licences, and approvals). Enforcement actions taken rose by 41% over the review period, and mostly took the form of warning notices/letters. Aside from NEPA PLS, the Forestry Department introduced its own PLS. NEPA expanded its AAQMP to include urban areas outside of the KSA.

On paper, Jamaica has exceeded spatial requirements of the Aichi targets of 17% terrestrial area and 10% marine areas with an 18% and 15% respectively being under some form of protection (estimated in 2012). However, it should be borne in mind that the target is for the areas to be "*effectively and equitably managed,* "and there is insufficient data to determine what proportion of the area that is under protected area designation falls into this classification. Fourteen new protected areas were designated, including three JNHT heritage sites, five new SFCAs, five globally recognized AZE sites as well as the BJCM UNESCO World Heritage Site.

18. Conclusions

18.1 Drivers & Pressures

18.1.1 Positive Trends

With regard to the intensity of **Drivers and Pressures**, Jamaica has made some modest improvements. These include:

- A trend towards a lower carbon future, with decreasing CO_2 emissions per capita, some inroads into energy efficiency and the addition of renewables in the energy mix. It has been noted that crude oil imports declined by 14% during the review period. It has also been reported that between 87% to 93.3% of the population rely primarily on clean fuels for household use, with a relatively small proportion using kerosene, charcoal and wood for cooking. This however is offset by the fact that disposal of household garbage and yard waste by burning is still widespread.
- During the review period, the economic impact of disasters was ~J$5 billion compared to the J$30 billion in the prior reporting period, with eastern parishes appearing to be more at risk , for example from earthquakes, landslides, floods; this may be a function of the non-limestone geology and higher rainfall in this area. While the economic and social costs of disasters are largely controlled by the magnitude and timing of sequential events, experience/expertise and risk reduction efforts may have also have played a role in offsetting costs. The 2013 SOE noted that the difference in the economic costs of hurricanes in that review period was due "*in part to improved preparedness prior to the arrival of the hurricane."* It is also likely that efforts at risk reduction have been successful. These efforts follow on from the 2005 National Hazard Risk Reduction Policy for Jamaica,[235] which set out to provide the necessary management frameworks, build capacity, improve coordination, empower communities and mainstream risk management into environmental management. These policies were implemented in the decade leading up to this review period.
- The decline of Jamaica's 500-year old sugar industry has continued in the review period. This trend is not unique to Jamaica, as other islands like St. Kitts (in 2005) and Trinidad and Tobago (in 2007) have closed the era of sugarcane. With the industry struggling to be profitable, it has been characterized by low levels of investment in environmental management and regulatory compliance.[236] It is expected that a range adverse environmental challenges will decline in intensity as sugar production falls, including: the occupation of prime lands (with attendant loss of forest, loss of fertility and erosion of top-soils); effect on air quality, related to cane-field burning and bagasse furnaces; pesticide and fertilizer use; cane wash water and compromising of receiving water bodies from the use of dunder for irrigation. However, reduction of environmental impact is offset by the potential loss of ~30,000 sugar industry farm and factory jobs.[237]

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[235] http://odpem.org.jm/Portals/0/Mitigation_Preparedness/Hazard%20Mitigation%20Planning/National%20Hazard%20Risk%20Reduction%20Policy%20for%20Jamaica.pdf Retrieved December 27 2018

[236] https://www.pressreader.com/jamaica/jamaica-gleaner/20170129/281513635875632 Retrieved December 26 2018

[237] https://www.jamaicaobserver.com/latestnews/Govt_stands_by_sugar_industry,_indicates_restructuring_to_take_place?profile=1228 Retrieved December 27 2018

18.1.2 Negative Trends

- In Jamaica, informal settlements generate significant environmental pressures as a result of being very dense, located largely within urban areas, and with poor access to municipal services and amenities. More than half of Jamaica's population now live in urban places, with ~61% of this subset living in slums. Data also suggest that the percentage of the population living under adequate housing conditions is declining (Chapter7.3). Waste collection in these informal settlements is generally lower than for more formal planned settlements, where it is estimated (for 2016) that less than two thirds of the total waste produced was being collected, even considering that between 2014 and 2017, total amount of waste collected increased by 30%. This likely results in increased levels of domestic waste burning and improper disposal in gullies and open spaces and inadequate landfill capacity which, in turn, have a deleterious effect on air quality and environmental health.
- Only three quarters of the total population was estimated to have access to flush toilets in 2015, and there are no data on the actual amount of sewage that is adequately treated. This trend, coupled with increasing levels of agricultural fertilizer use (including for both small farming and banana plantations) and poor performance of other wastewater and trade effluent systems, accounts for the declining trends in quality of surface freshwater, groundwater and coastal waters. Nutrient loads and BOD are observed to be elevated in monitored sites.
- Increasing intensity of yam production, loss of primary forest and extraction of bauxite ore and limestone/marl are also likely to result in increased soil erosion and turbidity in receiving water bodies. More than a third of the watershed area of Jamaica is classified as degraded or severely degraded. The spatial distribution watershed degradation roughly correlates with parishes that have been increasingly affected by flooding and landslides. Change in land use from loss of forest cover also affects groundwater recharge and water availability.
- During the review period there was a general trend towards higher temperatures and lower rainfall. Although four years is insufficient to attribute these trends to climate change, they are consistent with the global climate models predictions for the region. Drought, whether attributable to climate change or not, continued to impact southern and eastern parishes. These trends compounded the increases in water production, which was facilitated by a major increase in the issuance of water abstraction licences (Chapter4.3.3), and the fact that water stress levels have increased significantly since 2013 (Chapter4.3.1).
- There is a trend towards the concentration of tourism in the parishes of St. Ann, Trelawny, St. James, Hanover and Westmoreland (Chapter0). This puts a high degree of environmental pressure on freshwater resources (Chapter 12.3.2), coastal ecosystems (Figure 48), waste disposal capacity (Chapter 12.3.1), food supply and fuel and energy consumption in these parishes.
- Despite strides towards a low carbon future, Jamaica is presently very fossil fuel intensive, with more than 98% of the total primary energy supply (TPES) and 88% of electricity coming from fossil fuel sources (Chapter 8.3.2). Although Jamaica's energy intensity may be relatively lower than the global average, energy efficiency is reportedly low (Chapter 8.3.1) with losses in electricity production annually being 27%, compared to 12% contributed by renewables.
- Land transportation (road and rail) currently accounts for the largest category of fossil fuel consumption. Although there was a net decline in petroleum consumption (2%) in this category for the review period, there was a 40% increase in registered vehicles for the same period. It is likely that newer and more fuel-efficient vehicles account for this disparity.

18.2 State and Impacts

18.2.1 High Priority Issues

- **Water Resources Management**: For much of the review period, Jamaica experienced droughts and shortages in water supply. Climate change predictions indicate that Jamaica can expect high temperatures and more variable rainfall, which may impact water availability for domestic use, food production, as well as mining and quarrying, manufacturing, tourism and the service sectors. VECs such as aquatic ecosystems, forest ecosystems and air quality will also be affected under these conditions, with a heightened risk of wild-fires and increased particulates in the atmosphere. With rising sea levels, falling groundwater tables and increased abstraction, there is an increased risk of salinization of coastal aquifers. It is estimated that a third of all watersheds are degraded or severely degraded. Marine and coastal ecosystems lie downstream of watersheds, and the effects of watershed degradation amplify LBS impacts on these systems. The island's watersheds are unlikely to be resilient to drought, climate change and extreme natural events if the integrity of their basic functions is compromised by human actions such as deforestation, unsustainable farming and waste disposal practices among other causative factors. This will translate to more water restrictions and lock-offs in the coming years unless aggressive action is taken. Although there have been some projects focused on ridge to reefs approaches and integrated watershed management, in general, there has been a lack of routine data collection to properly assess the changes in watershed status over the review period. This is compounded by lack of inter-agency coordination and siloed approaches to resource management.
- Air quality is generally poor in the industrial and inner-city areas of Kingston. Particulate concentrations are high near Rockfort (East Kingston) and along the industrial area of Spanish Town Road. Performance, in terms of number of stations compliant with WHO standards for SO_2 and NO_2decreased, which is indicative of poor controls on industrial emissions at the monitored locations. There is likely to be a general decline in air quality in the KSA, where approximately a quarter of the total Jamaican population lives. This is exacerbated by occasional fires at the Riverton City Dump, trash burning and Sahara dust fall events. Climate change and drought conditions will likely also tend to increase overall dustiness in the atmosphere. What emerges from an examination of the period under review is a realization that there is a general lack of comprehensive and representative data coverage to draw firm conclusions. In some cases, estimates based on trends and general observations have been made.
- **Life on Land**: The annual rate of loss of primary forest (1998-2013) was estimated at 12.27 km^2. Based on the assumption that this rate did not change, the estimated loss of primary forest in the review period was likely to be of the order of ~49 km^2. Disturbance of primary forest (mainly due to anthropogenic factors) is closely linked to degradation of watersheds and habitats of endemic species, some of which are critically endangered. Short dry limestone_forests, found mainly in the Portland Bight Protected Area are declining at a rapid rate (6 km^2 per year), which means that, if current trends persist, this ecosystem would be obliterated from Jamaica in 62 years. This would have a deleterious effect on the biodiversity of Jamaica and could result in the extinction of critically endangered endemic species like the tree frog (*Eleutherodactylus cavernicola)*.

- Another rapidly disappearing ecosystem is the swamp forest, with remaining areas in the Black River Lower Morass, Negril Great Morass and Mason River Protected Area being severely threatened by invasive alien species. Without focused and aggressive action to protect this ecosystem, any pristine elements may be completely eradicated from Jamaica before the next SOE is produced. These swamp forests are important waterfowl and bird habitats, containing important medicinal plants and endemic plant species.
- **Life under Water**: The most critical area that has been flagged for this review period is the health of nearshore coral reefs. Continuing the negative trend noted in the previous review period, coral reef health indices for monitored reefs continue to decline in the current review period. Since 2013 there has been no improvement in the averaged indicators of coral reef health for the monitored reefs. Detailed examination of the individual sites suggests that managed sites such as Boscobel, Oracabessa and those within the marine parks are doing better than unmanaged sites, where higher levels of pollution stress have been observed; . Falmouth, Discovery Bay and Palisadoes are classic examples. Land-based sources (LBS) of pollution are likely to impact these sensitive oligotrophic ecosystems more, if the buffering effect of seagrass and mangrove ecosystems is degraded. Aside from LBS pollution, these reefs are under additional stress from artisanal fishing, tourism activities, diseases, invasive alien species, storms and climate change evident in warming, bleaching and acidification. Beach stability and the sustainability of artisanal fisheries are closely dependent on the health of these coral reefs.
- There are major environmental monitoring gaps in respect of critical coastal and marine resources. These include fisheries stocks, turtle nesting sites, beach erosion and ecosystems associated with many offshore banks and cays that provide a range of ecosystem services including fisheries, tourism, shoreline protection. Lack of monitoring and data collection is largely attributable to inadequate resources. It has been noted that valuable studies are opportunistically undertaken as funding becomes available. For this reason, it is critical for the country to have its environmental priorities in order.

18.3 Responses

During the review period, Jamaica finalized a range of critical national policies and other administrative mechanisms to improve environmental conservation, development control and pollution management. These are considered positives for environmental performance, but they do not automatically result in improvements in the environmental status of VECs or trends in ecosystem services availability, particularly if these policies and mechanisms are not implemented or properly resourced. Many of the VECs are in a critical state at this time, which would suggest that management responses have not been effective.

Although there continues to be room for improved inter-agency coordination and cooperation, during the review period there was a move towards more partnerships between NEPA and research institutions like UTECH and NCU, as well as government research agencies, including the Institute of Jamaica and the Scientific Research Council. A memorandum of understanding with UWI has been in place since 2012.

Planning for protected areas saw some important strides being made. While simply designating a protected area does not automatically result in preservation or restoration of a compromised area, it is a positive step in the right direction. Having designation as a legally protected area not only allows for mainstreaming of environmental protection into other national master planning processes, but it also gives a legal basis for controlling development in these areas and allows for prioritization of research and funding. There is a prevailing thought that designation of the entire island of Jamaica as protected watershed has precluded focus on critically degraded watersheds, and the attention that protected status allows.

During the review period, major accomplishments in this regard included the Great Goat Island co-management agreement, designation of the Blue and John Crow Mountains World Heritage Site, Cockpit Country Proposed Protected Area and five new SFCAs. Another noteworthy achievement was the recognition of several sites by the IUCN as Alliance for Zero Extinction Programme. This achievement was tempered by the fact that there were no new Forest Reserves (FRs), Environmental Protection Areas (EPA), Marine Parks (MPs) or Ramsar sites named during the review period.

18.4 DPSIR Models

The following diagrams (Figure 81,Figure 82, Figure 83, andFigure 84) are very simplified DPSIR models, which build on the work that was done at Working Group Session one for this SOE. The definitions for each of the parameters of the model (drivers, pressures, state and impacts and responses are the same as those given in Chapter 1). The pathways of effects between Drivers, Pressures and VEC States (indicators) are shown (red arrows), and the pathways between the Responses and optimal condition of the VEC and resulting positive conditions of ecosystem services (Impacts) are shown (green arrows). These models serve the purpose of illustrating that there are multiple mechanisms that force environmental change and that change in intensity of these or interventions can change the state of the VEC (indicators) and the availability of ecosystem services. The key to the diagrams is given below (Figure 80).

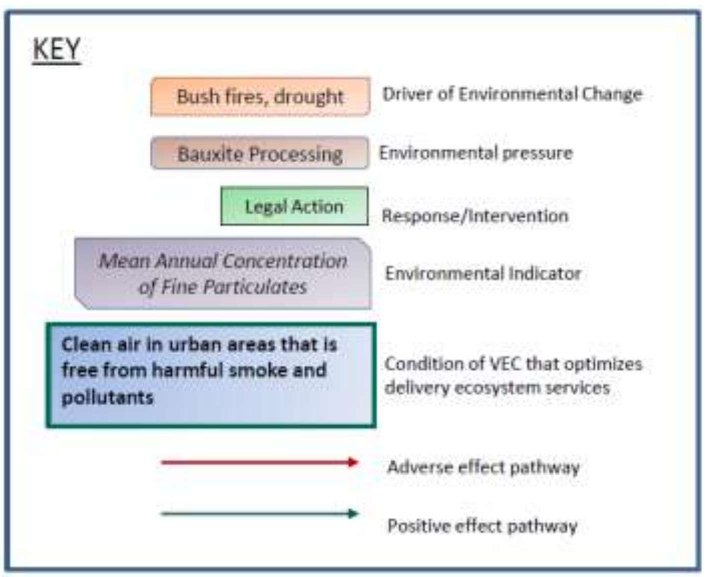

Figure 80 Key to Figure 81, Figure 82, Figure 83, and Figure 84

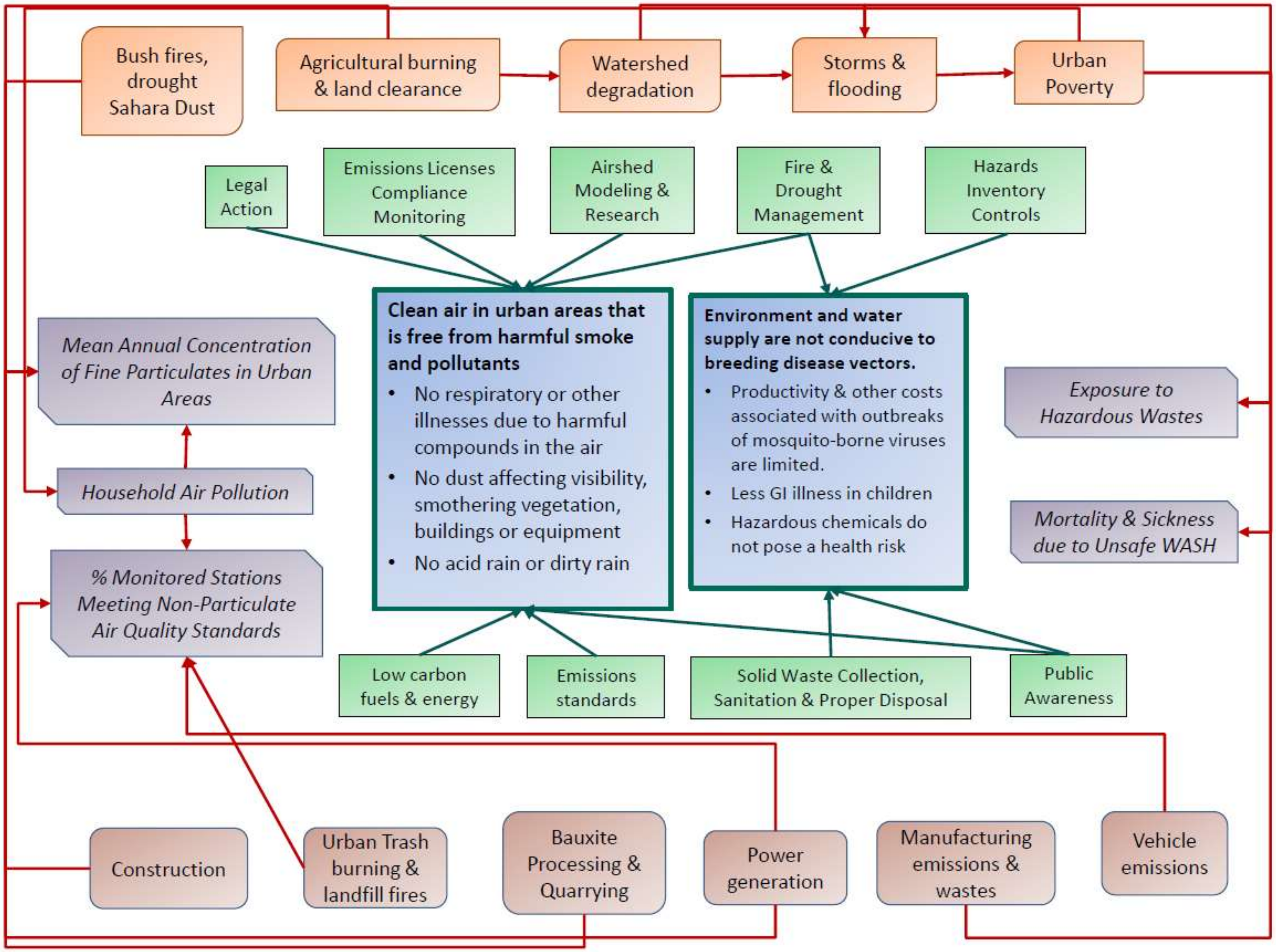

Figure 81Air Quality & Environmental Health DPSIR Diagram

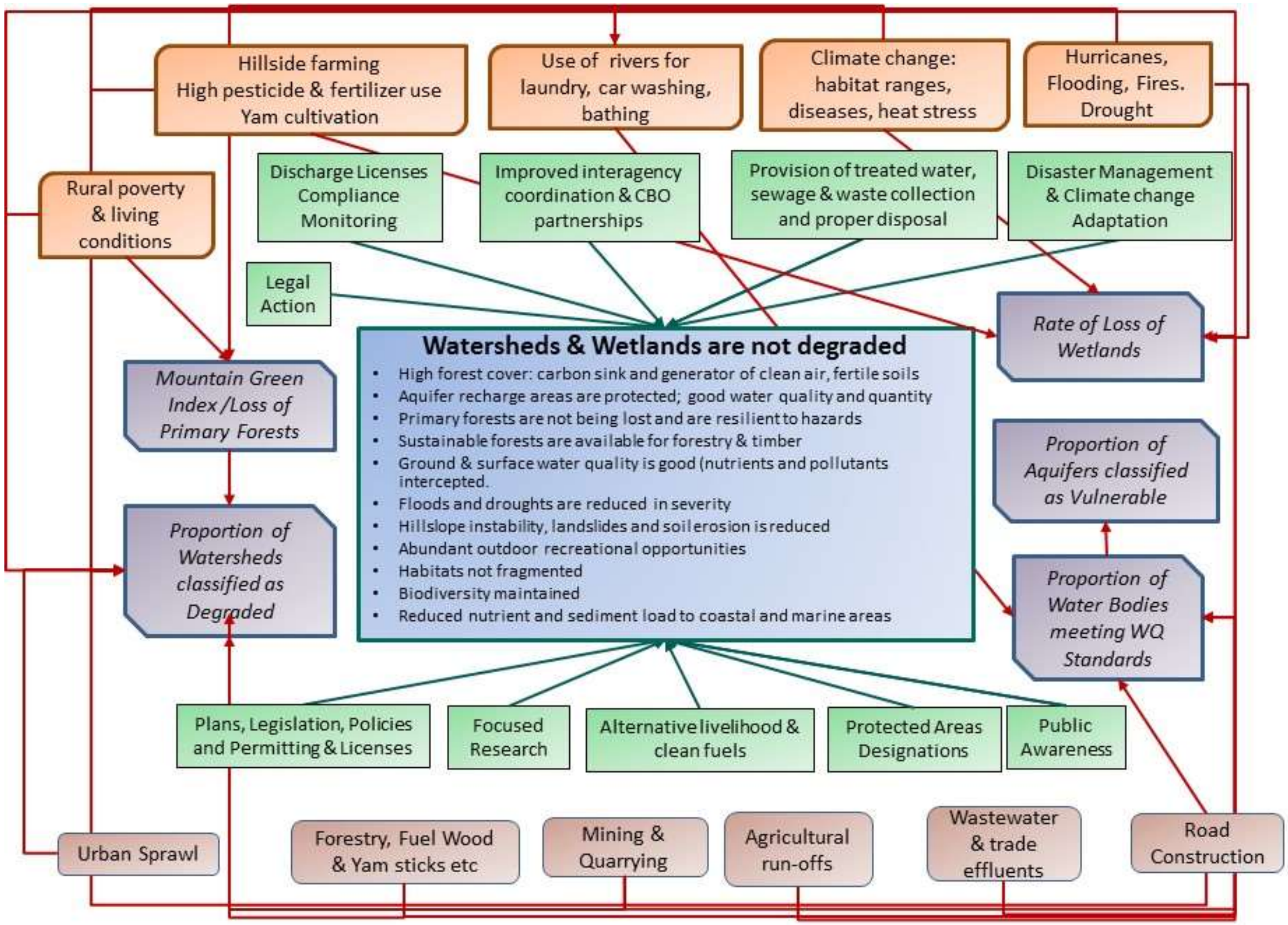

Figure 82Land & Freshwater Resources DPSIR Diagram

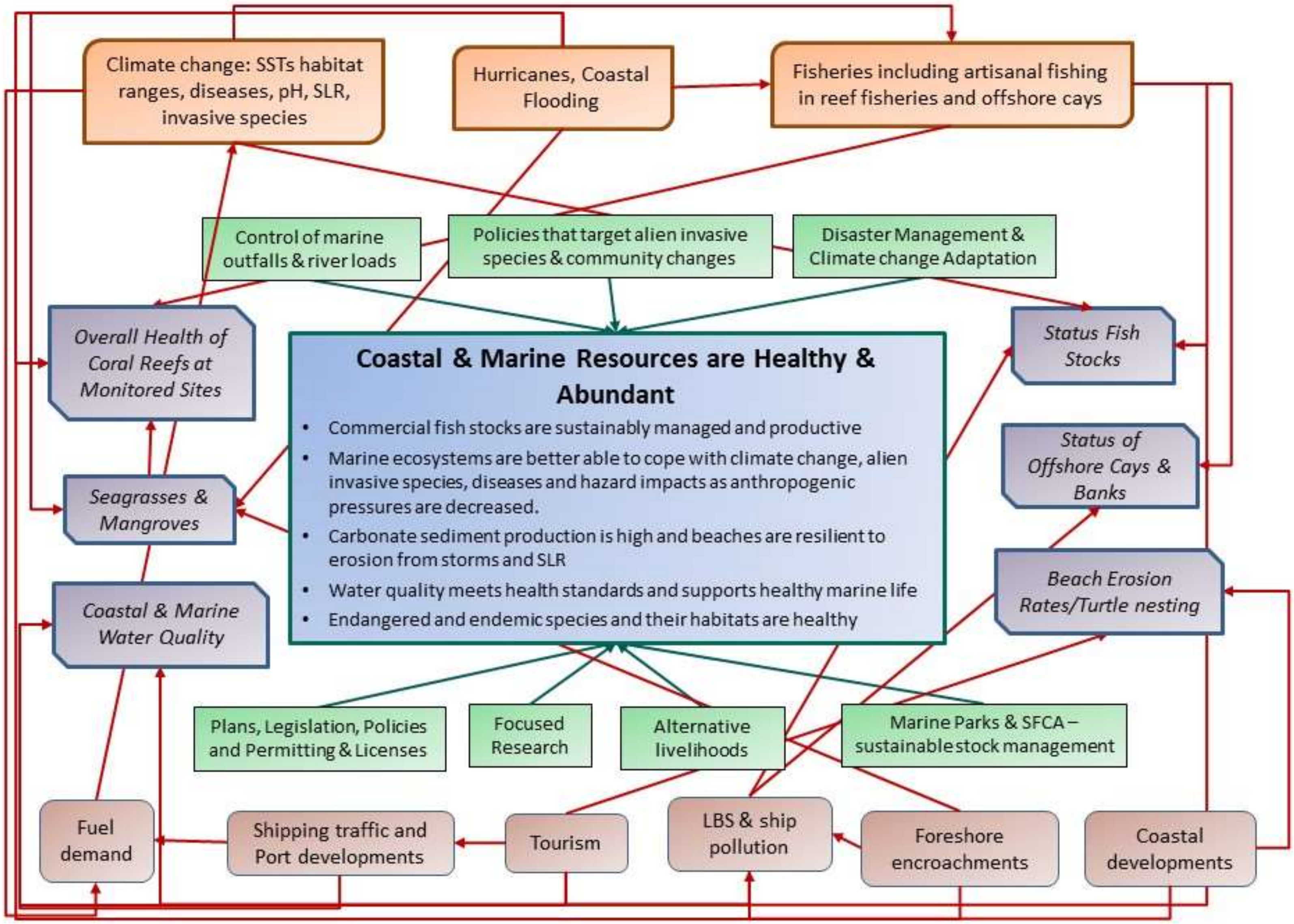

Figure 83Seas & Coastal Resources DPSIR Diagram

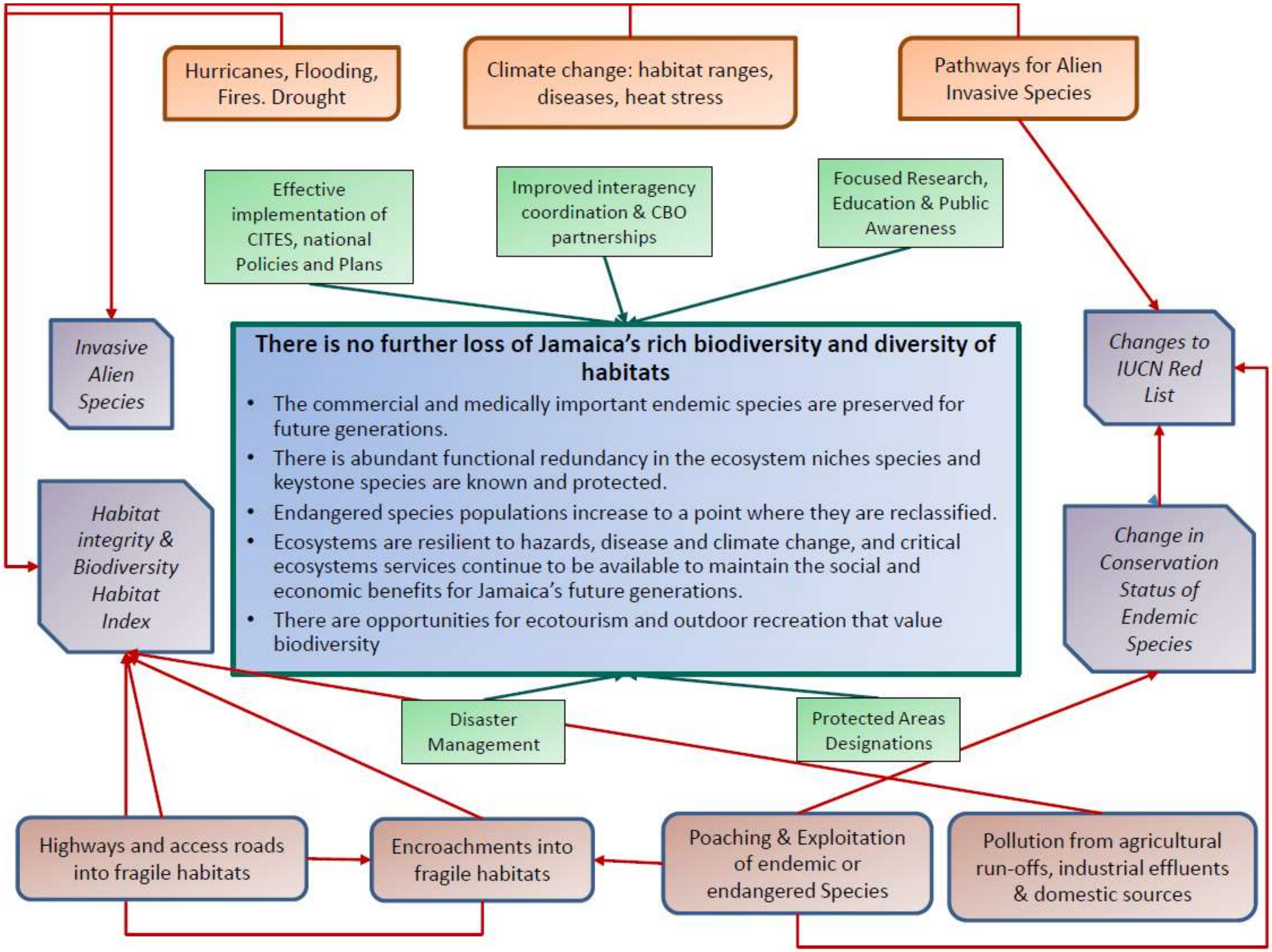

Figure 84Biodiversity DPSIR Diagram

19. LOOKING FORWARD

19.1 Overview

This report has presented a comprehensive evaluation of the state of Jamaica's environment, based on limited available data. This is the first time Jamaica's SOE reporting has applied a Driver-Pressure-State-Impact (DPSIR) framework to structure the SOE report and analysis. This approach is human-centred, resulting in the scope of coverage reaching beyond the state and condition of VECs. The report provides abundant information to facilitate an understanding of root causes of environmental degradation and opportunities for improvements, at the same time exploring room for trade-offs among economic, social and environmental outcomes. The report presents a *snapshot* of conditions over the review period, based on the best available information.

Based on relevance to Jamaican context, alignment with Jamaica's Vision 2030 and the United Nations Sustainable Development Goals, and comparability with previous SOEs, 64 key performance indicators (KPIs) were selected to characterize the state of Jamaica's environment. In some cases, there was insufficient data coverage or quality; in particular, this was the case with several of the indicators of the State of VECs and Impact on ecosystem services. Wherever possible, additional indicators (used in earlier SOEs) and data sets were discussed in the main body of the text to provide context and allow for qualitative understanding of the parameters.

In the absence of sustained monitoring and reporting, using consistent indicator sets, the ability to detect trends and identify casual links using one SOE report alone is limited. Nevertheless, it has been possible to spot gaps and emerging issues that warrant Jamaicans' attention going forward. Analysis of the information contained in this report has created an opportunity to improve on the baseline established, using the DPSIR approach which will eventually improve reporting and monitoring.

19.2 Scenarios for 2030

Scenario planning is increasingly popular as a tool to analyze complex problems and enable transformative change (McBride et al 2017). Scenarios are consistent with coherent storylines that describe possible futures. Development of the SOE report included a Working Group Session with approximately 61 stakeholders and 29 agencies in attendance . During that session stakeholders worked in groups to create alternative stories of the future to explore developments needed to reach Jamaica's 2030 vision for a healthy natural environment. These stories and existing scenarios for the region are the basis for the three qualitative scenarios presented (Marczak and Engelke 2016; UNEP 2016b).

19.2.1 Key Uncertainties

The three scenarios build on stakeholder feedback and on the trends in drivers, pressures, states, impacts and responses from preceding chapters and summarized in Chapter 18. Scenario analysis involved identifying key uncertainties shaping Jamaica's environmental outlook for 2030. The key uncertainties used here are listed below. These key uncertainties build strongly on stakeholder feedback and on generic domains of uncertainty (UNEP 2016b).

Society

- Power distribution among governments, the private sector and civil society
- Nature and level of public participation in management
- Relationship between individuals and community
- Respect for the rule of law
- Population changes
- Nature and rate of urbanization

Science and technology

- Investment levels in research, monitoring
- Degree of uptake of new technologies for environmental gain

Economy and markets

- Level and sectoral distribution of government investment
- Degree of integration across economic, social and environmental policies
- Structure of the economy
- Degree of government intervention

Climate change and disaster risk

- Degree of exposure and vulnerability to impact
- Strategy and partnerships

19.2.2 Scenarios

Based on the outcomes and vision statements pertaining to "A Healthy Natural Environment" in Jamaica's Vision 2030, the scenarios for Jamaica below integrate alternative assumptions about the evolution of key uncertainties and related implications on valued environmental components (VECs), using selected indicators (see Table 64). The scenarios provide brief narrative accounts of potential development pathways that shape Jamaica's environmental future. They are intended to expand thinking and function as a point of departure in identifying robust measures to improve the health of Jamaica's natural environment across scenarios. The operative thinking is: "*hope for the best, prepare for the worst.*"

Business-as-Usual

From the vantage point of 2030, looking back, Jamaica's environmental performance has been mixed over the past 12 years. Driven by continued global demand for commodities and "all inclusive" sun-sand-and sea tourism, the country is now in a better place economically. However, investments in environmental management have not kept pace with the rise in GDP. Stop and start efforts to implement Jamaica's Vision 2030 priorities for a healthy natural environment have led to some incremental gains. Strategic partnerships between Government agencies and research institutes have improved environmental monitoring. Implementation of the national environmental management system is well underway and this has made implementation of the national environmental management system easier. Jamaica has also been able to take advantage of increasing availability of global finance for climate loss and damage. Successes such as these have yet to "trickle down" to local levels and citizens are neither involved in environmental decision making nor feel empowered to be environmental stewards.

Environmental trends explored in the 2017 SOE report have continued, for the most part. Despite gains in compliance with air quality standards by industrial operators, air quality in cities remains poor. Higher ambient temperatures combined with ozone precursor emissions and particulates continue to make Jamaicans sick. Improving waste management finally becomes the number one political priority in Jamaica in 2027. By then contamination in major water bodies and incidence of water- and airborne illnesses among the poorest segments of the population were extremely high, for a country with high-middle income status. Jamaican hillsides remained verdant, although primary forests continue to shrink with every passing year as does the abundance and diversity of non-charismatic fauna.

More resources are now being devoted to coastal climate change adaptation, at least compared with 2017. Although the region has not suffered extended drought, compared to other parts of the world, Jamaica and other islands have had to deal with more frequent flooding, more heat waves, more storms and rising sea levels. Beaches have been reduced to thin stretches of sand, but are still desirable to international travellers.

With an overall positive fiscal situation, reasonable tax burden, corruption at bay (or at least not getting worse) and delivery of government services at a reasonable cost, Jamaica's middle class has not pushed for the deeper environmental reforms needed to restore and protect the island's natural heritage for the benefit of all.

The Wild West

Looking back from 2030, the main drivers for the relapse in Jamaica's environmental performance were the unwillingness to be inclusive, the corrosive effect that corruption and crime have had on governance, and the inability of Governments to harness the power of modern technologies. Despite the promise of "leaving no one behind", mechanisms for social inclusion and citizen participation in all aspects of governance remained limited; as a result, power continues to rest in the hands of political and economic elites. Jamaicans' calls for greater government effectiveness and transparency went unrealized, creating social discontent. Urbanization expanded uncontrollably, with urban growth taking place not in the central areas but expanding into the suburbs. Squatter settlements and precarious housing have proliferated. These social pressures came at a time when Jamaica was recovering from a stagnant economy. Wealthier, highly-educated Jamaicans are emigrating in droves.

Government's capacity for environmental monitoring and to implement and enforce environmental and planning rules has worsened. This, at a time when illegal harvesting of forest and marine resources, wildlife poaching, illegal water abstraction and illicit manufacturing activities are at a high. Because national and site-level monitoring has been severely gutted. SOE reporting occurs with even less frequency than it did in the 1990s. Ignorance is bliss, some say. Citizens, especially those suffering the consequences of industrial pollution or poorly-performing utilities, have turned to popular media shows to denounce environmental impact and the resultant hardships.

Cuts in research and monitoring spending in the 2020s freed up some resources to attend to urgent waste management needs but these resources were instead used for patronage. With a greater concentration of people in hazard-prone areas and rapid climate change, social and economic vulnerability has increased. Government agencies have very limited response capacity; even the capacity to benefit from global flows of climate finance is constrained.

The Dark Side of Globalization

By 2030, the global economy and its centrifugal forces have pulled Jamaica in directions not foreseeable in 2017, when political leaders were contemplating the island's preparedness for the Fourth Industrial Revolution. Driven by interests in opposing economic poles, Caribbean states failed to reach consensus on a unified regional trade strategy in the early 2020s. Jamaica, like other states, became increasingly dependent on extra-regional trade and investment and even more vulnerable to global shocks. The country focused on strengthening the economy through emphasis on maritime trade and cruise tourism. The island continued to rely on commodities (crops, bauxite and other low value-added goods) and sun, sea and sand tourism, areas of traditional comparative advantage.

With job opportunities concentrated in coastal areas, Jamaica's hilly and forested hinterland saw rapid outmigration. Reduced pressure on certain watersheds shifted their designation from severely degraded to moderately degraded. However, conversion of forests for cropping and livestock continued causing significant forest losses, imperilling species already driven to the end of their climate niche. Air quality remains a problem in both cities and rural areas, but for different reasons. In cities, traffic has worsened, due to inefficient road infrastructure and dysfunctional public transit. Trash and charcoal burning continue to be sources of air pollution in the few rural settlements left.

International tourists are spared nuisances like poor air quality and sitting in traffic; fleets of self-driving shuttles and passenger-carrying drones service resort clusters. A notable hotel operator funded a series of economic valuations of coastal and marine ecosystems and tourists now pay for these ecosystem services explicitly; revenues raised support coastal zone and fisheries management.

Aside from economic losses, poor regional coordination has also worsened human health prospects. Nations are slower to respond to pandemics and disasters caused by natural hazards than they were when collaborative mechanisms were in place. By 2030, disease outbreaks and extreme events have resulted in both increased loss of life and reduced faith in government institutions.

19.3 Emerging Issues (2014-2017)

19.3.1 Weaknesses & Gaps

Implementation Deficit

The Government of Jamaica (GoJ) is taking visible steps to strengthen national institutional frameworks and enable action toward a healthy natural environment. Numerous legal and policy instruments were completed or came into force during the review period. This included upward of 15 national policies addressing critical issues such as climate change, minerals development, offshore cays, hazardous waste and squatter settlements. At least 20 major plans and management strategies, addressing issues such as protected areas, water resources, conservation and spatial planning, were improved or created. Important laws also came into effect, including the Disaster Risk Management Act (2015).

Table 64 Scenarios of development pathways and environmental outcomes in Jamaica in 2030

Attributes, assumptions and outputs	Scenario #1: Business-as-Usual	Scenario #2: The Wild West	Scenario #3: The Dark Side of Globalization
Stories in 2030			
Overall description	Continues social, economic and environmental trends found in the 2017 State of Environment Report.	Erosion of democratic order. Crime and corruption combine, governments can't adapt and social exclusion and unrest prevail.	Reliance on extra-regional trade and lack of investment in infrastructure, resilience and education leaves Jamaicans highly exposed to global shocks and downturns.
Society	Incremental gains in public participation in environmental governance Weak stewardship ethic Low but stable rate of population growth Steady urbanization (0.8% per year) in suburbs	The media are the only recourse. Power is in the hands of political and economic elites Weak stewardship ethic Dramatic increase in emigration ("brain drain") and migration through deportation More rapid rural outmigration to city centres and suburbs, more illegal squatting	Trade and economic interests overwhelm public concerns over the environment Consumer-focused Low but stable rate of population growth with temporary displacements More rapid rural outmigration to city centres and suburbs
Economy and markets	Higher growth in gross domestic product (GDP) but limited budgets for environmental management Continued reliance on commodities and "sun, sea and sand" tourism Environmental enforcement evolves with implementation of environmental management system	Lower growth in gross domestic product (GDP) Growth in unregulated, illicit manufacturing and services Poaching and illegal harvesting and water abstraction Privatization of basic services	Higher growth in gross domestic product (GDP), investment in environmental management to comply with international trade requirements Continued reliance on commodities and "sun, sea and sand" tourism, areas of traditional comparative advantage Decline in maintenance of land based infrastructure focus on infrastructure for extra-regional trade Mismatch in skills and market needs
Science and technology	Partnerships support gains in monitoring and R&D Renewables and low carbon energy grow in line with market evolution	Unclear picture of the status of the environment due to funding cuts to monitoring and data initiatives Benefits of new technology adoption unevenly spread	Missed opportunities to pool regional resources to advance knowledge for public health, land, water and ocean health
Climate change and disaster risk	DRM and climate change continued as silos and donor funded	Increased vulnerability to climate change and disaster risk, with no capacity to benefit from global flows of climate finance	Low capacity to respond to climate change and disaster risks erodes confidence in government. Marked rise in climate-related disease outbreaks.
Environmental outcomes in 2030			
Environmental health and air quality	↑of fine particulates in urban and some rural areas ↑emission of SOx and NOx 10% of the population still lack access to sanitation	National and site-level monitoring severely curtailed. Environmental outcomes in 2030 rely on anecdotal evidence from affected Jamaican and from global datasets, including: ↓↓air quality in Jamaica's major cities ↓mountain green cover ↑watershed degradation, some recovery in areas left fallow, largely devoid of human activity ↓↓coral reef health ↓in quality of freshwater and coastal water bodies ↓ abundance and diversity of fish species ↓ in populations of endemic species	↑↑of fine particulates in urban and some rural areas ↑↑emission of SOx and NOx ↑public health emergencies (air quality, vector and water-borne diseases)
Watersheds and land resources	↓primary forests ↔Mountain green cover 50% of watersheds degraded or severely degraded ↓wetlands and swamp forests ↑phosphate and biological oxygen demand in water bodies		↓↓primary forests ↓mountain green cover ↓↓wetlands and swamp forests ↑watershed degradation in some areas, improvements in others
Seas and coasts	↓coral reef health ↓commercially-harvested fish species ↑phosphate and nitrates in coastal water bodies		↔ coral reef health ↔ commercially-harvested fish species, more aquaculture
Biodiversity	↑in red-listed reptiles ↑in invasive alien species ↓ in quality and integrity of forest habitats		↑in red-listed reptiles ↑in invasive alien species ↓↓ in quality and integrity of forest habitats

Jamaica continued to support multilateral action on the environment, including acceding to the Paris Agreement on climate change and the Minimata Convention on mercury. However, *"the mere production of plans, studies, and processes as outputs does not automatically translate into results*" (p 8 Terminal Evaluation of the NPAS Project). Thus, the challenge in achieving environmental gains lies in implementation and enforcement. This conclusion is evident from the GoJ's own analysis (GoJ 2017b) and in discussions with stakeholders during the development of the SOE report. One indicator illustrating the nature of the implementation deficits relates to financing. Environmental protection overall is poorly resourced through Jamaica's national budget.

The 2017/2018 budget for environmental protection amounted to under three percent of the total budget; less than half of this three percent goes to core aspects of environmental protection (water management, land management, waste management and forestry; see Chapter 17). Lack of budgetary allocation to environmental management, to some extent, is an indicator of political will. However, other factors affect resource allocation and decision-making, including the availability of information, knowing what remedial steps to take, and being able to prioritize the needs, given scarce resources. Lack of implementation and enforcement reflects the reality that some agencies do not have the required resources to carry out their mandates. For example, Jamaica has experienced persistent challenges to source funding to make the National Protected Areas System operational or to improve waste collection and disposal capacity (see Chapter 17). Donor funding streams can only go so far in addressing environmental protection and conservation concerns on a sustained basis.

Identifying and implementing catalytic projects is gaining currency in tackling persistent, complex problems. *"A catalytic project is an intervention that has a strong leverage and/or multiplier effect by addressing a critical market failure, or by creating a strong leverage factor. A catalytic project addresses the root cause of obstacles to development, rather than symptoms. It unlocks resources and business opportunities."*[238] Such a project often creates or strengthens public good, such as healthy ecosystems and the services flowing from them that benefit humanity. Candidate areas for catalytic interventions include the following (GoJ 2017b).

- **Land use management**, including the identification and mapping of environmentally-sensitive areas, economic valuation of natural assets and connecting these sources of information to land use, permitting development decisions.
- **A functioning national system of protected areas** that helps diversify Jamaica's tourism product and promotes ecotourism and community-based tourism.
- **Public awareness** campaigns to enhance the connection between Jamaican people and the environment. Concepts of civic mindedness, environmental stewardship and pride in natural heritage come into play.
- **Waste management**, involving improvements in efficiency and effectiveness of collection and processing but also capitalizing on waste as a resource. Since imports of plastic almost tripled between 2014 and 2017 (see Chapter 3) and global concern about the blight of single-use plastic is high, this is an area that the GoJ is already pursuing.

Urban Development

Jamaica's main urban centres face enormous challenges in providing basic infrastructure and services to their growing populations, putting severe pressure on the environment. Just over half of Jamaicans live in urban areas and this proportion could reach close to 60% by 2025 (see Chapter 2) as the trend of rural

[238] http://www.ledknowledge.org/UserFiles/UserAdmin/File/Document-Blog/Genesis%20Brochure%20lr.pdfRetrieved December 27 2018

outmigration continues. Almost three in five city dwellers either live in squatter settlements or in precarious housing, with poor access to basic services such as waste collection, waste disposal and improved sanitation services (see Chapter 7). Air quality in urban centres regularly fails to meet international health standards, with vehicular and industrial emissions, road and other construction and trash burning significantly contributing to air pollution (see Chapter 13). A chronically poor baseline air quality is periodically exacerbated by droughts, landfill and bush fires, and Sahara dust, which can tip the scales for widespread human health issues and smog development.

Further, populations and economic activities are often concentrated in coastal areas, leading to depletion or degradation of natural areas and coastal pollution by virtue of weak or partial waste management and poor drainage systems (Chapter 12), among other pressures. Unplanned urban sprawl and high population density also increase the vulnerability of people to climate-related disaster risks.

At a global level, countries are faced with the multiple challenges of rapid growth, social inequalities, budget constraints, environmental degradation, climate change and disaster risk, and urban centres around the world are looking to development models that promote multiple benefits. Transit-oriented development, urban forestry and agriculture, soft shoreline development and sustainable urban drainage systems are all examples of attributes of future cities. Indeed, new models of city planning and management are emerging. For example, the Inter-American Development Bank runs a technical assistance programme to support national and city governments in developing and implementing urban action plans that rest on three pillars: environmental and climate change sustainability, urban sustainability ,fiscal sustainability and governance. Fifty cities throughout Latin America and the Caribbean have received this support to date, including Montego Bay.[239]

Connected to the SDGs is the New Urban Agenda (UN 2016), adopted at the UN Conference on Housing and Sustainable Urban Development (Habitat III, UNHSP 2016) which commits parties, including Jamaica,[240] to building city dwellers' resilience to disasters and impacts of climate change. Action areas include improved planning, stronger and higher quality infrastructure, city-level assessments of climate vulnerability and risk, "*building back better*" during disaster recovery and nature-based solutions for adaptation and disaster risk reduction.[241]

The Fourth Industrial Revolution

The Fourth Industrial Revolution is underway. Previous industrial revolutions liberated humankind from animal power, facilitated mass production and brought digital capabilities to the world. This Fourth Industrial Revolution is, radically different. It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, touching all disciplines, economies and industries, and even challenging ideas about what it means to be human.[242] Technological advances such as artificial intelligence, machine learning, networks of satellite-connected sensors, 3D printing, drone technology and distributed ledgers combine the physical, digital and biological domains in ways that could yield

[239]https://www.iadb.org/en/urban-development-and-housing/emerging-and-sustainable-cities-programRetrieved December 27 2018
https://issuu.com/ciudadesemergentesysostenibles/docs/montego_bay_action_planRetrieved December 28 2018

[240]http://habitat3.org/the-new-urban-agenda/preparatory-process/national-participation/jamaica/ Retrieved December 27 2018

[241] Such nature-based solutions "*enable people to adapt to the impacts of climate change and disasters by using opportunities created by sustainably managing, conserving and restoring ecosystems to provide ecosystem goods and services"* (Lo 2016). For example, adaptation efforts that integrate wetlands conservation and restoration – are therefore focused on nature rather than grey infrastructure or institutional approaches— have the potential to reduce flood damage and costs to provide clean drinking water. Other examples of nature-based solutions and related performance indicators appear in Kabisch et al. (2016).

[242] World Economic Forum https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab Retrieved September 5 2019

environmental benefits.[243] Jamaicans are starting to recognize the importance of preparing for this revolution.

In 2017, the Caribbean Maritime University (CMU) launched a new Centre for Digital Innovation and Advanced Manufacturing. Based at CMU's Palisadoes Park home in Kingston, the Centre is the first innovation hub of its kind in the English-speaking Caribbean. It houses a fleet of 3D printers for application in the manufacturing sector and delivers a research and development agenda that includes design and building of drone technology.[244]

Jamaica's Global Logistics Hub Initiative - a plan to establish Jamaica alongside Rotterdam, Singapore, and Dubai as a node for facilitating the movement of goods, persons, and data, around the world - contributes to making the island *"a competitive, resilient and sustainable nation in the era of the Fourth Industrial Revolution."*[245] Jamaica is boosting its ability to handle and store transhipped cargo to capitalize on commercial opportunities created by the expansion of the Panama Canal and the resulting increase in volume of transit shipping between the Atlantic and Pacific oceans (Brown 2019). These developments are resulting in a fundamental change in the structure of Jamaica's economy; it is shifting the country's focus from primary industries to manufacturing and services (see Chapters 2, 4 and 12), with a concomitant shift in the mix of environmental pressures. Managing the transition requires societal preparation through emphasis on relevant education and skills development, fostering of a culture of collaboration across disciplines, strategic partnerships, and judicious financing, as well as vigilance and creativity to harness new technologies and business models for environmental protection and management.

Development of the SOE report revealed several environmental data gaps that new technologies can help fill. Monitoring efforts can be erratic, sometimes failing to deliver information for evidence-based decision-making on a timely basis. For example, the number of monitored coral reef survey sites around the island is limited to 26 sites, due to resource constraints (Chapter 15); wildlife monitoring tends to focus on charismatic species (Chapter 16); habitat monitoring for critically-endangered or endangered animal species is partial, limiting understanding of biodiversity trends (Chapter 16). Even when data are collected, access can be an issue. For example, data recovery from the air quality monitoring network is variable and inconsistent (Chapter 13).Data verification processes can result in significant reporting lags; for example verified data on used lead acid batteries were only officially reported up to 2015 at the time of preparation of this report (2019). Another example is that annual reporting on air pollution discharges from licencees has reportedly only been validated to the year 2016. In part, the reason for this is that licencees start submitting reports six months after the end of a calendar year on which they are reporting. No data on reporting compliance were available. Air and water quality are not necessarily consistent, so learning of a major problem three years after the fact does not facilitate effective management.

Jamaica has released a draft national policy on environmental management systems, with little detail on monitoring and data management (GoJ 2017c). Nowhere does it mention deployment of new technologies (e.g. sensors, machine learning and drone technology) for status and trend or compliance monitoring, nor new partnerships to make data more available.

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[243] https://www.weforum.org/focus/fourth-industrial-revolutionRetrieved October 02 2018
[244] https://jis.gov.jm/cmu-opens-centre-digital-innovation/ Retrieved October 02 2018
https://jis.gov.jm/jamaicans-urged-prepare-fourth-industrial-revolution/ Retrieved October 02 2018
[245] http://jamaica-gleaner.com/article/news/20190114/ainsley-brown-exed-postgrad-students-cutting-edge-logistics-projects-part-iRetrieved October 02 2018
http://www.jseza.com/jamaica-logistic-hub/Retrieved October 02 2018

Interconnected Risks and Impact

As climate change and extreme natural disasters intensify, it will be necessary for Jamaica's current approach to environmental and risk management to give way to integrated planning and consideration of cumulative effects. At present, only projects falling into a scheduled category consistent with NRCA regulations, such as large-scale construction projects and subdivisions, require environmental impact assessments (EIAs); this is although the cumulative impact on air, water, land and biodiversity of multiple small projects can be significant (Chapter 10). Furthermore, if large-scale projects do not account for their carbon footprint or how climate change impact might affect their performance, these investments could become stranded assets or liabilities. Similarly, Parish Development Orders apply to new development within formal economies, but smaller, informal developments either do not require or do not seek permits (Chapter 7). Failure to consider the cumulative effects of development on VECs can place an undue burden on the poor, who are often dependent on natural resources for livelihood.

It has been raised at stakeholder meetings for this SOE that there is a lack of personal responsibility for environmental degradation and that priority is placed on financial gain over environmental protection for a variety of reasons. In a context of scarce resources, for people living in poverty, meeting basic needs takes a priority over environmental considerations. Another key reason is that many people don't understand that the condition of the ecosystem directly relates to the availability of the very resources and services on which communities rely. For that reason it is important to communicate the economic and social benefits that stem from natural resources, not just in terms of monetary value, but also the cost of replacing or restoring lost ecosystem services. Lack of information, as distinct from understanding of linkages, is another problem facing Jamaica's environmental resources. Without adequate baseline surveys that are routinely updated, and without research to understand pathways of effects, it is difficult to manage complex environmental ecosystems. A simple example of this is the hotel gardener who puts raw animal manure on flower beds within 100 m of the shoreline,; there is rainfall and manure particles are washed into the sea resulting in elevated coliforms and nutrient loads and decline in water quality of the sea water on which the hotel relies to satisfy its guests. If they understood the effect of natural or chemical fertilizers on water quality, it is fair to say that stakeholders would not knowingly choose actions that result in poor beach water quality and degraded marine ecosystems.

Recognizing that sustainable livelihoods play a critical role in environmental protection is critical. A multi-million dollar (USD) flagship project, Integrated Water, Land and Ecosystem Management in Caribbean Small Island Developing States (IWEco), commenced in 2016. This project prioritizes ecosystems that are of global significance, such as wetland sites and UNESCO heritage sites, and places importance on the sustainability of livelihoods and climate resilience with respect to the management of water, land,and forest resources.[246.] Funded by GEF, this regional project involves 10 Caribbean nations and includes a focus on pollution control, ecosystem restoration for conservation of migratory species and climate-resilience, building of the Negril Morass in Jamaica

Decoupling Economic Growth and Environmental Degradation

Economic growth and environmental outcomes tend to be connected. Jamaica's sluggish growth in GDP, high inflation rates[247] and unemployment of 12.5% (see Figure 10) constrained spending on environmental protection during this review period (GoJ 2017c). Even under the best of circumstances,

[246] http://www.cep.unep.org/gef-iweco-1/gef-iweco Retrieved October 02 2018

[247] Inflation stood at 5.2% in 2017, averaging at 4.3% for the period. For comparison, in 2017 the World Bank reported the following inflation rates: Heavily indebted poor countries: 5.0%; Latin American & Caribbean (excluding high income): 3.3%; UN classified Least Developed Countries: 5.1%

creating the right balance between development needs and environmental protection is challenging. Achieving this balance lies at the centre of sustainable development. The question raised at the first SOE Working Group Session (March 2018) was whether it was possible to decouple economic growth and environmental degradation in Jamaica. Decoupling can take two main forms: (1) reducing the intensity of natural resource exploitation, and (2) reducing environmental impact while continuing to increase economic output (Conrad and Cassar 2014). Generally, Jamaica has strived for the latter. The former requires significant improvements in the efficiency of resource consumption and material production patterns.

Decoupling economic growth from GHG emissions is possible. For example, it has been reported that in the USA, GHG mitigation efforts have not resulted in a contraction of the economy (Obama 2017). Globally, all countries that have signed the Paris Agreement, have agreed to pursue a low carbon economy. However, GHG emissions (or carbon intensity and energy intensity) are only one aspect of environmental degradation; no country has achieved absolute decoupling (e.g. Pulselli et al 2015, cited in Ward et al 2016). The real question is whether we can stop the negative trends that have been observed in the VECs (see Chapter 18) and retain a level of economic stability and growth in Jamaica. An emerging field of scholarship called "envirodevonomics" is studying why households with low incomes implicitly register a low willingness to pay for improvements in environmental outcomes (Greenstone and Jack 2015). Tracking this area of scholarship and applying this type of research to policy analysis and development in Jamaica can shed some light on these questions.

19.4 Strengths/Opportunities

The following positive trends documented during this review period also stand out as potential opportunities for environmental management:

- Jamaica has a relatively high national literacy rate of 91.7%, which, when coupled with the high rate of electrification (98% of the total population, and 96% of the urban population), and access to the internet[248] translates to a population that is self-educating, with the potential to make more informed decisions about environmental issues. This has the potential to translate into improvement at operational and management levels, when supported by the necessary legal and administrative framework.
- The economy is rapidly shifting from being based on agriculture and manufacturing (i.e. goods-producing economy) to a services-dominant economy (GoJ 2017c), with only 21% of the labour force involved in primary industries and manufacturing (see Figure 11) and less than 25% of the total real GDP contributed by goods production[249] (PIOJ 2018a) in 2017. Service industries (with the exception of tourism) tend to place less stress on the natural environment than goods production.
- There is a relatively large non-resident population of persons who identify as Jamaican, living in developed countries (i.e. the Diaspora). In recent years, this group has been organized and coordinated in its efforts to provide assistance to Jamaica, with the formation of several Diaspora task forces. Private remittance inflows increased by ~12% between 2013 and 2017, and amounted to over US$2.3 billion in 2017[250] (or ~16% of the GDP). The Jamaican Diaspora is an untapped resource that can be brought to bear on the efforts to protect the environment.

[248] Internet access in 2016 was estimated by PIOJ (2018a) to be 45 people per 100 population. Mobile communications penetration (including smartphones) was estimated (PIOJ 2018a) to 120 phones per 100 population.

[249] As calculated in the 2017 ESSJ, this includes agriculture, mining & quarrying, manufacture and construction (PIOJ 2018a).

[250] https://tradingeconomics.com/jamaica/remittancesRetrieved October 02 2018

- Environmental management has taken some steps in the right direction, as evidenced by the increased level of accession to MEAs and compliance with reporting requirements (e.g. Ramsar, LBS Protocol and the Paris Agreement), placing priority on climate change adaptation, making the link between alternative livelihoods and protection of ecosystems and biodiversity and increasing collaboration with stakeholders and community-based organizations. This approach addresses the compromising choices that prevent the implementation of sustainable livelihood practices among small farmers and fishermen. There is also increasing understanding that the resilience of ecosystems to drivers of environmental change like disease, invasive alien species, climate change and natural hazards is compromised by direct anthropogenic pressures (pollution, habitat destruction, over-exploitation) and indirect changes that occur within the ecosystem as a result (e.g. macro-algal blooms). Human interventions to improve the resilience of ecosystems and enable them to better cope with large-scale and abrupt disturbances arising from the adverse effects of anthropogenic pressure as well as other drivers like climate change, natural hazards and disease. Jamaica therefore has the opportunity to address some global issues facing ecosystems if ways and means of reducing anthropogenic pressures can be identified.

19.5 Recommendations

Building and leveraging strengths, and taking into account the major gaps and emerging issues, the following recommendations were selected for their national applicability and their ability to: (1) reduce drivers of adverse environmental impact and pressures to VECs; (2) improve the quantity and / or quality of VECs, and (3) address barriers to change. These recommendations are not intended to be comprehensive. Greater effort has been placed on characterizing the strengths and weaknesses inherent in the environmental management framework of Jamaica.

19.5.1 Reduce Impact of Drivers and Pressures

Cumulative Effects Assessment (CEA)

Jamaica was the first Caribbean nation to enact legislation requiring EIAs to be conducted. However, it must be recognized that the effectiveness of project-level EIAs in protecting the environment has its limitations. Cumulative Effects Assessment (CEA),[251] unlike EIA, focuses on the condition of VECs rather than on causes of impacts. Project-based environmental impact may be functionally defined as a measurable deviation from established baseline/reference conditions at a particular site beyond the normal functioning parameters of the system, that are directly or indirectly caused by a known cause related to the project. In comparison, "*cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to in this document as "developments") when added to other existing, planned, and/or reasonably anticipated future ones" (*IFC, 2013). Many of the changes in SOE indicators are the result of cumulative effects: for example, air and water quality; changes in watersheds status; water stress levels; endemic species

[251] See the IFC Good Practice Handbook for Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets.
https://www.ifc.org/wps/wcm/connect/3aebf50041c11f8383ba8700caa2aa08/IFC_GoodPracticeHandbook_CumulativeImpactAssessment.pdf?MOD=AJPERESRetrieved October 02 2018

population levels, and habitat degradation. CEAs, which focus on what is happening with the VECs, can allow for better understanding of carrying capacities and tipping points[252] in the system. There is currently no legal or administrative framework for CEA in Jamaica.

Improve Waste Management

Inadequate solid waste and sewage management, as well as poorly managed wastewater and effluent associated with industry continue to threaten freshwater, terrestrial and marine ecosystems. The reality is that there is a major imbalance in the demand for waste management services, compared to the municipal resources that exist to manage waste, particularly in urban squatter settlements. Although there have been some positive moves towards recycling, much more has to be done to reduce some of the environmental effects arising from stressed municipal wastewater treatment systems and dumps. On the supply side, there is an urgent need to increase capacity of both private and municipal wastewater treatment plants and engineering landfills. On the demand side, a major waste reduction programme is also critically needed.

Focus on Sustainable Agriculture

Domestic and export food production systems create far-reaching environmental pressures that have the potential to impact air, freshwater and marine ecosystems, as well as land (including watersheds, forests and biodiversity), in the short to medium term. The FAO has put forward a common vision for Sustainable Food and Agriculture[253] that is aligned with the UN's SDGs, which is intended to guide transitioning to more sustainable agricultural systems. Agricultural sustainability is assessed using three main lenses: economic, environmental and social. Under this vision, sustainable agriculture is characterized by:

- Improving efficiency in the use of resources;
- Direct action to conserve, protect and enhance natural resources;
- Protection and improvement of rural livelihoods and social well-being;
- Enhanced resilience of people, communities and ecosystems.

In the course of reviewing available literature for the SOE, several areas have been flagged for medium-term action to improve agricultural sustainability in Jamaica. These include:

- Specific projects to increase sustainable land management for yam and banana cultivation (especially in relation to plastic and pesticide dependencies), and artisanal finfish and lobster fisheries;
- Improved water management and alternative energy production systems for small farmers;
- Exploration of organic markets for major export crops to reduce chemical input;
- Increased attention to private-public partnerships for water conservation and disaster risk reduction;
- Expansion of the green cane harvesting programme to reduce burning and emissions;

[252] Lenton et al (2008) define a tipping point as "*a critical threshold at which a tiny perturbation can qualitatively alter the state or development of a system*", in which case, a relatively small change in a natural system can result in a major and abrupt change in how the system responds to future perturbations.

[253] http://www.fao.org/sustainability/background/en/Retrieved October 02 2018

- Increased research into how climate change is likely to impact coffee cultivation, and pests and diseases vulnerability;
- Land reforms to address whether and how disused sugar lands could be made available to small farmers; and
- Research to characterize the impact of commercial ganja farming in Jamaica.

19.5.2 Improve the Quantity and Quality of VECs

Link Water and Energy Conservation

There is a need to build awareness that water conservation will also contribute to energy conservation, and that water conservation ultimately impacts the cost of water that is treated and supplied to Jamaicans. According the NWC's 2017 Annual Report, a significant issue faced by the Commission is the cost of energy, which currently accounts for a quarter of NWC's total operating costs. NWC reported a 5% increase in energy consumption between 2016 and 2017, to a high of 204 GWh. Energy is used for sourcing, treatment and distribution of water supply; the environmental issues associated with energy consumption are therefore key factors with respect to water supply.

Energy Policy

Renewables currently contribute 1.7% of the TPES or 12% of electricity produced. To meet the 20% renewable energy share of the TPES by 2030 (now at less than 2%, in breach of the 12.5% target set for 2015), very aggressive strategies must be put in place. This would require clean (non-carbon-based) renewables to generate at least 872,000 MWh by 2030, in comparison to the 504,500 MWh generated by these sources in 2017. This is a 72% increase in clean sourced electricity (renewable), or ~90,000 MWh increase per year.

Strategies to achieve this include policies that create an enabling environment for:

- **Expansion of wind and solar farms:** There could be more rapid expansion of photovoltaic (PV) power (solar), possibly using private sector investment in solar farms that are not tied into the national grid;
- **Diversification of the renewables portfolio:** This can include exploration of the potential for geothermal energy. PCJ has done preliminary research indicating geothermal potential in association with known hot springs. Geothermal energy exploration appears to have lost traction in Jamaica since 2013, despite increased attention from the international donor community in funding geothermal projects in the Caribbean. Additionally, the potential for waste-to-energy power plants can also be explored. An estimated 420 kilotons of organic waste are produced in Jamaica annually, with the potential to produce 21 million Nm^3 of methane per year. However, these plants could create more air pollution than natural gas plants;
- **Electrification of transportation (vehicles**): A plan should be developed to transition Government bus fleets to electric vehicles, and to encourage private sector adoption, particularly in urban areas;

- **Taking a critical review of the medium to long term barriers to diversification** of renewable energy portfolio and transitioning from fossil fuel-dominated energy supply, and determination of appropriate strategies to combat these;
- **Addressing the average annual 27% electricity (1,151,620 MWh) losses** reported by JPS. To put it in perspective, this amount of loss is 15% greater than the total contribution of non-carbon renewables to the total amount of electricity supplied in 2017 (estimated at 12%), and amounts to an estimated 677 KBOE. This is estimated[254] to account for 814,369 mt of CO_2 emissions that could be eliminated if losses were reduced. A study of the specific points/areas of electricity losses and how efficiency could be improved should be undertaken;
- Introducing standards for minimum energy performance and fuel-economy. Some countries have complemented policy measures with fiscal and financial incentives (e.g. tax incentives on building renovations and electric vehicle imports); and
- Enhancing electricity storage potential (e.g. battery arrays) to support penetration of renewable energy technologies and moving the island toward low carbon development.

Knowledge Gaps

It is recommended that the linkages made with major research institutions be used to fill major data gaps, for example:

- **The effects of climate change** on biogeographical ranges and biodiversity in Jamaica.
- **Ocean acidification** is a key indicator that should be included as part of the monitoring requirements to satisfy the relevant indicator (SDG 14.3.1). Developing a national system that incorporates the use of long-term environmental monitoring systems (buoys, multi-probe units) that capture ,among other parameters, changes in sea surface temperature, pH and aragonite saturation will be useful as part of monitoring impacts of global warming. This may require partnerships with key local and international stakeholders. The likely increased frequency of elevated sea surface temperatures and prolonged high degree heating events may result in coral bleaching events. Jamaica experienced instances of bleaching during the period of interest (2014-2017).
- **Beach Erosion Rates***.* Given the importance of beaches to tourism this sub-indicator (Voluntary National Review) will continue to require assessment until more suitable proxies for SDG14 indicators are developed. In light of the potential impact of global sea level rise and climate change, additional sites for monitoring are required to provide a true picture of the resilience of these beaches and their ability to maintain equilibrium. Erosion risk at turtle-nesting beaches also needs to be monitored.
- ***Coastal Water Quality****:* There is broad consensus that the Index of Coastal Eutrophication[255] will not be operational for several years. A low level but scientifically valid proxy, Secchi disc depth, could be developed particularly in instances where consistent and replicable nutrient or chlorophyll monitoring is not feasible. Secchi disc depth is a measure of water clarity or

[254] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculatorRetrieved October 02 2018

[255] Referring to the inputs of nutrients (nitrogen, phosphorus and silica, in different forms) from rivers, and corresponding nutrient-ratio sub-indicator

turbidity. This indicator captures general changes if monitored consistently over time. There are other instances of changes in nearshore water quality: environmental accidents such as oil spills as well as excessive sedimentation from dredging and maintenance of ports, harbours and shipping channels. A recommendation would be to track these incidents as part of a national monitoring system. Climate and extreme weather events will impact nearshore water quality and change baselines for ambient water quality conditions. Given the challenges associated with assessing some of these indicators, particularly for developing countries, an approach that blends national level in-situ measurements, remote sensing using satellite images, and globally modelled data is the recommended approach.

- There is insufficient data available to properly manage offshore cays and banks. Moreover, aside from the SW Cay SFCA on the Pedro Bank, there are no designated marine protected areas. Economic valuation of the commercial fisheries supported by offshore cays and banks might justify routine environmental surveys. In respect of the Pedro Bank, Bruckner et al 2014 has made important cases for expanding the boundaries of the SW Cay SFCA and designating MPAs at Banner Reef, Blower Rock, as well as C and D Shoals.
- Increased protection should be given to key herbivorous reef fish species (e.g. parrotfish) as a possible means of improving the Coral Reef Health Index.

Watershed and Aquifer Management

The entire island of Jamaica is currently classified as a protected watershed. It is strongly recommended that this designation be reviewed, as it infers that all watersheds are equally important. Moreover, current watershed classification focuses on severity of degradation or vulnerability rather than importance of the watershed. It is recommended that WMUs and related sub-basins be assessed in terms of ecosystem services they provide. There is notable variation between WMUs with regards to parameters including water supply, flood control and biodiversity. Economic evaluation of watersheds and the ecosystem services they supply can allow for some level of prioritization of interventions and designation of critical basins that must be protected to reduce water stress. This approach can complement existing assessments of status and vulnerability of aquifers.

It is recommended that a working group that looks at forest cover, watershed status, flood/landslide hazards and aquifer vulnerability be formed to advance integration of how these environmental parameters are managed, and to optimize use of budgetary allocations for integrated watershed management.

Swamp Forests

It is strongly recommended that a study of remnant swamp forests be undertaken with a view to establishing key protected areas for swamp forests. Without urgent and effective action, existing remnants of this ecosystem can disappear from Jamaica before the next SOE is completed. In 2017 World Wetlands Day the theme was "*Wetlands for Disaster Risk Reduction,*" and the Forestry Department issued an urgent call for protection of the remaining swamp forests.[256]

[256] http://jamaica-gleaner.com/article/news/20170206/jamaicas-swamp-forests-all-most-gone Retrieved October 02 2018

19.5.3 Address Barriers to Change

Improve Inter-agency Collaboration

A key barrier to change that has been identified in the stakeholder meetings is the lack of inter-agency collaboration, and 'silo-thinking'. Examples of how collaboration can be improved include the following:

- **Boosting the capacity of the Climate Change Division to fully exert its mandate** as a facilitator of mitigation and adaptation implementation. This includes expanding technical skill sets and competencies within the Division (e.g. an Economics Unit), improving soft skills that enable nurturing partnerships, aligning programme and project-level priorities with other key Ministries, departments and agencies, and transferring knowledge.
- **Improving online databases and information clearing houses**. Several agencies like NEPA and WRA have already made data available online. Additional programmes are needed for invasive alien species, for example.
- **Harmonizing the existing and proposed categories of natural protected areas with the management categories of the IUCN**. Alignment of complementary pieces of legislation across various key agencies is one way to make progress towards improved protected areas management. A key entry point seems to be enforcement and strengthening of existing laws as well as creation and the promulgation of new laws that can keep pace with emerging needs and technologies.

Connect Indicator Monitoring and Collation with Management

- Many of the data needed for indicators reporting (for the SOE, SDGs and other international programmes) are not being managed in an easily accessible format, or may not be collected as part of a representative and verifiable sampling programme. For example, it is not possible to determine changes in the proportion of protected areas because there is no comprehensive, geo-referenced list of protected areas.
- Spatial databases (GIS) that utilize remote sensing mapping rather than extensive field surveys could improve the cost efficiency of monitoring. Data collected for regulatory compliance (e.g. EIAs) could also be integrated into a standardized GIS, if the parameters and rules of data collection are issued to consultants and applicants before data are collected.[257] Large amounts of private sector money are presently used for EIA baseline surveys that could become part of a national environmental inventory.
- Improving monitoring, data analysis and reporting is important only if the information supports management. Despite numerous consecutive monitoring reports (e.g. air quality, coral reef health, turtle nesting and beach erosion) that report continuing negative trends, other than enforcement warnings to specific non-conformers that can be easily identified, no corrective actions appear to be taken (). It must be recognized that monitoring is not mitigation. Once a threshold is exceeded, plans must be in place to reverse trends and manage causes.

[257] A system like this has been adopted by the EMA in Trinidad for example.

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