Commonwealth of Dominica

Management of post-hurricane disaster waste

October 2017

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Published in Switzerland, 2017 by the UN Environment/OCHA Joint Unit, Emergency Services Branch, OCHA

Information has been compiled by the experts on mission based upon best available knowledge when drafted.

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Cover photo: Marigot, October 10, 2017

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*The **UN Environment/OCHA Joint Unit (JEU)** assists Member States in preparing for and responding to environmental emergencies by coordinating international efforts and mobilizing partners to aid affected countries requesting assistance. By pairing the environmental expertise of United Nations Environment and the humanitarian response network coordinated by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the JEU ensures an integrated approach in responding to environmental emergencies. The Environmental Emergencies Centre (EEC) (www.eecentre.org) is an online tool designed to build the capacity of national responders to environmental emergencies developed by the JEU.*

*The **Union Civil Protection Mechanism** (UCPM) facilitates co-operation in disaster response, preparedness, and prevention among 34 European states (EU-28 and Serbia, Montenegro, Turkey, the Former Yugoslav Republic of Macedonia, Iceland, and Norway). With the support of the European Commission, Participating States pool resources and experts that can be made available to disaster-stricken countries all over the world as well as for prevention and preparedness operations. When activated, the Mechanism coordinates the provision of assistance from its Participating states. The Emergency Response Coordination Centre (ERCC) is the heart of the Mechanism. The ERCC monitors risks and emergencies around the world on a 24/7 basis and serves as an information and coordination hub during emergencies. Among other tasks, the ERCC also ensures that Participating States are fully aware of the situation on-site and can make informed decisions for providing financial and in-kind assistance. For more information, please refer to the ECHO website and/or ERCC Portal. The Union Civil Protection mechanism closely cooperates with the United Nations and it participated in several joint missions.*

*The **Swiss Agency for Development and Cooperation** (SDC) designs its activities to reduce poverty and hardship, curb global risks and promote development that preserves natural resources for future generations. The **Swiss Humanitarian Aid** (SHA), as a part of SDC, acts through prevention and rescue measures, contributing to safeguarding lives of endangered people and alleviating suffering. At the multilateral level, it works to create a more effective international system for responding to crisis.*

*The **General Inspectorate for Emergency Situations** from Romania is the national regulatory authority in the field of civil protection. Its main relevant thematic competences with nationwide applicability include issuing of methodologies, regulations, operational standards and procedures in the field of planning, preparedness for and emergency response as well as coordinating and developping training programs in the field of protection against disasters/emergency situations and humanitarian assistance at national and international level.*

Executive Summary

In September 2017 the Caribbean was struck by two devastating hurricanes, Maria and Irma. Dominica was the first island hit by the full category 5 force of Hurricane Maria. Still reeling from the hurricane's impacts, the country was struck by Hurricane Irma only days afterwards. Almost 100 per cent of the agriculture sector was destroyed, with the majority of buildings destroyed or damaged. The capital of Roseau experienced widespread destruction and almost all of the island's lush forests were torn apart.

A team of two experts was sent to Dominica by the UN Environment / OCHA Joint Unit upon the request of the Caribbean Disasters and Emergency Management Agency to assess and provide advice on the the situation in terms of disaster debris. The experts were mobilized with support of the (European) Union Civil Protection Mechanism and the Swiss Agency for Development and Cooperation. The team was composed of a geographer and environmental manager, specialised in disaster risk reduction and disaster waste management, along with a chemical engineer, also specialised in disaster waste management, hazardous material and humanitarian emergencies. Collaboration with two United Nations Development Programme waste management experts was established to ensure maximal uptake of recommendations.

The principal objective of the mission was to identify needs for technical assistance, assess the existing local capacity for addressing disaster waste management issues, ascertain specific risks posed by exposure to various chemicals, and to pinpoint key recommendations to ameliorate the situation and improve the overall disaster waste management.

The mission outcomes showed the hurricane to have caused a significant additional strain on an already limited national system for waste management. In fact, it is clear that Dominica's existing centralised system for domestic waste collection and dumping has reached its limits and that a new long-term solution for waste management needs to be identified. Disaster waste management must be integrated in any future waste management plans and solutions being developed.

The mission's key recommendations are for the Government of Dominica to:

- Develop a clear long-term waste management strategy, integrating, among others, tourism development which is considered an economic development priority;
- Include disaster waste management into the future waste management master plan as well as the disaster preparedness master plan;
- Ensure waste management becomes a priority, allowing the country to harness economic opportunities of the Caribbean and regional waste market;
- Consider biomedical waste as a potential hazard requiring more rigorous management and disposal standards;
- Secure a long-term operational and maintenance budget for waste, which ensures the continuity of public services;
- Develop a detailed natural and technological hazards mapping at national and community levels;
- Develop a detailed industrial cadastre which records all hazardous material storages;
- Construct and maintain hazardous material storages and waste sites to resist disasters.

List of abbreviations and acronyms

CARICOM	Caribbean Community
CBI	Caribbean Basin Initiative
CCRIF SPC	Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company
CDEMA	Caribbean Disasters and Emergency Management Agency
DLP	Dominica Labour Party
DOWASCO	Water and Sewerage services
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSWMC	Dominica Solid Waste Management Corporation
ECCU	Eastern Caribbean Currency Union
ECHO	European Commission Civil Protection and Humanitarian Aid Operations
FEAT	Flash Environmental Assessment Tool
FSU	Financial Service Unit
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
IBC	International Business Company
JEU	UN Environment/OCHA Joint Unit
NGO	Non-Governmental Organization
OCHA	(UN) Office for the Coordination of Humanitarian Affairs
OECS	Organization of Eastern Caribbean States
PAHO	Pan American Health Organization
PDNA	Post Disaster Needs Assessment
PMH	Princess Margaret Hospital
PPE	Personal Protective Equipment
SDC	Swiss Development and Cooperation Agency
SHA	Swiss Humanitarian Aid Unit
SID	Small Island Development
UCPM	(European) Union Civil Protection Mechanism
UN	United Nations

UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNITAR	United Nations Institute for Training and Research
UNOSAT	UNITAR's Operational Satellite Applications Programme
UWP	United Workers Party
WWTP	Wastewater Treatment Plant
WWPS	Wastewater Pumping Station

An environmental emergency is defined as a sudden onset disaster or accident resulting from natural, technological or human-induced factors, or a combination of these, that cause or threaten to cause severe environmental damage as well as harm to human health and/or livelihoods.
UNEP/GC.22/INF/5, 13 November 2002

1. Mission background and scope

In September 2017 the Caribbean was struck by two devastating hurricanes, Maria and Irma. In response to a request from the Caribbean Disasters and Emergency Management Agency (CDEMA), the UN system deployed a United Nations Disaster Assessment and Coordination (UNDAC) team, initially based in Barbados but subsequently redeploying across various islands.

The two hurricanes were the strongest storms ever recorded in the Atlantic Ocean. The country of Dominica was particularly affected by Hurricane Maria, a Category 5 hurricane which hit the country shortly after Hurricane Irma. It made landfall in Dominica on 21 September. At least 27 deaths were reported in Dominica and flyovers confirmed that 80-90 per cent of buildings were damaged to varying degrees. The storm tore apart homes, ravaged businesses and wiped out infrastructure and agriculture

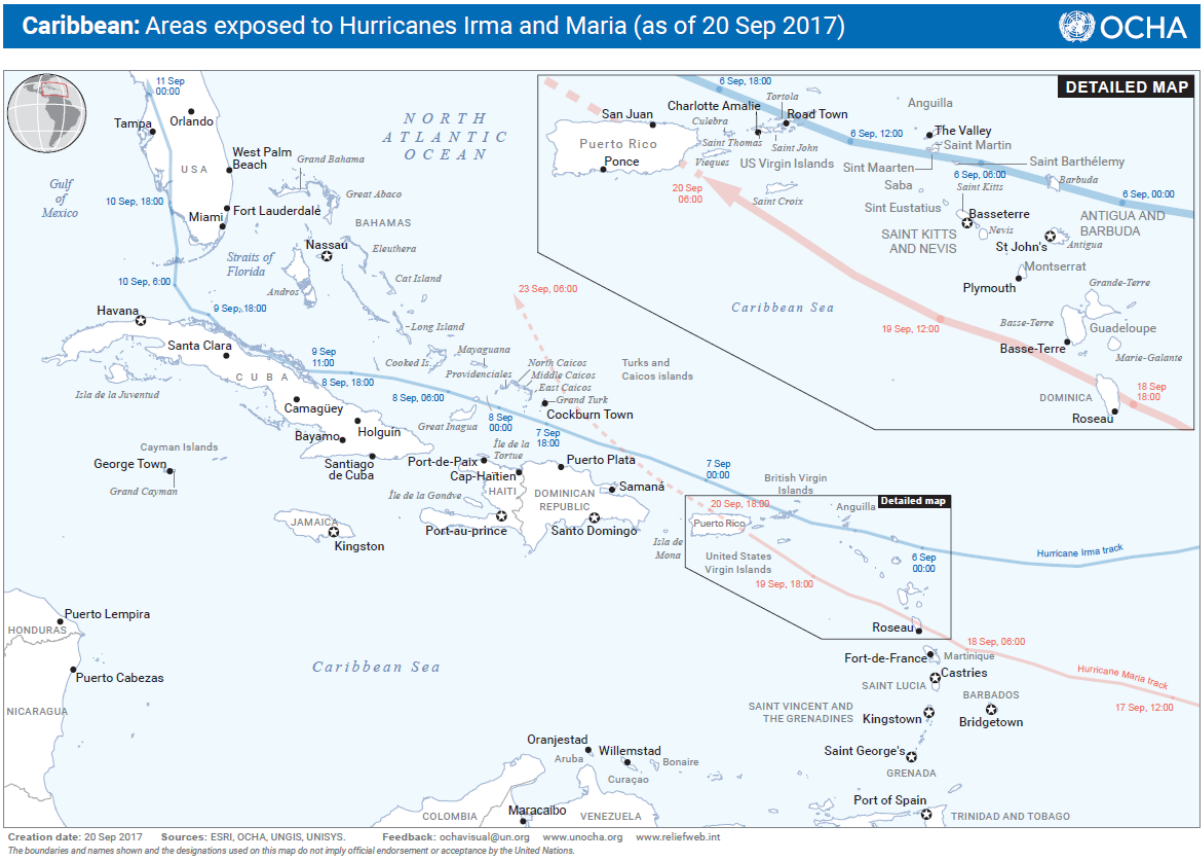


Figure 1: Caribbean: areas exposed to Hurricanes Irma and Maria (as of 20 September 2017)

There were countless roadblocks due to fallen trees and boulders and there was an acute need for clearing of roads and management of debris, sediments and disaster waste. Approximately 75 per cent of trees were reported blown down or having foliage and branches stripped.

CDEMA organised two coordination bases to attend to the emergency in Barbados and Jamaica. Through CDEMA, the Government of Dominica requested the support of disaster waste management experts, to be affiliated with the UNDAC team in order to provide support to the Government of Dominica on disaster waste.

A mission consisting of two experts was subsequently mobilized through the UN Environment / Office for the Coordination of Humanitarian Affairs (OCHA) Joint Unit (JEU):

- Laurent Nicole, Switzerland, deployed through the Swiss Agency for Development and Cooperation (SDC) – chemical engineer, disaster waste management specialist, expert on hazardous material and humanitarian emergencies;
- Roxana Mihaela Popescu, Romania, deployed through the (European) Union Civil Protection Mechanism (UCPM) – geographer and environmental manager, specialised in disaster risk reduction (DRR) and disaster waste management.

The initial scope of the mission (Annex 1) was adjusted to the context, as two United Nations Development Programme (UNDP) experts on disaster waste were already on the ground when the team arrived. The mission objective was to, in close collaboration with the relevant local and national authorities and international emergency responders, conduct an overall assessment of the disaster waste situation. This included the tasks to:

- Identify any needs for further technical assistance, as well as medium and long term needs for capacity building;
- Assess the existing local capacity for addressing disaster waste management issues;
- Identify specific risks posed by asbestos, healthcare waste, hazardous materials, agricultural or industrial chemicals / pollution and other environmental legacies impacted by the hurricane and/or the subsequent response;
- Disseminate and promote the use of the Disaster Waste Management Guidelines[1];
- Communicate rapidly and regularly all findings to the UNDAC team, the local authorities, the United Nations Resident Coordinator, and the JEU as appropriate;
- Document, in electronic form, the assessment results, recommendations, and mitigation measures implemented, if applicable;
- Provide advice and support to any Post Disaster Needs Assessment (PDNA) or similar process, if appropriate (conducted in part through the support of the UN Environment Regional Humanitarian Affairs Officer);
- Support any coordination groups or agencies promoting work programmes such as cash for work involving waste clearance, to ensure that those activities minimise risks to people and the environment and do not generate longer-term environmental legacies.

1.1 Context

Dominica, being a Small Island Developing State (SIDS), is characterized by a challenging geomorphology. This makes the country particularly vulnerable to disasters while also making it ardous to identify feasible disaster waste management solutions. The limited number of suitables places for waste disposal constitutes one of the major challenges in terms of planning. For instance, torrential rains, flooding and landslides brought on by Tropical Storm Erika in 2015 caused significant damage to the island in 2015. In fact, Erika's

[1] http://dwmg.eecentre.org/index.asp

impacts had left the country in a vulnerable state and set up conditions for the failure of the country's waste management system.

Picture 1: As an example of the situation all across the island, between Fond Cassé and Rosalie, 12.10.17 Ncl

1.1.1 Impact of Hurricane Maria

The damage caused by Hurricane Maria proved to be extensive. Almost 100 per cent of the agriculture sector was destroyed and the tourist infrastructure was heavily impacted. Additionally, the Hurricane caused widespread destruction in the capital of Roseau. Many buildings were damaged, cars and boats were overturned and roads and bridges were blocked by debris and tree trunks. Communities paid heavily, with building roofs torn away, entire homes ripped open and debris littering the land. The lush and green terrain of the country was not spared - trees were snapped and spread across the landscape and the island stripped of its vegetation.

Picture 2: Anglican Church in Roseau and power cables on the road, 06.10.17 Ncl

Across the island, running water, electricity and telecommunications were cut. Communications towers on hilltops were broken which later hampered the gathering of information from the island.

Due to the island's mountainous terrain, dozens of landslides occurred which caused further destruction and hampered road access. Another landslide was cause by a collapsed river bridge which diverted a river right through the capital and caused subsequent flooding.

The loss of agricultural commodities will be devastating for the island and its people, who rely on sugar cane, banana and citrus fruits plantations for income. Additionally, the massive damage to vegetation is expected to impact the tourism sector.

Picture 3: Centre of Dominica, 11.10.17 Ncl

1.1.2 Geography

Dominica is the most mountainous island in the Caribbean, with the land rising straight from the sea and towering to high peaks. A rugged landscape is softened by luxuriant forests that coat the hills, giving the island its distinctive verdant beauty. After nearly 3,000 years of human habitation, Dominica, known to many as "the Nature Island of the Caribbean," is one of the few places where untouched primary tropical forests can still be found. More than in most Caribbean islands, this rugged terrain has guided the course of Dominica's history. The steep mountains and deep valleys provided the early Carib Indians with a natural fortress against European colonizers, making Dominica one of the last islands to be fully colonized (for a full history of the country, please refer to Annex 6).

1.1.3 Economy

Although the financial services industry is increasingly becoming its largest income, agriculture, with bananas as the principal crop, is still Dominica's economic mainstay.

Dominica is one of the eight members of the Eastern Caribbean Currency Union (ECCU) and is also a beneficiary of the U.S. Caribbean Basin Initiative (CBI). Furthermore, Dominica is a member of the 15-member Caribbean Community (CARICOM) and of the Organisation of Eastern Caribbean States (OECS).

Agriculture

About 22.6 per cent of the total land area is arable. Agriculture accounts for about 20 per cent of gross domestic product (GDP) and employs about 40 per cent of the labour force. Banana production employs, directly or indirectly, more than one-third of the work force. Most crops are produced on small farms, the 9,000 owners of which are banded together in about 10 cooperatives. There are also several large farms that produce mostly bananas for export.

This sector is highly vulnerable to weather conditions and to external events affecting commodity prices. Dominica has made some progress in terms of export economy, with small quantities of citrus fruits and vegetables, coffee, patchouli, aloe vera, cut flowers, and tropical fruits being exported. Fruits and vegetables are produced mostly for local consumption.

Financial Services

In recent years the Commonwealth of Dominica has become a major international financial hub, and is quickly becoming one of the largest banking centres in the world with offshore services one of the main sources of income. The country has tried to expand its base by building up offshore financial services. Regulation and supervision of the financial services industry is the responsibility of the Financial Service Unit of the Commonwealth of Dominica (FSU) under the supervision of the Ministry of Finance.

Animal husbandry

There are about 2,000 hectares (4,900 acres) of pastureland, comprising 2.7 per cent of the total land area. The island does not produce sufficient meat, poultry, or eggs for local consumption so there are large imports of animal products.

Fishing

There is a relatively large fishing industry in Dominica, but it is not modernized and almost exclusively serves the domestic market. Before Hurricane David (1979), around 2,000 people earned a living fishing in coastal waters, producing about 1,000 tons of fish a year and meeting about one-third of the local demand. The hurricane destroyed almost all of the island's 470 fishing boats; afterward, only about a dozen vessels could be reconstructed for use. In 2000, the catch was 1,150 tons, up from 552 tons in 1991.

A successful experiment in fresh-water prawn farming, supported by Taiwanese aid, has produced substantial amounts of prawns for the domestic and local markets. Japan has provided support for a fish landing and processing plant in Roseau.

Forestry

Dominica has the potential for a lumber industry. Around 46,000 hectares (110,000 acres) are classified as forest, representing 61 per cent of the total land area. In 1962, Canadian experts produced a study indicating that over a 40-year period the island could produce a yearly output of 22,000 m3 of lumber. Before Hurricane David, annual output had reached about 7,500 m3. There are approximately 280 hectares (690 acres) of government land allocated to commercial forestry and about 100 hectares (250 acres) of forestland in private hands. Commercially valuable woods include mahogany, blue and red mahoe, and teak.

Mining

Dominica's mining sector has played a minor role in its economy. Pumice was the major commodity extracted from the island for export, and Dominica produced clay, limestone, volcanic ash, and sand and gravel, primarily for the construction industry. There is some mining potential in Dominica, especially in the island's northeast where there are believed to be deposits of copper.

Tourism

Because Dominica is mostly volcanic and has few beaches, development of tourism has been slow compared with that of neighbouring islands. Nevertheless, Dominica's high, rugged mountains, rainforests, freshwater lakes, hot springs, waterfalls, and diving spots make it an attractive destination. Cruise ship stopovers have increased following the development of modern docking and waterfront facilities in the capital. Eco-tourism is also a growing industry on the island.

Secondary industries

The island has built up a handful of successful industries specializing in soaps and other agricultural by-products. The largest manufacturer is Dominica Coconut Products, controlled by Colgate-Palmolive, which produced soap from coconuts. Dominican soap is also exported

throughout the region, but has recently encountered intensified competition from other regional producers, especially in the important export markets of Jamaica and Trinidad and Tobago.

There are four plants to process limes and other citrus fruits; two bottling plants; two distilleries; four small apparel plants; and four small furniture factories. Dominica exports water to its Caribbean neighbours; shoes, cement blocks, furniture, and soap and toiletries are also exported. Home industries produce some leatherwork, ceramics, and straw products.

Since the 1990s, the small manufacturing sector has been expanding at a modest pace, including electronic assembly, rum, candles, and paints. The Trafalgar Hydro Electric Power Station is operational, making the island virtually energy self-sufficient.

Dominica has not yet been able to attract significant numbers of foreign manufacturers, partly because its wage rates are relatively high and partly because its infrastructure is not suited to high-volume manufacturing. Like other islands, it seeks to attract investors with tax concessions and other financial inducements, but several offshore manufacturing plants have closed after their duty-free concessions expired, normally a 10-year span.

1.2 Mission assessment methodology

Arriving on site, the team set up the necessary collaboration with two UNDP waste management experts to ensure maximal uptake of recommendations. While the UNDP team focussed on Roseau more specifically on debris and waste, the JEU team focused on healthcare waste in Roseau and all type of waste and debris across the entire island.

The assessment was conducted using primary as well as secondary data: research of existing projects, field visits and interviews. Findings and analysis were shared immediately with UNDP, OCHA and other humanitarian response, after which further work was planned on a daily basis in order to ensure maximum efficiency.

In the field of healthcare waste, close collaboration was established with the Pan American Health Organization's (PAHO) team and engineers.

1.3 Encountered challenges

The team arrived on 4 October 2017, almost three weeks after hurricane Maria, and remained in country until 23 October 2017. Upon arrival, the team found the emergency response to still be in a hectic phase. To some extent, the work of the experts was hampered by their late arrival on site. This was in turn in part due to delays in receiving the official request for assistance. At the time of arrival, electricity, water and telecommunications were still suffering frequent interruptions. A large number of UN staff, aid agencies and international NGOs were present.

Coordination with the different ministries and state body was largely left to the initiative of the individuals. There was a lack of overall coordination, which led to people overcrowding

the Dominica's officials' offices, which in turn hampered their ability to work. Nevertheless, a major challenge was that local authorities are at a persistent lack of staff and funding.

2. Vulnerability

2.1 Disaster risk profile of the country

The Commonwealth of Dominica is vulnerable to numerous natural hazards arising from meteorological and geophysical events, including excess rainfall and hurricanes that result in floods and storm surges, earthquakes, and volcanic eruptions. These recurrent events have significantly harmed the population's socioeconomic well-being and the country's general economic and fiscal stability. Particularly damaging are events associated with excessive or prolonged rainfall.

In August 2015, total damages and losses from Tropical Storm Erika were estimated to be $483 million, equivalent to 90 per cent of Dominica's GDP with a majority of damages in the transport sector. Dominica also experienced significant flooding and landslides in 2011 and 2013 which had a substantial economic impact.

A majority of the population resides near the coastline, leaving infrastructure and people vulnerable to the impacts of hurricanes and tropical storms. Additionally, two of Dominica's major economic drivers – agriculture and eco-tourism – are closely tied to the island's natural environment, making the economy particularly vulnerable to disasters.

2.2 Policy context

The Government has taken significant steps to strengthen disaster risk management (DRM) in various sectors. In Dominica, DRM programs are governed by the Emergency Powers Act, which was established in 1951 and last revised in 1990. The country also has a National Disaster Plan to direct mitigation and response efforts.

There are some references concerning disaster waste management in existing legislation. For example, in the Solid Waste Management Act adopted in 2002 it is stipulated that *"every (private) licence has to review his disaster preparedness response plan no later than March of every calendar year". On the other hand, the waste management corporations (WMC) are responsible for preparing and maintaining contingency plans for: "the restoration of waste management services following a hurricane, for actions that will be taken in the event of landfill flooding, waste haulage vehicle accident, spillage of waste and other disruptions to daily waste management services".* Another shared responsibility of the corporations is to ensure that the plans are in conformity with the National Disaster Preparedness Response Plan[2].

The National Disaster Plan was elaborated and approved in 2001 by the National Emergency Planning Organisation, located within the Office of Disaster Prepardness of the Ministry of Communications, Works and Housing. The Plan references disaster waste management, stating that the Public Works responsibilities in case of a disaster are to identify solid waste

[2] Government of the Commonwealth of Dominica, 2002, Solid Waste Management Act, 57p

disposal and landfill sites before a disaster, clear roads and dispose of debris as directed by the National Emergency Operations Centre[3].

Disaster and climate risk management are guided by additional policy and legislative efforts, including the National Climate Change Adaptation Policy, National Hurricane Management Plan, and Disaster Preparedness Plan for the Agriculture Sector, and the Low-Carbon Climate-Resilient Development Strategy.

Dominica has also made efforts to strengthen its fiscal resilience to natural hazard shocks and is a member of the multi-country risk-pooling Caribbean Catastrophe Risk Insurance Facility Segregated Portfolio Company (CCRIF SPC).

To further advance Dominica's Disaster Risk Management (DRM) agenda, government priorities include:

- Building back better after 2015's Tropical Storm Erika;
- Continuing to implement the Low-Carbon Climate-Resilient Development Strategy, which identifies climate change vulnerabilities in key sectors;
- Exploring additional options to strengthen fiscal resilience to natural hazard events;
- Strengthening the resilience of infrastructure; and,
- Conducting additional assessments and mapping to better understand natural hazard risk.

Projects related to these priorities have also been established, with one project having ended in June 2017 this year one project running up to 2019:

Managing Spatial Data and Identifying Vulnerable Schools and Emergency Shelters in Dominica $722,000 12/2012 - 06/2017	This project will inform delivery of select activities under the World Bank-financed Dominica Disaster Vulnerability Reduction Project. This technical assistance aims to reduce Dominica's vulnerability to natural hazards by conducting vulnerability assessments of schools and emergency shelters and strengthening the government's capacity to manage and share geospatial data for informed-decision making. Key outputs to be delivered include the development of: i. a geospatial data platform ii. a methodology to evaluate the vulnerability of schools and emergency shelters; and iii. a prioritized list of investments based on the evaluation performed and a defined package of vulnerability reduction investments. These outputs will be accompanied by advanced training for relevant technicians.

[3] The National Emergency Planning Organization, Ministry of Communications, Works and Housing of Dominica, 2001, National Disaster Plan, 92.p

Improving the Resilience of Roads and Bridges in Dominica $1,056,000 02/2016 - 08/2019	This project supports the Government of the Commonwealth of Dominica's Ministry of Public Works and Ports (MoPWP) with the reconstruction of damaged critical infrastructure following Tropical Storm Erika, which struck the country on August 27, 2015. Activities aims to: i. develop and deploy an asset management tool to help target reconstruction investments more effectively; ii. conduct landslide and flood risk assessment along the transportation network to quantify the risk of failure due to these perils; and iii. provide engineering support to the MoPWP by embedding technical experts within the Ministry to work collaboratively with government engineers and staff in the overall reconstruction. The asset management tool will generate a comprehensive asset inventory that is geo-referenced and presented in a GIS platform. The system will provide the capability to use risk and condition assessments to model asset life cycles, understand system vulnerabilities and assist in the prioritization of near and long-term investments. The landslide and flood risk assessment will: (i) estimate the likelihood of landslide and flood occurrences based on field investigation and review of previous studies; (ii) quantify potential physical damages and disruptions if landslides or floods were to occur; and (iii) generate a list of mitigation options for each site and their corresponding costs. The results of the risk assessment will be a critical input of the asset management system.
More detailed information on the projects or their related outputs were not made available to the mission.	

The Global Facility for Disaster Reduction and Recovery (GFDRR)[4] has helped enable DRM efforts in Dominica since 2008 through country-specific and regional grants. The majority of GFDRR support has focused on risk identification and reduction efforts, with assistance also provided for post-disaster recovery and reconstruction.

GFDRR has helped improve the government's ability to collect, harmonize, store, and share geospatial data through the development of a risk data management platform, DomiNode[5], in 2012. GFDRR supported training on the use and sharing of spatial data through the platform, which brought about greater understanding amongst ministries and better availability of information about landslides and flood hazards.

[4] https://www.gfdrr.org/en

[5] http://physicalplanning.gov.dm/land-use-and-development/dominode

GFDRR also facilitated knowledge exchange related to shelter building standards, helping to improve the government's capacity to identify and retrofit vulnerable shelters, and design and construct resilient new structures. These efforts have informed additional activities, including the planning process for developing the World Bank's $39.5 million Disaster Vulnerability Reduction Project[6] in the country.

With GFDRR support, Dominica participated in the regional Caribbean Risk Information Program. This led to the creation of flood and landslide hazard maps[7] for the country, as well as the development of a handbook[8] that can support hazard and risk analyses for physical and infrastructure planning.

In addition, GFDRR has facilitated engagements following major disaster events. This includes supporting the government as it conducted a rapid damage and impact assessment[9] after Tropical Storm Erika.

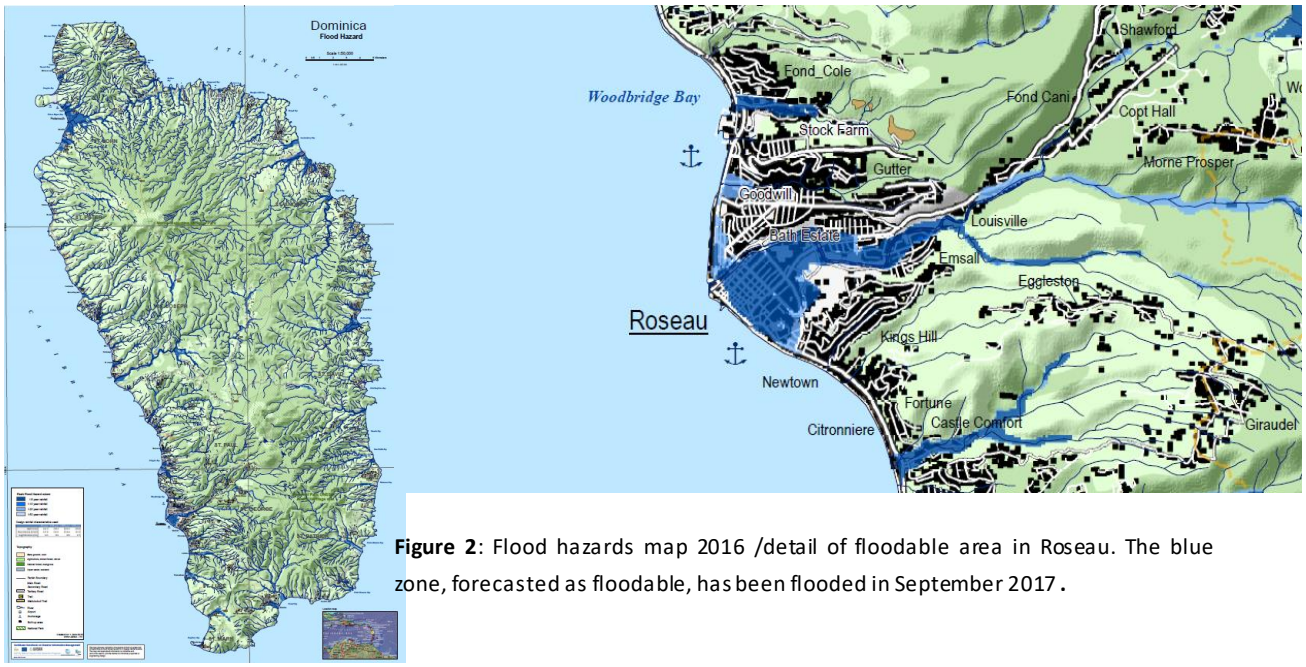


Figure 2: Flood hazards map 2016 /detail of floodable area in Roseau. The blue zone, forecasted as floodable, has been flooded in September 2017.

Such hazard mapping is a real land use management tool and, followed properly, will avoid infrastructures major destruction.

[6] http://projects.worldbank.org/P129992/third-phase-disaster-vulnreduction-apl-dominica?lang=en
[7] http://www.charim.net/dominica/maps
[8] http://www.charim.net/
[9] https://www.gfdrr.org/en/publication/dominica-2015-rapid-damage-and-impact-assessment

3. Mission findings

Institutional and legal context

As part of the initial response by national government authorities, there were attempts at disaster waste management and sorting, using a staging post on a school playground. This unfortunately did not endure for long due to the urgent need to clear the flooded center of Roseau.

In order to have a wider understanding of Hurricane Maria's impact, it is necessary to reflect on the way Dominica's waste management functioned before the disaster. The Dominica Solid Waste Management Corporation (DSWMC) was established by an Act of Parliament in 1996 with its responsibilities further defined in the Solid Waste Management Act of 2002.

The intent of the legislation was to establish DSWMC as a semi-autonomous body within the Government framework. Lack of adequate funding and the resulting lack of personnel at the upper management level resulted in the Corporation remaining essentially an extension of the Ministry of Health and Environment, working closely together with the Environmental Health Department. Its responsibility is to develop solid waste management facilities for storage, collection, treatment and disposal at national level.

Before the opening of the actual Fond Colé sanitary landfill in 2007, waste was being stored in two controlled dumpsites in Roseau (Stock farm) and Portsmouth (Point Rond). A structured waste collection was missing in the southeastern part of the island, having a negative impact on tourism.

In 2003, these issues were addressed by a World Bank funded project to reduce public health risks and protect the environmental integrity of the East Caribbean States islands and their coastal and marine systems. The project's main objective was to improve domestic solid waste management facilities by strengthening countries' capacities to manage effectively and dispose of solid waste in an environmentally sustainable manner.

The evaluation report rated Dominica's performance as unsatisfactory in almost all the project's outcomes: establishing and fully functioning autonomous or semi-autonomous National Solid Waste Management Entities; increased coverage and improved quality of land-based solid waste management services (collection, transport and disposal); enhanced public awareness of solid waste management issues resulting in behavioral changes.

In 2007, with the additional funding by the European Union, the Fond Colé landfill was officially opened. One transfer station was also constructed at Melville Hall and two others planned but never developed. The initial capacity was 170,000 m3 but planned to increase up to 230,000 m3 in order to allow acceptable solid waste disposal for the whole island over a period of 15 to 20 years.

The project also foresaw the restoration of the two obsolete landfills (Stock Farm and Portsmouth). Restoration would have included the provision of earth embankments where necessary, backfilling, sealing of the landfill by an impermeable liner, provision of ventilation for landfill gas and planting.

For Dominica's waste management system, 2007 was the turning point for the passage from an informal decentralized system to the current centralized one in Roseau. The landfill was designed to receive almost all types of waste: industrial, organic waste, commercial, household and institutional waste, hazardous and healthcare waste, with each type being stored in its own compartment.

Waste collection is handled by three compacting trucks from the DSWMC and a few other contracted trucks. On a (bi)weekly basis, these collect waste from pickup points in communities and bring it to the sanitary landfill.

The landfill is located alongside a river in a steep narrow valley close to the sea.

Following the opening of the Fond Colé landfill, other internationally funded projects emerged, aimed at sustaining the development of the DSWMC, investing in necessary equipment to reduce the volume of the waste, as well as increase recycling. A few examples of such projects include the procurement of a compactor financed by the Caribbean Development Bank, a PET shredder funded by PAHO, a small PET-dedicated truck funded by the Swiss Government and a biodiesel facility financed by Global Environment Facility (GEF) and UNDP.

However, the above-mentioned equipment was seriously damaged by the tropical storm Erika in 2015, and its condition has been exacerbated further by Hurricane Maria. Although there is a separate quarter for scrap metal and tires, all other waste, including medical waste, is being dumped at Fond Colé.

Various attempts to improve the waste management system have been conducted over the past years. However, the problems identified more than a decade ago still remain unsolved. There is urgent need for a suitable space to facilitate a new sanitary landfill, and improve the already aggravated current situation.

3.1 Domestic Waste

Findings

- The Font Colé dumpsite, designed in 2004 as part of the centralised waste management plan is almost saturated.
- Its location in a narrow valley alongside a river is environmentally sensitive.
- The domestic waste collection system is deficient due to the lack of logistical means, and part of the island has no other choice than to look for local and/or temporary dumping solutions.
- The lack of waste collection in the communities outside Roseau causes the people to turn to outdated practices like burning waste or reusing old dump sites.
- The sorting and recycling potential of waste is largely underused.
- The country urgently needs to develop a sustainable vision for domestic waste management in the long term, which needs to be accompanied by short and medium term action.

Analysis

- Equipment including the waste compacting trucks are only partially functional due to the lack of maintenance.
- The way waste has been dumped in the landfill makes the access to the top of the dumpsite difficult for large vehicles.
- The recommended practice of alternating waste layers and soil layers does not appear to be followed at the dumpsite.
- The excess waste and debris generated by the hurricane Maria will saturate the dumpsite which, according to mission's observation, has already reached its initially planned capacity, officially expected to be reached in 2022.
- The systems for waste management, while compromised and impacted by Maria, were already dysfunctional beforehand. It should be noted that Dominica has the lowest percentage of waste collected in the Eastern Caribbean[10].

Recommendations

- The closure plan of Fond Colé must be developed immediately and alternatives identified with a vision for 30 to 50 years.
- A concept of national waste management covering all types of waste (domestic, hospital, hazardous and disaster waste) should be developed in the short term, including a masterplan, a business model and an implementation action plan.
- Efficient waste sorting strategies must be developed emphasising sorting / reusing / recycling. These strategies should address large scale composting of organic waste, scrap metal collection and recycling across the island, PET collection and recycling, and critically managing deadwood.

[10] World Bank, Implementation completion report on 4 loans / 3 credits / 7 GEF grants in the amount of US$24.0 million equivalent to Antigua & Barbuda, Commonwealth of Dominica, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines for the OECS ship-generated waste management project and the solid waste management project, November 21, 2003, 100p.

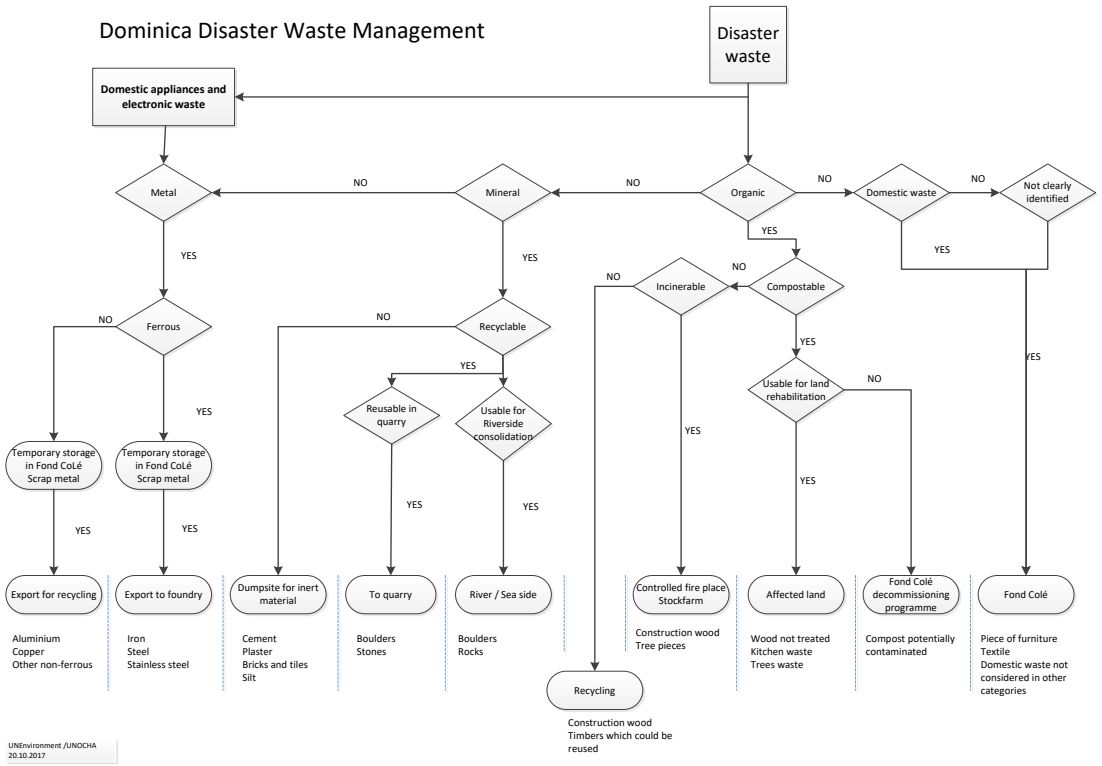


Figure 2: Dominica Disaster Waste Management Logical Scheme (see Annex 2) Prepared by expert mission (Nicole and Popescu)

- Education, information and communication campaigns on key elements of the waste management strategy must be developed in order to reach the entire population in the medium to long term.
- The Fond Colé decommissioned dumpsite can be transformed into a composting platform.
- Methanization of organic waste can be envisaged in connection with landfill gas collection and the collected gas can be used to produce electricity.
- Private sector involvement and investment should be encouraged and actively sought for recycling, reuse and export of valuable waste.

3.2 Healthcare Waste

Findings

- Currently there is no functioning facility for healthcare waste treatment.
- There is no adequate healthcare collection system. The cooling truck allocated for that function has been out of order for over two years.
- Hospitals need to store their healthcare waste for hypothetical collection. In some instances, healthcare waste is dumped in landfills without treatment. At other times it is simply burned on site.
- Special containers for sharp objects and spikes are properly available.

- A new incinerator, to be installed in Princess Margaret Hospital (PMH), is at the port awaiting clearance and logistical arrangements for preparing the site at the hospital as well as delivery and installation.

Picture 4: Prince Margaret Hospital, Roseau, disconnected freezer with body parts, under the sun, 18.10.17 Ncl

Analysis

- The current situation poses a severe public health risk, specifically the collection of healthcare waste in non-equipped trucks. The application of acceptable standard operating procedures is at best inconsistent.

Recommendations

- The old non-functioning incinerator must be urgently decommissioned and removed, along with the disconnected deep-freezer containing body parts exposed to the elements (operation under preparation at the time the mission left).
- A new incinerator must be urgently installed (operation under preparation at the time the mission left).
- A set of at least two cooling trucks must be acquired in the coming months to ensure healthcare waste collection across the island with an acceptable frequency for all hospitals and health centres. A maintenance programme must ensure that the trucks are permanently operational.
- PMH, functioning as a collection centre for healthcare waste, should be equipped with a specific waste cooling room in the framework of the on-going hospital development project.

3.3 Debris

A powerful hurricane such as Maria generates a large quantity and type of debris all around.

A few main types of debris can be identified:

- Roofing material, mainly CI sheets (thin steel sheets coated with zinc), some aluminium sheets and some asphalt based tiles;
- Trashed vechicles[11];
- Construction wood, carpentry, walls, floors;
- Element of masonry, broken windows, tiles;
- Broken trees;
- Sand, silt, stones and rocks;
- Miscellaneous (including domestic waste, broken furniture, domestic appliances, etc.)

Over the past years and using the experience from previous disasters, various methodologies, guides and tools have been developed to estimate the volume of debris produced by natural disasters.

Estimations can be made using visual observation and detailed data collection. Additionally, one can combine field measuring methods or extrapolated data with aerial and satellite data (before and after photographs), to estimate the amount of debris. Satellite or aerial images are analyzed based opn available algorithms, analyzing the structures and features seen in the images. Satellite imagery of the hurricane damage produced by the United Nations Institute for Training and Research's Operational Satellite Applications Programme (UNOSAT / UNITAR) can be used tot his end. Some computer models additionally take other type of data, such topography and land use, into account.

Although these methodologies cannot offer a precise estimation, the results can be used to manage debris removal planning, to estimate the cost of removal operation or for emergency preparedness and planning. This type of assessment has to be done as soon as possible after the impact, which may prove challenging.

[11] Trashed vehicles: A number of the vehicles located on the island have been damaged by the impact of the hurricane, if not destroyed. The carcasses will have to be decontaminated before they can be considered as scrap metal ready for recycling. The mission did not identify a mechnism in place to remove the cars fluids and contaminants. The decontaminated carcasses will join the already exisitng stock of scrap metal looking for a recycling solution across the country.

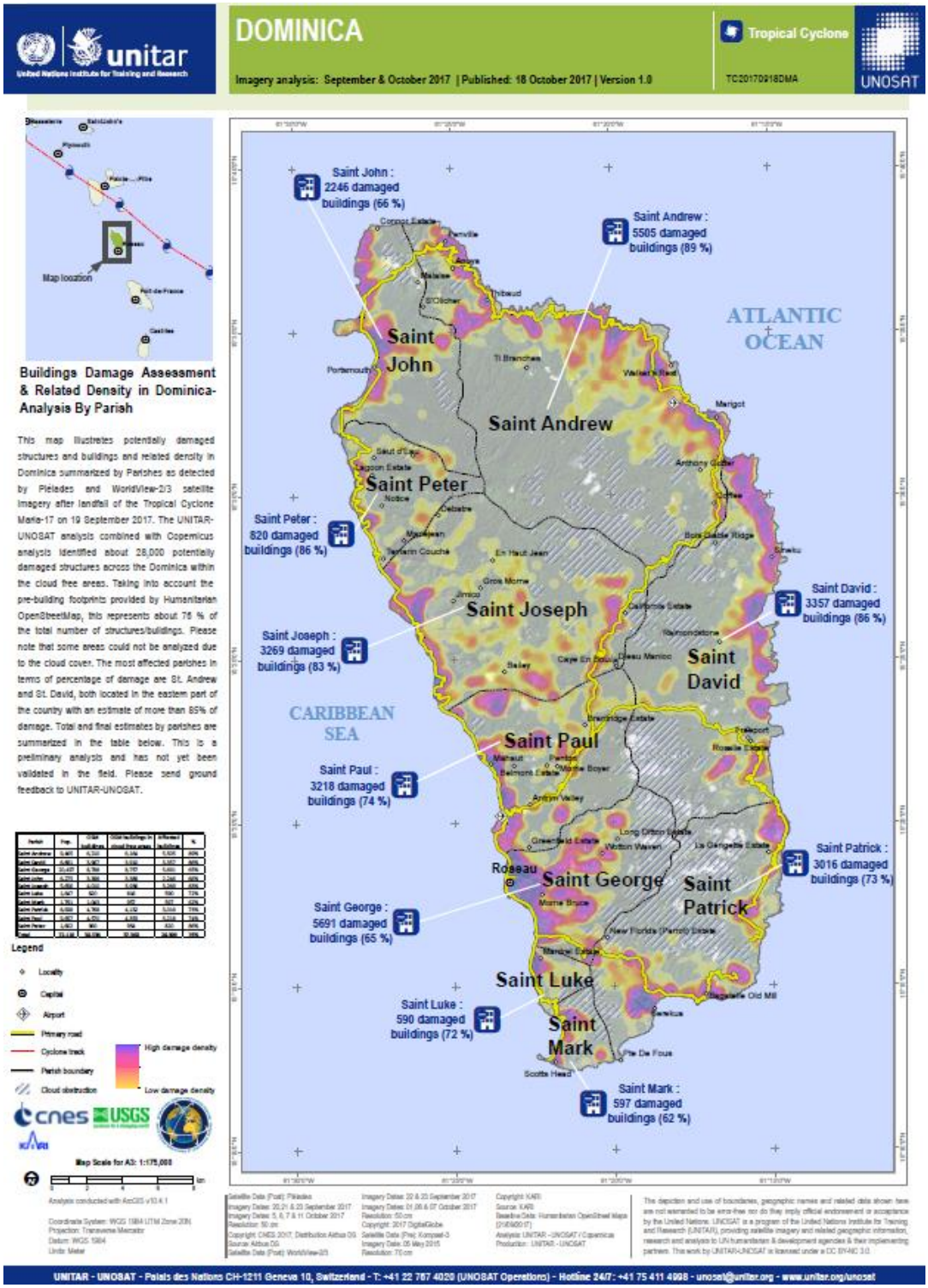


Figure 4: Building damage assessment

Picture 6: Aerial picture of Soufrière made by a drone, 10 October 2017

High definition aerial images even allow the counting of missing metal sheets:

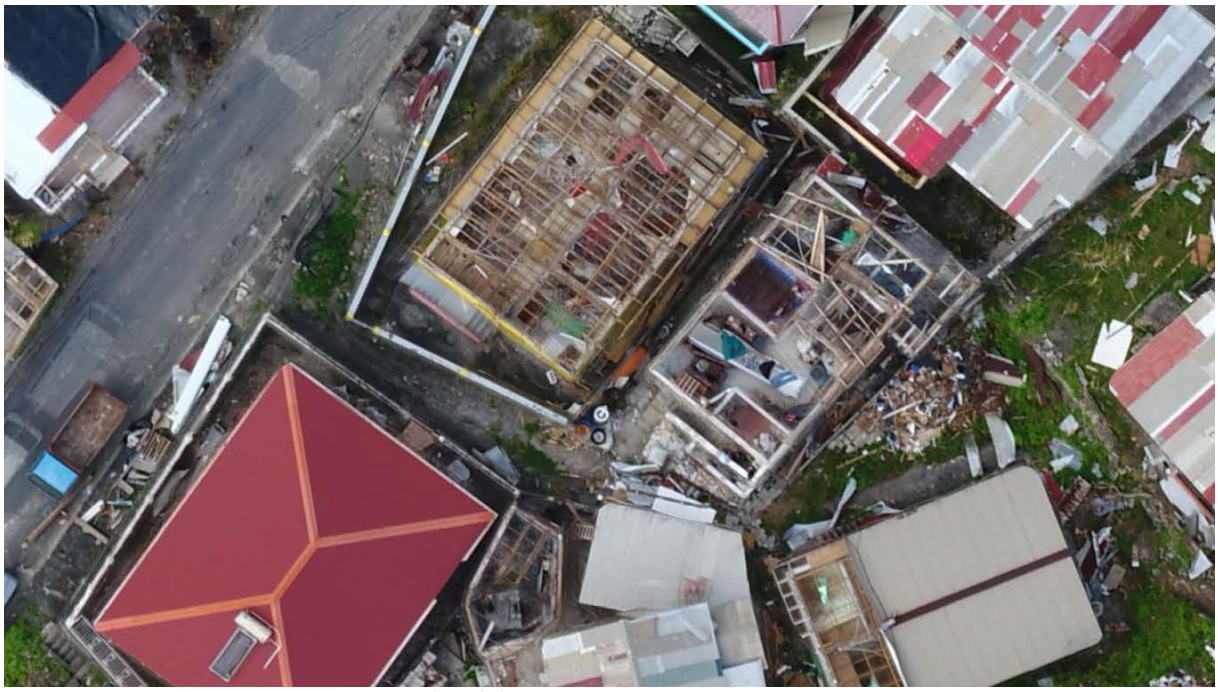
Picture 7: High-resolution aerial picture of Soufrière made by a drone, 10 October 2017, same as previous, enlarged

Satellite imagery analysis would allow for a more detailed analysis of why certain roofs resisted the hurricane while others (in similar and adjacent areas) did not. The impact of Hurricane Maria could even be used to classify the resistance of various building typologies.

The riverbed load carried by the storm stream is seen in picture 7. However, the river mouth remained almost clean. A visit a kilometre upstream showed that the largest part of displaced stones, rocks and sand were deposited on a large plain, previously occupied by agriculture and a school.

Picture 8: Higher resolution aerial picture of Soufrière made by a drone, 10 October 2017, same as previous, enlarged

The picture above shows a section of forest near Souffrière, where one can see the broken or unrooted trees. The vegetation became green again after two to three weeks.



Picture 9: Higher resolution aerial picture of Soufrière made by a drone, 10 October 2017, same as previous, enlarged

A closer view of the same initial aerial image, shows, a few meters one from the others, three houses, one intact (at least the roof), another with the naked carpentry and the last one without any roof or structure.

In order to accurately determine the volume of debris generated by the hurricane, the analysis would need to consider how to address debris which could be recycled on site. Any estimates are likely to have an error factor of 5 to 20 or more.

Despite the possibility to conduct assessments on the exact volume of debris, clearing away debris quickly was given higher priority in order to ameliorate community life. Although in principle, such estimations are possible, whether they will inform or bring more funds for recover is questionable.

Findings

- No proper strategy exists for the temporary storage of the large volumes of debris creating environmental and health risks for the population; this leads to large volumes of material being ¨dumped¨, widespread burning of material; and other challenges.
- With the exception of Roseau (and partly Portsmouth), the rest of the country has very limited or no equipment and resources to clean the roads and yards.
- Because of the heavily impacted forests, the roads and agricultural fields are covered with broken or uprooted trees, soil and stones.
- Many rivers have been transporting huge volumes of rocks, soils and trees, flooding villages and farm land.
- Bridges built too low on the river beds have been acting as dams, pushing the river and the material out of its bed. The mission did not find evidence of any existing substantial desilting programme.
- House building techniques and practices used in the past proved to be limited in terms of hurricane resistance, which led to a large number of roofs and house parts deposited on the ground.

Analysis

- The disaster preparedness plan did not anticipate effective debris management such as the need for temporary storage sites and an analysis of suitable open spaces.
- Building codes and guidance for disaster resistant building are insufficiently supported.

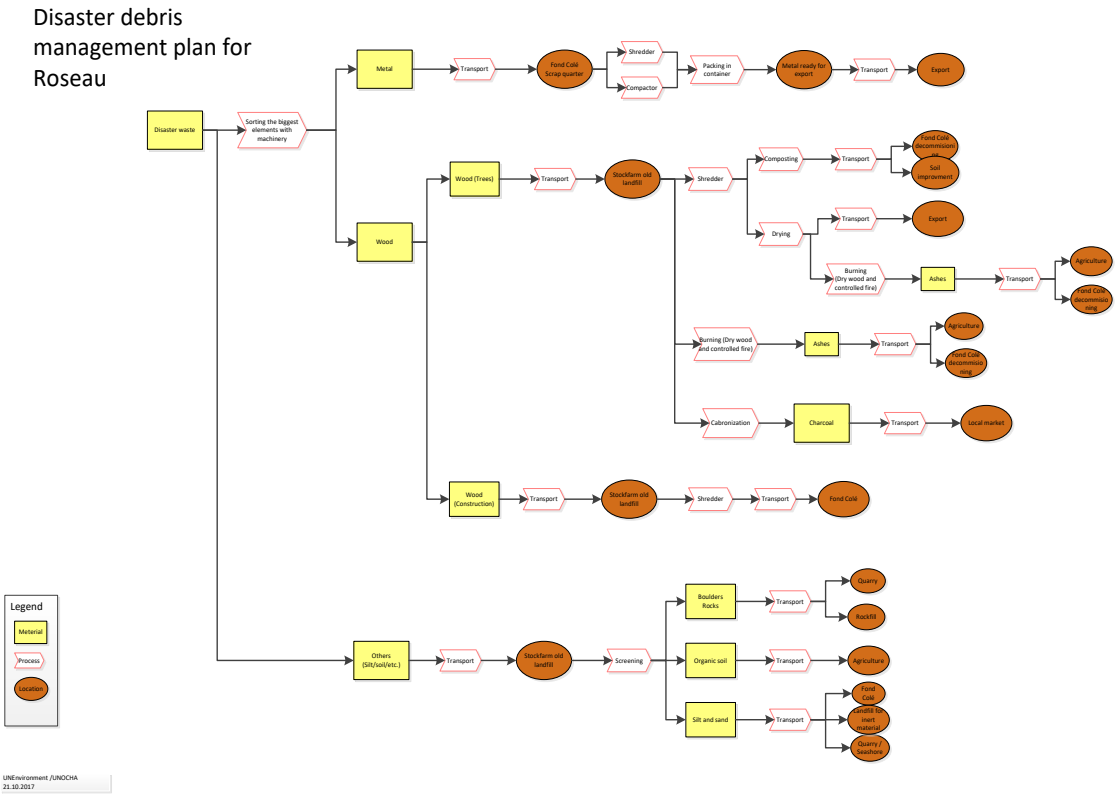


Figure 3: Disaster debris management plan for Roseau (see Annex 3) prepared by RP and LN

Recommendations

- The building code must be amended and subsequently enforced in order to develop a generation of disaster resistant buildings.
- Major infrastructure works should be planned, with due consideration of surrounding environment, river behaviour, rock falls, landslides, etc.
- Public services (water pipes, wastewater pipes, electricity cables, etc.) should not be reachable by floods along bridges as hanging below or alongside of the bridge deck.
- A disaster waste management plan must be developed and integrated into the waste management and disaster preparedness masterplan. It must include, among others: temporary storage sites, priority equipment and available capacities within the most exposed communities, pre-established contracts for future debris removal and recycling options.

3.4 Wastewater

Findings

- The Roseau WWTP (Wastewater Treatment Plant) only provides physical treatment, without further chemical or biological treatment. Consequently, dissolved organic load and fine particules are not treated.
- The primary screening's compacting screw of the WWTP, as well as its support, are broken due to corrosion.

- The WWTP appears to be in good condition and ready to operate, with minor electrical and technical checks.
- Parts of the wastewater network have been broken and flushed away by material carried along the river as well as through the destruction of houses.
- One of the two WWPS (Wastewater pumping station) does not work.

Picture 5: Roseau wastewater filtering station, first screening level, and broken endless screw used to compact the extracted material. 13.10.17 Ncl

Analysis

- Apparently the WWTP maintenance procedures have not been followed, as (for some time already) a broken element stops the process at an early stage.
- The wastewater networks location may have to be analysed in the light of recent disasters.
- The WWTP was not functioning properly before Hurricane Maria.

Recommendations

- The company, which built and commissioned the WWTP, should be invited to inspect it and undertake remedial work immediately.
- The wastewater network must be cleaned / repaired / bypassed when needed in order to bring back the wastewater to the WWTP.
- A proper maintenance plan must be developed and implemented, associated with trained mechanics and electricians having adequate tools and spares.
- Education / communication campaigns must be developed and implemented in order to ensure proper use of the sewage system.

3.5 Water

Findings

- Water and wastewater networks are vulnerable to natural hazard events, as experienced by Dominica recently.
- Water catchments are not always well protected from the consequence of climate related hazards.
- The chlorination unit which uses compressed dry chlorine, is located in an area prone to erosion during periods of excessive river and debris flows. At least one case has been observed where the chlorine tank disappeared when the flooded river wiped away the treatment unit.

Analysis

- The construction code for water catchment, water catchment protection area and water distribution network needs to be reinforced in order to better mitigate foreseeable natural hazards.

Recommendations

- The direct chlorination with dry chlorine is highly hazardous and should be replaced by other disinfection methods (sodium or calcium hypochlorite or chlorine dioxideor similar).
- The location of catchment and chlorination/disinfection units must be carefully studied to avoid natural hazards.

4. Hazardous Chemicals

UN Environment carried out a rapid remote assessment of potential chemical impacts on 19 September 2017, just after Maria had struck. The Flash Environmental Assessment Tool (FEAT[12]) was used to estimate potential sites. The mission confirmed the situation at these sites, with key findings summarized below.

	Operation type	Substances	Comment
1	Airports	Kerosene	Relevant
2	Fond Colé Landfill	Benzene	Not relevant after site verification
3	Electricity Services	Oil and solvent	In addition, generators are functioning with diesel
4	Petrol station	Petroleum	Diesel / gas

[12] www.eecentre.org/feat

5	Hospitals	Ethylene oxide	Not relevant after site verification, disinfection is carried out by autoclaves
6	Ports	Petroleum	Diesel, heavy oil and mechanical lubricants
7	Water and Sewerage services (DOWASCO)	Methanol	Not relevant, but anhydrous chlorine is used for disinfection as well as hypochlorite
8	Pure Aqua (bottling)	Chlorine	Not relevant after interview

The remotely conducted FEAT analysis shows some discrepancies in comparison to site findings. The most important one is the case of DOWASCO (n°7). As a water service provider, the DOWASCO does not use any methanol, but chlorine and calcium hypochlorite.

At least in one observed case, the chlorination unit, upstream Soufrière, was washed up by the debris and the chlorine tank disappeared (Ton-cylinder). Luckily, due to the strong wind and torrential rain, the gaseous chlorine did not provoke any damages.

5. Conclusions

The recovery of Dominica is tightly tied to the overall economic development of the country, which until now has largely been based on subsistence activities. While there has been some tourism, as well as some export of agricultural products and minerals from stone mines, the export and tourism sectors are unlikely to significantly develop in the upcoming years.

Consequently, suggested hurricane recovery solutions must be adapted to the local economic and institutional realities and must be affordable for the community. Ideally, a gradual development of the country using existing resources would be foreseen and form part of the Government's vision. When it comes to waste management, activities should be undertaken in order to stimulate citizens' behaviour and responsibility towards a more sustainable management of waste. Key activities and changes in behaviour would include a move towards waste reduction, waste sorting and waste recycling.

Dominica's aspiration to become an eco-tourism hotspot requires dedicated efforts and needs to be coupled with significant improvements in existing waste management and wastewater treatment processes. Consequently, an adapted waste management masterplan covering the next 10 to 30 years should be developed. The plan should pay attention to the local conditions. Its implementation must be carefully prepared and carried out with financial and institutional support made available over the long run. Given Dominica's location in the hurricane corridor, disaster debris management must be an integral part of this plan.

The development, implementation and monitoring of the national plan would ideally be supported by a long-term advisory team. Such a team would provide support to the Government and its agencies, ensuring quality management in the implementation of the activities. Individual organizations could support on various technical elements, where for example PAHO is already providing support in the field of health.

During past decades many plans have been developed at country and regional level. These include significant data in the form of context analysis, GIS and hazard mapping. This existing data should form the basis of work going forward, in order to avoid duplication of what already exists.

6. Recommendations

Based on the findings of the two-week assessment, the mission concludes that the existing centralised system for domestic waste collection and dumping has reached its limit and should be replaced. The following activities should be undertaken by the Government of Dominica as a priority:

- Develop a clear long-term waste management strategy (covering both domestic, healthcare, hazardous and disaster waste), integrating, among others, tourism development which is considered an economic development priority;
- Include disaster waste management into the future waste management master plan as well as the disaster preparedness master plan;
- Ensure waste management becomes a priority, allowing the country to harness economic opportunities of the Caribbean and regional waste market;
- Consider healthcare waste as a potential hazard requiring more rigorous management and disposal standards;
- Secure a long-term operational and maintenance budget for waste, which ensures the continuity of public services;
- Develop a detailed natural and technological hazards mapping at national and community levels;
- Develop a detailed industrial cadastre which records all hazardous material storages;
- Construct and maintain hazardous material storages and waste sites to resist disasters.

7. Annexes

Annex 1. Request for assistance

Annex 2. Logical scheme for waste sorting

Annex 3 Flowchart for debris management

Annex 4 Presentation delivered on October 18, 2017

Annex 5 History

Annex 6 Recommendations

Bibliography

Annex 1

7. 1 Terms of reference

DISASTER WASTE MANAGEMENT EXPERT (Senior Technical Adviser)

TERMS OF REFERENCE

UN Environment / OCHA Joint Unit (JEU)[13]

Disasters such as earthquakes and floods often result in significant secondary environmental impacts including the potential for polluted water and related health hazards. These secondary impacts can pose immediate, life-threatening risks to humans (both local communities and responders), the aquatic environment as well as longer-term challenges to water monitoring and water use for agricultural purposes.

Disasters often generate large volumes of disaster waste, comprised of a mixture of soil and sediments, building rubble, vegetation, municipal waste, hazardous materials (including asbestos and healthcare waste), as well as human and animal remains. This combination of diverse waste materials poses a serious risk to human health from biological, chemical and physical sources, and may also impede urgent humanitarian access routes. Disaster waste places an additional burden on a nation or community already struggling to cope, and often overwhelms existing waste management services and infrastructure. Experiences from past disasters show that wrong handling of waste in the immediate aftermath of a disaster may be the cause for future environmental problems. Disaster waste management is an integrated approach where early interventions may lead to more effective response and recovery operations with less impact on the environment and better utilisation of natural resources.

In environmental emergencies and disasters with major environmental impacts, the UN Environment/OCHA Joint Unit (JEU) can mobilise specialised assessment missions and/or deploy associate environmental experts with the United Nations Disaster Assessment and Coordination (UNDAC) team.

Context:

Category 5 Hurricane Irma hit the Caribbean in early September 2017, devastating Barbuda and Anguilla, St Maarten, parts of the Turks and Caicos Islands and the Bahamas and seriously affecting the British Virgin Islands and St Kitts and Nevis. It is estimated that Irma damaged at least 90% of the buildings on Barbuda and St Maarten. The UN system deployed a UNDAC team, initially based in Barbados but subsequently redeploying across various islands. Category 5 Hurricane Maria hit the Caribbean shortly after Hurricane Irma, making landfall in Dominica on 21 September. 14 deaths have been reported in Dominica and flyovers confirm that 80-90% of buildings have damaged to varying degrees. There are countless road blocks due to fallen trees and boulders and there is an acute need for clearing of roads and management of debris, sediments and disaster waste. Approximately 75% of trees are reported blown down or having foliage and branches stripped. The Caribbean Disasters and Emergency Management Agency (CDEMA) organised two coordination bases to attend to the emergency in Barbados and Jamaica. Through CDEMA, the Government of Dominica has requested the support of one disaster waste management expert, to be

[13] For more information, see: http://www.unocha.org/unep

affiliated with the UNDAC team, providing support to the Government of Dominica on disaster waste.

Deployment duration: The deployment is foreseen for three weeks. There could, however, be a need for a longer deployment into the recovery phase. In this case, the modalities for extension and/or additional deployment will be separately discussed.

Operating base and logistics: Dominica, with travel to affected areas. Transport within the country region to be organised by CDEMA or member states, using either their own resources or humanitarian or military transport.

Key responsibilities:

- The following describes the key responsibilities and required background and skills of the disaster waste management expert. The list is only a guide, since needs vary and evolve according to the emergency.
- Support the initial damage and needs assessments, identifying relevant disaster waste management issues and their potential interaction with humanitarian needs across the different sectors / clusters;
- Provide on-site practical advice and guidance to the Government, UNDAC team, CDEMA, and sectors/clusters as appropriate, by proposing solutions to minimise environmental and health impacts of disaster waste;
- Assist local authorities in the development of a disaster waste management plan/system, including guidance on proper management of existing waste disposal sites, logistics of waste collection services, and optimisation of recycling and re-use options;
- Liaise and coordinate with other mechanisms and entities involved in disaster waste issues such as the IASC[14] clusters[15] for Water, Sanitation and Hygiene, Shelter and Early Recovery (and other clusters or coordination mechanisms as appropriate), and agencies such as PAHO (WHO), UNDP and UNICEF;
- Coordinate with all other actors undertaking activities related to waste management, either directly or in the framework of sectoral activities, to promote synergies and best practice and avoid overlap;
- Pay particular attention to waste collection and disposal in shelters, especially concerning household waste, sanitation, drinking water and recycling;
- Provide advice and guidance to national and international aid organisations with disaster waste management issues if requested;

Expected Actions:

[14] Inter Agency Standing Committee: http://www.humanitarianinfo.org/iasc/
[15] Cluster Approach: http://www.humanitarianreform.org

Undertake, in close collaboration with the relevant local and national authorities and international emergency responders, an overall assessment of the disaster waste situation, including:

- Identify any needs for further technical assistance, as well as medium and long term needs for capacity building;
- Assess the existing local capacity for addressing disaster waste management issues;
- Identify specific risks posed by asbestos, healthcare waste, hazardous materials, agricultural or industrial chemicals / pollution and other environmental legacies impacted by the hurricane and/or the subsequent response;
- Disseminate and promote the use of the Disaster Waste Management Guidelines[16];
- Communicate rapidly and regularly all findings to the UNDAC team, the local authorities, the United Nations Resident Coordinator, and the JEU as appropriate;
- Document, in electronic form, the assessment results, recommendations, and mitigation measures implemented, if applicable;
- Provide advice and support to any Post Disaster Needs Assessment (PDNA) or similar process, if appropriate;
- Support any coordination groups or agencies promoting work programmes such as cash for work involving waste clearance, to ensure that those activities minimise risks to people and the environment and do not generate longer term environmental legacies.

Note: Contact with media, including interviews, should only be undertaken with consent of the government and in consultation with the UNDAC team, the United Nations Resident Coordinator and the JEU.

Education and work experience:

- University degree in a relevant discipline, such as environmental science and/or civil engineering;
- Background in solid and/or hazardous waste management issues with at least ten years of experience;
- Experience in environmental impact/risk assessment;
- Knowledge of disaster waste management;
- Working experience in a disaster-affected environment and/or developing countries an asset;
- Ability to work under stressful circumstances and/or in hardship conditions for up to three weeks;
- Availability for additional follow-up, collaboration and editing of mission report after the official mission deadline, if required;

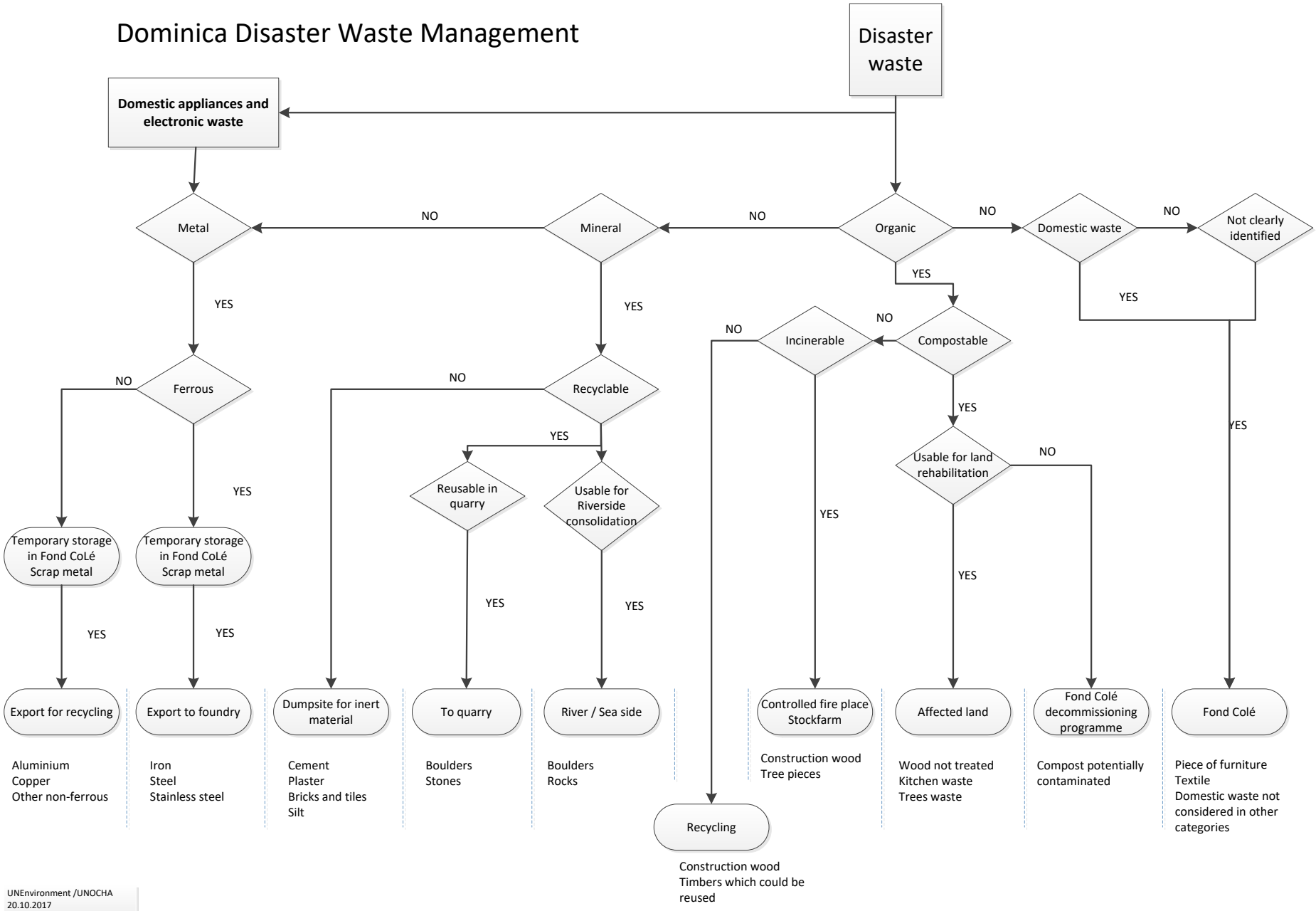
[16] http://dwmg.eecentre.org/index.asp

- Fluency in English, oral and written;
- Flexibility to work across multiple countries and territories, with different governments, agencies and needs, considering the diverse characteristics of the countries and territories affected;
- Knowledge of MS Windows and MS Office and ability to operate standard IT and communications equipment.

Annex 2

7.2 Logical scheme for waste sorting

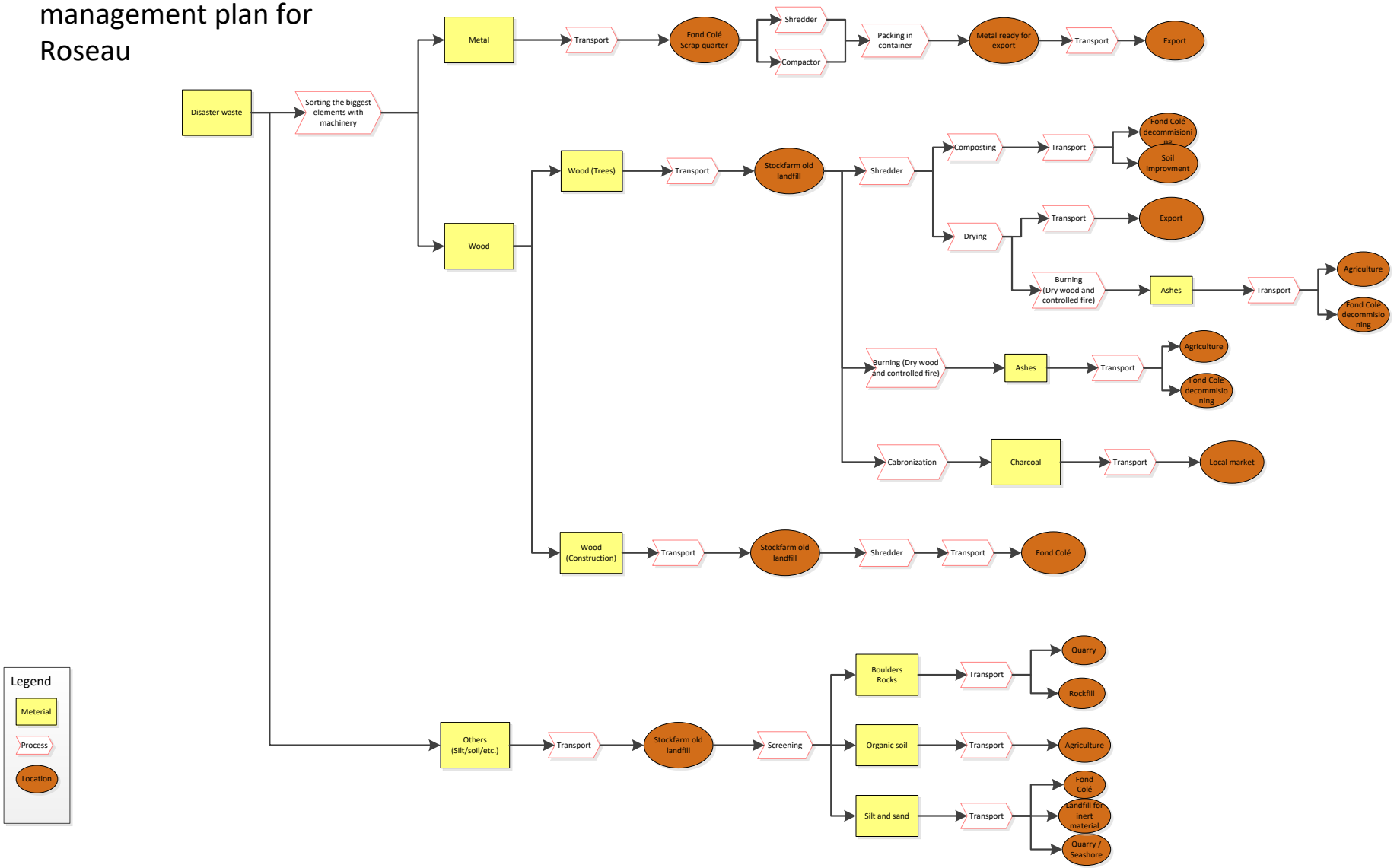
Dominica Disaster Waste Management



Annex 3

7.3 Flowchart for debris management

Disaster debris management plan for Roseau



UNEnvironment /UNOCHA
21.10.2017

Annex 4

7.4 Presentation

delivered on October 18, 2017 in the Ministry of Finance in Roseau, Dominica

OCHA

UN Environment / OCHA Joint Unit
Prepare. Respond. Protect.

UN environment

UNDP
Empowered lives. Resilient nations.

European Civil Protection

Schweizerische Eidgenossenschaft
Confédération suisse
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Swiss Agency for Development and Cooperation SDC

Interim Report, 18 October, 2017

Disaster Waste and Early Recovery Specialists Team

Dominica

October 2017

Topic	Key findings	Evaluation	Normal context	Post disaster context
Biomedical waste collection	The centralized collection system is not regular	Critical	Hospital and clinics require waste collection but service is not regularly guaranteed. PMH has its own contractor for collection.	The accumulation of waste due to the absence of collection after the hurricane and the damaged stocks may become a serious problem in the short term giving the limited capacity of secure storage (in open spaces exposed to the rain and sun)
Biomedical waste treatment	The incinerator does not work since ~2013	Critical	The PMH incinerator is out of order since 2013 A new one, with a capacity of 50 kg/h has still to be installed. Since 2013, all biomedical waste, body parts, sharps and infectious are dumped in Fond Colé without treatment.	Not changed

Topic	Key findings	Evaluation	Normal context	Post disaster context
Domestic waste collection	The centralized domestic waste collection system does not have the necessary frequency or geographical reach.	Critical	The waste collection is difficult outside of Roseau and Portsmouth. Private contractors are handling waste in different areas for commercial and industrial spaces	The service (DSWM Co) has been insufficient up to 1 month after the hurricane. Due to limited funding, lack of equipment and maintenance, the service was unable to influence the clearance of the city, the work being carried out by the Ministry of Public Works.
Domestic waste dumping	The Fond Colé landfill is almost full	Critical	The dumpsite, established in an old quarry was commissioned in 2007. The Fond Colé dumpsite reaches its full capacity. The leachate are partly collected and directed to a pound. Location of the dumpsite is critical by itself. An WB mission studied, in 2016, a possible extension of the site	Despite of its location, the dumpsite was not flooded. Some of its facilities such as the Solid Waste Management Corporation office or some equipment and workshops have been affected by the flash floods. Giving the fact that the site is reaching capacity, the additional waste generated by Maria will saturate it.

Fond Colé landfill at the beginning of its operation Around 2007

Today, the landfill is full October 2017

Topic	Key findings	Evaluation	Normal context	Post disaster context
Organic waste	Only a few local initiatives for composting	Problematic	30 to 50 % of the domestic waste could be composted, reducing the volume of waste to be dumped. The compost to be reuse in agriculture.	Maria generated an enormous quantity of broken trees. The existing practice is to burn it on the side of the road or to leave it decomposing in the forest. Part of it could be, among others composted.
PET	Non-functioning equipment. Limited sorting	Problematic	In practice domestic waste is not sorted and is full of PET, unnecessarily loading the dumpsite.	The PET shredding facility, located in Fond Colé was damaged by Erika (!) and not restarted since than (walls, roof).



Topic	Key findings	Evaluation	Normal context	Post disaster context
Metal ferrous / non-ferrous	Sorting exists Recycling practices inefficient	Problematic	Scrap metal can be seen all around the country Regular collection and export practices are missing	The consequences of Maria are an additional considerable quantity of scrap metal from damaged houses and cars.
Hazardous waste	No sorting	Problematic	The hazardous waste are mainly dumped in Fond Colé. Sorting of the main hazardous waste such oil, batteries (dry or not) would reduce the burden on environment.	Not changed



Topic	Key findings	Evaluation	Normal context	Post disaster context
Inert waste / construction waste	Missing specific landfill	Problematic	Inert material should be dumped in ad hoc dumpsite. There isn't a specific regulation or practice on this type of waste	Maria didn't produce an large quantity of construction waste, as people are reusing most of the material.

Topic	Key findings	Evaluation	Normal context	Post disaster context
Disaster debris	Some metal sorting by individual exists No disaster waste management plan has been identified	Problematic	Although the country is frequently affected by storms/hurricanes disaster waste management preparedness plan does not seems including pre-planned temporary storage areas. Disaster debris are often difficult to sort being a mix of soil, stones, sand, wood and pieces of construction, furniture, domestic appliances, etc.	Most of the disaster waste was quickly removed from the centre of Roseau by the Public Works Ministry. The disaster debris were stored mostly on public land as temporary locations. In the rest of the country, the debris are being stored on the side of the road, on old dumpsites or open spaces. The involvement of the Solid Waste Management Corporation was insufficent.

Action plan in order to keep the situation of waste management under control

Preliminary comment: Even if the Fond Colé extension is approved, a new site is needed. The process, taking 3 to 4 years before the new site is operational, no time can be wasted.

Action	When	Time frame		Comment	Cost estimate
Identification a few suitable sites for a sanitary landfill (location / geology / hydrogeology / specific zone / population / landscape / etc.)	NOW	3-5 months	Between 16 and 21 months	In order to make a reasonable choice, different sites have to be analysed.	Complete process: 4 to 8 million USD
Site selection		3-6 months		The selection must integrate all the technical parameters and the local population acceptance. Therefore communication is part of the selection process.	
Project preparation		2 months		The project must integrate the state of the art techniques in order to secure the leachate collection and treatment, gas collection, access independently from the weather, etc.	
Technical and financial feasibility study (including business model)		4 months			
Environmental impact assessment including alternatives analysis (including public consultation)		4 months		The World Bank model of EIA provides good basis and references if the legal framework is not detailed enough.	

Action plan in order to keep the situation of waste management under control

Action	When	Time frame		Comment	Cost estimate
Detailed project		4 months	10 to 22 months		Complete process: 4 to 8 million USD
Site preparation /could be phased		6 -18 months			
Fond Colé decommissioning	From now	4-5 years		The decommissioning can follow different ways, considering the internal chemical/biological life of the dumpsite (up to 100 years). The Site and existing recycling activities can be better reclaimed. Composting can be envisaged one the site is properly reclaimed, etc.	
Legislation adaptation	From now	1 to 2 years		The environmental framework should be updated in order to integrate the waste management in general, the waste sorting, the dumping, the recycling, the implementation tools, the business model adopted for waste management, the responsibility of the waste producers, etc.	

Action plan for biomedical waste management

Action	When	Time frame		Comment	Cost estimate
Cleaning-up of the existing bio-medical waste storages	Now	2 to 4 weeks		Out of Roseau, the bio-medical waste has not been collected since early September. In PMH, the process is on-going	
Removal of the old incinerator in PMH	On-going	2 to 4 weeks		The incinerator is recorded as out of order for some 4 years	
Installation of the new incinerator in PMH	Now	2 to 4 weeks		A 50 kg/h incinerator has been ordered by PMH. It still has to be released from custom. Provider has to install	
The capacity of the new incinerator, will only be sufficient to treat the most hazardous of the medical waste produced by Dominica's healthcare network					
A proper medical waste collection system must be implemented.	Now	2 to 6 months		The necessary logistic must be secured in terms of investment, operation and maintenance in order to reduce the storage time at all of the health posts.	
Medical waste collection trucks must be purchased	Now	2 to 6 months		A minimum of two refrigerator trucks are needed to ensure a permanent collection service	
Legislation adaptation	From now	1 to 2 years		The environmental framework should be reprocessed to integrate the waste management in general. Specific consideration must be paid to bio-medical waste, infectious waste, body parts, drugs, etc.	

Action plan for debris management

Issues	When	Time frame	Actions
ROSEAU Emptying public spaces Priority being given to school yards (Goodwill for instance)	Within a month	1 months	**1. On-site debris sorting in large categories** • Metal • Wood • Domestic waste • Silt, soil and stones (and to mixt material)
			2. Transportation (as soon as a truck load is ready) • Metal can go to Fond Colé scrap metal quarter before being recycled • Domestic waste must go to Fond Colé • Wood can be temporary stored on the Stockfarm old dumpsite • Silt, soil and stones should be screened to separate the different fractions: a. In a quarry having screening equipment b. On the Stockfarm old dumpsite
			3. Recycling • **Wood** can be used / recycled in different ways a. Shredded, mixed with soil and use to reclaim part of Fond Colé b. Used as a structuring material to consolidate the Fond Colé dump pile sides c. Burned in a controlled fire d. Transformed into charcoal • **Stones** can be recycled in the quarry • **Rocks** can be used to stabilized river beds or in the quarry or to stabilize any other slope

Action plan for debris management (continuation)

Issues	When	Time frame	Actions
			3. Recycling (Continuation) • **Soil and silt** can be used for Fond Colé decommissioning, can be mixed with wood chips. • **Soil,** if quality is good enough, can be used to reclaim poor soils, eroded area, etc.
Similar scenario should be developed for the other areas affected by heavy landslides and mud flows. (South of Roseau for instance)			
Noth of Canefield airport temporary deposite			As dumped, part of the material will be washed by the sea. A large rocks reinforcement line should be built in front of the sea with the large rocks recovered from the rivers dredging. Debris should be screened and processed as described above.

Key messages

Dominica should take the opportunity to improve on the previous situation and not go back to business as usual

Waste management masterplan should consider the disaster waste management as an integral part

Waste management masterplan must include a financing model

Dominica should adopt and implement a 3R strategy
Reduce – Reuse - Recycle

Annex 5

7.5 History

After nearly 3,000 years of human habitation, Dominica, known to many as "the Nature Island of the Caribbean," is one of the few places where untouched primary tropical forests can still be found. More than in most islands, this rugged terrain has guided the course of Dominica's history. The steep mountains and deep valleys provided the early Carib Indians with a natural fortress against European colonizers, making Dominica one of the last islands to be fully colonized.

These same features later provided a safe haven for escaped slaves. Since then, the struggle between man and mountain has significantly affected the direction and pace of Dominica's development by determining the location and cost of roads, farms, and buildings.

Some 593 years after the Caribs settled in Dominica, Christopher Columbus first sighted the island on his second voyage to the New World. Unaware that the Caribs had already named the island Waitukubuli ("Tall is her body"), Columbus renamed it Dominica, after the Spanish word for Sunday, the day of his arrival, November 3, 1493.

For the next 200 years, no European power was able to conquer Dominica. The determined and often violent resistance of the island's Carib inhabitants was a major deterrent to colonization. As the Spanish empire grew in the 1500s, Dominica became increasingly important but only as a point for collecting wood and water. The island's resources were abundant, but attacking Caribs put the mariners at great risk. Only in the year 1627 when the French standard was raised did a European power claim the island as an occupied possession. Fifty years later, following repeated hostilities between the French and English over the island's ownership, a treaty was signed between the two countries declaring Dominica a neutral territory to "be inhabited by the savages to who [sic] it has been left . . .”

Long years of battle against French and English settlers and diseases contracted from these adversaries took their toll on a once defiant people until the Carib population was reduced drastically from a high of 5,000 in the year 1647 to just 400 in 1730. At this point, permanent settlers from Europe and other island colonies began to move into Dominica in increasing numbers.

French settlers were the first to establish themselves on Dominica, extracting timber and commencing small-scale farming. As more land was cleared, the French met labour needs by bringing in African slaves, who were already in the other West Indian colonies. In addition to working the plantation fields, these slaves were permitted to establish provision gardens and to raise small stock. Much of this produce was sold at Sunday markets where slaves from neighbouring plantations gathered to socialize and trade. Many slaves saved the income from these sales and used it to buy their freedom from the estate owners. This practice led to the early establishment of a group of free black inhabitants known either as «Affranchis» or as «mulâtre," many of whom later owned small estates and slaves. This unique mix of slave plantations owned by Europeans and Africans, existing alongside small garden plots and farms cultivated by escaped slaves, freed slaves, and Carib Indians, charted a markedly different colonial course for Dominica compared with that of the sugar colonies of Barbados and Jamaica. In these other islands, classic slave plantation structures became entrenched around large-scale sugar cultivation, which delayed the emergence of the system of small-scale, peasant farming that still characterizes Dominica's agriculture.

The evolution of this mixed agricultural sector was interrupted between 1756 and 1763 by the Seven Years War between Britain and France. After several battles, the British finally occupied Dominica in 1761, and two years later, in the Treaty of Paris, the French ceded the island to Britain.

Under this new European power, several changes occurred that greatly affected Dominica's future. The British introduced a system of colonial government in which the authority of the crown was vested in an administrator who had responsibility for defence, the treasury, law and order, and religion. British planters, merchants, and professionals were appointed to serve in a local assembly or legislature that sat as an oversight body to the administrator. This alliance of British property, wealth, and political power created a system of government that excluded the French planters from participating in the governance of the island. The result was increased tension between the growing number of British settlers and the French planters, who continued to be important to the export earnings of the colony. The freed slaves, black estate owners, and the large slave population remained completely excluded from involvement in political and economic discussions and decision-making.

Another significant development of this period that still affects land ownership patterns in Dominica was the distribution and sale of large tracts of land to British citizens resident in Britain. A land tenure system of absentee ownership rapidly became entrenched, and speculation by the owners kept good agricultural land out of production.

Beginning with the 1770s and continuing for the next sixty years, events throughout the world caused rapid and major changes in the island's colonial status. The 1775 declaration of war by the North American colonies against Britain disrupted a thriving trade that had developed between the colonies and Dominica in wood, rum, horses, cattle, and other items. In 1778, France took advantage of British difficulties in America to reclaim several British colonies in the West Indies, including Dominica; however, only a few later, in 1784, control of Dominica returned to the British through terms of the Treaty of Versailles. Finally, the Abolition of Slavery Act was passed in the British Parliament in 1833 and became law in Dominica on August 1, 1834. These events thrust Dominica firmly into the period of open struggle for an end to crown colony rule.

In 1832, three black members were elected to the Dominican House of Assembly, and by 1838, there was a black majority. Dominica became the only island in the British West Indies where white rule was successfully challenged. Political tensions grew rapidly as legislators began to press for laws promoting the welfare of the newly liberated citizens of the island. When legislators attempted to extend voting rights to freed people without property, the conservative British merchants and professionals, by then organized into a political party, countered with a call for the creation of a single executive council comprising nineteen elected representatives and nine members appointed by the crown.

Following elections conducted under the rules limiting voting rights to those of property, the blacks lost control of the government. As a result, they increased agitation against crown colony rule and launched a campaign that advocated the removal of the land tax and called for a special investigation by the British government into the affairs of the colony.

In response to this challenge, the British attempted, for the first time, to meet the social and infrastructure needs of the island. Roads were built through the mountainous interior,

agriculture was supported with research, extension services, and training and agroindustry was begun with the processing of lime juice for export to Britain. By the start of World War I, sufficient goodwill toward Britain had been re-established to encourage locals to volunteer for service in the British army.

The event that singlehandedly thrust Dominica into the modern era was the publication of the Moyne Commission Report in 1939. The Commission itself had been formed in response to riots that erupted throughout the British West Indies in the late 1930s. The report exposed the primitive conditions of the colonies and called for a comprehensive economic development program (see Labour Organizations, ch. 1). During the next twenty years, Dominica experienced what many of that generation refer to as "the good old days," when British aid, trade, and investment boosted local living standards, created jobs, trained public servants, and provided education and health facilities.

The expectations of workers and farmers rose with the advent of roads, radios, and newspapers. In the 1950s, demands for better work conditions, higher farm prices, and more land for farming began a period of popular social and political activism that led to the formation of trade unions and political parties representing the interests of workers and small farmers on the one hand and business interests on the other. The 1961 election of a government led by Edward Oliver Leblanc, a small farmer and agricultural extension worker, marked an important turning point in Dominica's history. Leblanc was the first person without links to the city- based ruling elite to ascend to government leadership in Dominica.

The political platform of his Dominica Labour Party (DLP) was very simple--"it was time for the little man to begin enjoying the fruits of his labour." Leblanc had first come to prominence as a member of the Federal Party, which represented Dominica in the short-lived West Indies Federation, and subsequently led the DLP to electoral victories in 1965 and 1970 (see The West Indies Federation, 1957-62, ch. 1). In 1967, he negotiated Associated Statehood with Britain, a constitutional status essentially one-step removed from political independence, which made the Dominica government responsible for all aspects of state except external affairs and defence. Although Leblanc resigned as premier in 1974 for reasons of health, the DLP, under Premier (the pre-independence title for head of government) Patrick John, won the next general election in 1975 and led Dominica to political independence in 1978.

In mid-1979, political discontent led to the formation of an interim government. After the 1980 elections, it was replaced by a government led by the Dominica Freedom Party under Prime Minister Eugenia Charles. She was the Caribbean's first female prime minister. Chronic economic problems were compounded by the severe damages of hurricanes in 1979 and in 1980.

In 1981, Dominica was threatened with a takeover by mercenaries[18] of Operation Red Dog, led by Mike Perdue of Houston and Wolfgang Droege of Toronto. They tried to overthrow the Charles government. These North American mercenaries were to help ex-Prime Minister Patrick John and his Dominica Defence Force regain control of the island, in exchange for control over its future development. The United States FBI was tipped off, and the ship hired to transport the mercenaries never left dock. The mercenaries lacked formal military experience or training, and most of the crew had been misled into joining by the ringleader

Mike Perdue. White supremacist Don Black was also jailed for his part in the attempt, which violated US neutrality laws.[19]

By the end of the 1980s, the economy recovered. It weakened again in the 1990s due to a decrease in banana prices and worldwide recession.

In the January 2000 elections, the Edison James United Workers Party (UWP) was defeated by the Dominican Labour Party (DLP), led by Roosevelt P. "Rosie" Douglas. Douglas died after only a few months in office. He was replaced by Pierre Charles, who died in office in January 2004. Roosevelt Skerrit, also of the DLP, replaced Charles as Prime Minister. Under Prime Minister Skerrit's leadership, the DLP won elections in May 2005 that gave the party 12 seats in the 21-member Parliament, to the UWP's 8 seats. An independent candidate affiliated with the DLP won a seat as well. Later, the independent candidate joined the government and one UWP member crossed the aisle, making the total 14 seats for the DLP and seven for the UWP.

In the December 2009 elections, DLP won 18 of 21 seats. UWP claimed campaign improprieties and boycotted Parliament; by-elections were conducted for two of its seats in July 2010, and the UWP again won the seats.[20] On 17 September 2012 Eliud Thaddeus Williams was sworn in as President, replacing Dr Nicholas Liverpool who was reportedly removed from office due to ill health. The current President, Charles Savarin, was elected on 30 September 2013. He resigned as a Minister of Government only days before his appointment.

Annex 6

7.6 Recommendations

Recommendations for the Management of Post Hurricane Disaster Waste

<table>
<tr><th colspan="2">Key recommendations for all type of waste</th></tr>
<tr><td colspan="2">

Develop a clear long-term waste management strategy, integrating, among others, tourism development which is considered an economic development priority;
Include disaster waste management into the future waste management master plan as well as the disaster preparedness master plan;
Ensure waste management becomes a priority, allowing the country to harness economic opportunities of the Caribbean and regional waste market;
Consider biomedical waste as a potential hazard requiring more rigorous management and disposal standards;
Secure a long-term operational and maintenance budget for waste, which ensures the continuity of public services;
Develop a detailed natural and technological hazards mapping at national and community levels;
Develop a detailed industrial cadastre which records all hazardous material storages;
Construct and maintain hazardous material storages and waste sites to resist disasters.

</td></tr>
<tr><th colspan="2">Recommendations for each type of waste</th></tr>
<tr><td>Domestic waste</td><td>

The closure plan of Fond Colé must be developed immediately and alternatives identified with a vision for 30 to 50 years.
A concept of national waste management covering all types of waste (domestic, hospital, hazardous and disaster waste) should be developed in the short term, including a master plan, a business model and an implementation action plan.
Efficient waste sorting strategies must be developed emphasizing sorting / reusing /recycling. These strategies should address large scale composting of organic waste, scrap metal collection and recycling across the island, PET collection and recycling, and critically managing deadwood.
Education, information and communication campaigns on key elements of the waste management strategy must be developed in order to reach the entire population in the medium to long term.
The Fond Colé decommissioned dumpsite can be transformed into a composting platform.
Methanization of organic waste can be envisaged in connection with landfill gas collection and the collected gas can be used to produce electricity.
Private sector involvement and investment should be encouraged and actively sought for recycling, reuse and export of valuable waste.

</td></tr>
<tr><td>Healthcare waste</td><td>

The old non-functioning incinerator must be urgently decommissioned and removed, along with the disconnected deep-freezer containing body parts exposed to the elements (operation under preparation at the time the mission left).

</td></tr>
</table>

	• A new incinerator must be urgently installed (operation under preparation at the time the mission left). • A set of at least two cooling trucks must be acquired in the coming months to ensure healthcare waste collection across the island with an acceptable frequency for all hospitals and health centers. A maintenance programme must ensure that the trucks are permanently operational. • PMH, functioning as a collection centre for healthcare waste, should be equipped with a specific waste cooling room in the framework of the on-going hospital development project.
Debris	• The building code must be amended and subsequently enforced in order to develop a generation of disaster resistant buildings. • Major infrastructure works should be planned, with due consideration of surrounding environment, river behavior, rock falls, landslides, etc. • Public services (water pipes, wastewater pipes, electricity cables, etc.) should not be reachable by floods along bridges as hanging below or alongside of the bridge deck. • A disaster waste management plan must be developed and integrated into the waste management and disaster preparedness master plan. It must include, among others: temporary storage sites, priority equipment and available capacities within the most exposed communities, pre-established contracts for future debris removal and recycling options.
Wastewater	• The company, which built and commissioned the WWTP, should be invited to inspect it and undertake remedial work immediately. • The wastewater network must be cleaned / repaired / bypassed when needed in order to bring back the wastewater to the WWTP. • A proper maintenance plan must be developed and implemented, associated with trained mechanics and electricians having adequate tools and spares. • Education / communication campaigns must be developed and implemented in order to ensure proper use of the sewage system.
Water	• The direct chlorination with dry chlorine is highly hazardous and should be replaced by other disinfection methods (sodium or calcium hypochlorite or chlorine dioxide or similar). • The location of catchment and chlorination/disinfection units must be carefully studied to avoid natural hazards.

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