GRENADA DROUGHT MANAGEMENT PLAN

JANUARY 1, 2019

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Glossary

C&PM	Carriacou and Petite Martinique
C&PM	Carriacou and Petite Martinique
CEHI	Caribbean Environmental Health Institute
CIA	US Central Intelligence Agency
COP	Conference of the Parties
DEWIS	Drought Early Warning and Information Systems
DEWIS	Drought Early Warning and Information Systems
DS&DMP	Dry Season and Drought Management Plan
DS&DMP	Dry Season and Drought Management Plan
ECLAC	Economic Commission for Latin America and the Caribbean
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	United Nations Food and Agriculture Organisation
GDMC	Grenada Drought Management Committee
GDMC	Grenada Drought Management Committee
GDS&DMP	Grenada Dry Season and Drought Management Plan
GDS&DMP	Grenada Dry Season and Drought Management Plan
GOG	Government of Grenada
GOG	Government of Grenada
GRENCODA	Grenada Community Development Agency
GRENCODA	Grenada Community Development Agency
NADMA	National Disaster Management Agency
NaDMA	National Disaster Management Agency
NAWASA	National Water and Sewerage Authority
NAWASA	National Water and Sewerage Authority
NDRC	National Drought Response Coordinator
SPI	Standardised Precipitation Index
UNCCD	United Nations Convention to Combat Desertification
UNCCD	United Nations Convention to Combat Desertification
UNDESA	The United Nations Department of Economic and Social Affairs
MDGs	Millennium Development Goals
DRR	disaster risk reduction
UNFCC	United Nations Framework Convention on Climate Change
GWP	Global Water Partnership
MC&PMA	Ministry of Carriacou and Petite Martinique Affairs
PURC	Public utilities regulatory authority

Executive Summary

As precipitation is the sole source of Grenada's freshwater supply, a lack of rain in any season can reduce the amount of water available in rainwater cisterns, soil, streams, and groundwater, stressing natural ecosystems and triggering environmental and socio-economic problems. From time to time, Grenada has experienced droughts and the 2010 Drought highlighted its vulnerability to this natural hazard, which in an era of climate change may be an indicator of a new normal. The plan is divided into eight sections- (a) Introduction, (b) Relationship to other plans and policies (c) Overview of drought in Grenada (d) Organisation and assignment of responsibilities (e) Drought monitoring, forecasting, and impact assessment (f) Drought risk and vulnerability (g) Drought communication and response actions (h) Drought mitigation and preparedness (i) Recommendations.

The Drought Plan which provides a coordinated and consistent program and a framework for integrating public and private; sector actions to reduce the impact of human suffering from droughts is based on participatory approaches in decision making. It recognises the important role of women in disaster management. When implemented, it is expected to achieve the greatest public benefit for domestic water use and sanitation in an efficient and equitable manner during severe dry periods such that there is sustainable economic, social and environmental development

A. Introduction

The goal of the Grenada Dry Season and Drought Management Plan (GDS&DMP) is to achieve the greatest public benefit for domestic water use and sanitation in an efficient and equitable manner during severe dry periods such that there is sustainable economic, social and environmental development. The Plan which is part of the country's initiatives efforts at improving climate resilience in the water sector, is based on participatory approaches in decision making, gender sensitive and the need to urgently address the adverse impacts of climate change on water resources and assuring social and economic well-being through improved water resources management.
The purpose of this plan is:

- to provide a coordinated and consistent program and a framework for integrating public and private; sector actions to reduce the impact of human suffering;
- to minimize property losses due to drought;
- to maximize the efficient use of limited water resources under the public water system's control in order to protect the health and safety of the public and the environment;
- to serve as a working guide for the key stakeholder' agencies that have the capabilities and resources to develop effective response and mitigation programs within their areas of jurisdiction;
- to establish a consistent basis for evaluating the severity of drought situations; and
- to identify the lines of communications to allow the smooth flow of information to decision-makers.

The plan focuses on four areas or sectors for discussion- Carriacou and Petite Martinique due to its unique climatic conditions; NAWASA as the main public water supplier, and agriculture and tourism as the main economic drivers.

B. Relationship to other plans and policies

Despite decades of donor support for the water sector, many Small Island Developing States (SIDS) including Grenada, have failed to make acceptable levels of progress towards achievement of water-related Millennium Development Goals and reduction of water-related risks such as droughts. Grenada is committed to the accepted Integrated Water Resources Management approach as the way forward for efficient, equitable and sustainable development and management of the region's limited water resources and for coping with conflicting demands. Drought management is one element of integrated water resources management and when actions are taken they can result in benefits to enhance water supply during non-drought periods. The

National Drought Management Plan cannot be successfully implemented in isolation of other current environmental and climate change policies and plans or the - Water Resources Master Plan proposed in GOG (2017b). A number of policy documents which in one way or another, consider issues of drought in Grenada and contributes to an overall effort for responding to droughts have been identified and are discussed.. The most comprehensive effort on drought and dry season management is the draft Agriculture Drought Management Plan put together by the Ministry of Agriculture in 2016. As shown in Section 3, Grenada has been and is likely to be impacted by broadly by droughts. Hence, while the Agriculture Plan is appropriate, a plan that encompasses the other water-dependent sectors would improve the current available draft.

Of note is the Gender Equality Policy and Action Plan (GEPAP) GOG 2014a) which the Government has committed to ensure gender responsiveness in programmes and initiatives to strengthen the economy, reduce poverty and create employment and indicated its preparedness to encourage financial and private sector agencies to promote gender responsive operations and programming. Further, Government recognises and is committed to integrate the different and complementary roles of men and women into policies and strategies on climate change, disaster management

C. Overview of drought in Grenada

Drought is a normal occurrence in most, if not all parts of the world, regardless of climate. However, its "creeping" nature, high spatial magnitude and variability relative to other disasters, the lack of structural damage, and absence of a precise definition, have made it one of the most complex and least understood of all natural hazards. Drought, like "bad weather" is a relative term. For the purposes of this plan, the definition of drought is accepted as defined by the International Strategy for Disaster Reduction, is a "deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors." (UN/ISDR. 2009). Following are brief summaries of the classification of droughts

In Grenada, extreme cases of low rainfall have been experienced, particularly in the smaller dependencies over the last century. The severity of dry season and droughts has spatial variation and is generally worst in the dependencies of C&PM. Like on many small tropical islands, drought can affect many economic sectors in Grenada. For example, Carriacou which accounts for 30% of the country's livestock production, experienced 20% and 40% losses due to the drought in 1984 and 1992 respectively; increase in bush fires which lead to lost wildlife and increased risk of soil erosion and flooding when the rains arrive; reduced crop production and increased domestic food prices by as much as 20%; and the hotel sector which is a high consumer of water is challenged due to the unavailability and or shortage of water which lead to increased guests complaints and ultimately reduction in occupancy rates.

D. **Organisation** and assignment of responsibilities

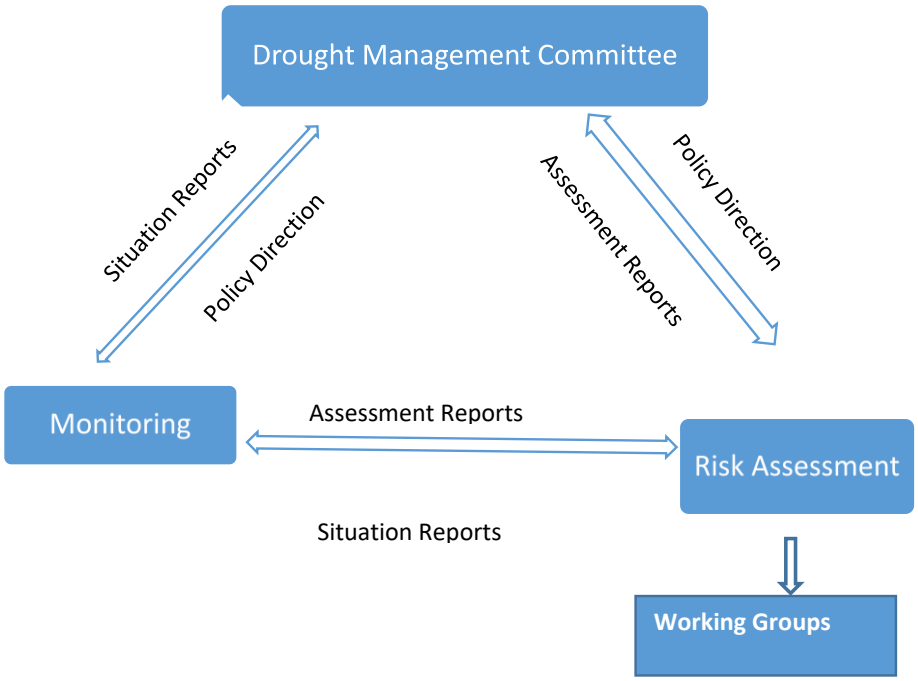
The management of disasters generally require the participation of all sectors of the society. Although the state has a leading role, success is more likely when everyone buys into the initiatives, particularly those at the grassroots. Moreover, it must be cognizant that The Drought Management Plan must address the conflicting interests of all subsectors, fairly and equitably, based on limited availability of water. For example, the public water provider's priority in a point in time would constrain the provision of water for farmers while at the same time, the provider may be pressured to meet the needs of the tourism sector which is a key economic sector in Grenada.

During droughts, women who often have a management and leadership role at the household are impacted greater than men as they carry out their daily activities in mitigating negative impacts on the family. The Grenada Drought Management Plan therefore recognizes the vulnerability of women and girls and takes special measures to involve them in drought management efforts.

A proposed organizational framework for drought event reporting is presented. It takes into consideration ongoing initiatives such as the proposed establishment of the Water Resources

Management Unit (WRMU) and incorporates three main components: (1) monitoring (Committee 1), (2) risk assessment (Committee 2) and (3) mitigation and response (TF)

Drought Severity	Drought Response Stage	SPI	Percent of Reservoir Storage	Streamflow Percentage Exceedance
Normal	Normal	0.99 to - 0.99	80 to 100	70 to 79
Moderate	Pre-Alert	-1.0 to -1.49	65 to 80	80 to 89
Severe	Alert	-1.5 to -1.99	50 to 65	90 to 94
Extreme	Emergency	< -2.0	< 50	95 to 98



E. Drought monitoring, forecasting, and impact assessment

Drought is a regional phenomenon with characteristics differing from one climate regime to another, particularly in a chain of small islands such as those of the Caribbean. Drought monitoring and forecasting are important components of preparing and mitigating for drought, albeit challenging for an island such as Grenada. Through monitoring drought indicators, scientists are able to describe drought consistently through different times, locations, and impacts. Being able to forecast drought allows for advance warnings that help prepare sectors for the adverse effects of drought. The following sections describe available drought monitoring and forecasting systems Caribbean

The Caribbean Drought & Precipitation Monitoring Network (CDPMN) through its monthly Caribbean Drought Monitor publication provides a regional outlook of precipitation and drought conditions using the Standardised Precipitation Index (SPI). The Plan promotes a monitoring and warning system based on SPIs for households with cisterns in C&PM. For NAWASA the monitoring is based on a combination of indices; SPI and reservoir storages and streamflow conditions while for C&PM the SPI, cistern size are used to provide advisory for households.

Drought Impact assessments are important in that they examine and attempt to quantify the consequences of a given event. For example, in the Agriculture and Commerce sector, direct impacts

such as reduced crop yields, livestock losses, and reservoir depletion often lead to secondary and cumulative impacts, such as reduced profits, increased feed costs, forced sale of land or assets, and physical and emotional stress.

F. Drought risk and vulnerability

Risk entails the combination of the probability of an event and its negative consequences, hence Drought (Disaster) Risk refers to the potential loss of lives, reduced health status, livelihoods, assets and ecosystem services in connection with drought, which could occur to a particular community or a society over a specified time period in the future (UN-ISDR, 2009). Mathematically, Drought risk = Vulnerability (V) x Hazard (H).

During a drought, there is great interest in solving the problems it creates. However, in the period after the event there is a tendency is to move on to other priorities. During periods of abundant water, drought issues capture neither public interest nor media attention. Government, in general, limited its programs to providing direct relief to drought victims where possible.

There are a number of challenges which contribute the vulnerability: misperceptions, lack of data and limited technical capacity.

The areas of greatest risk to the public water supply and environment, public health and safety sectors is in C&PM. This exists throughout all stages from moderate, severe, and extreme drought. The other area with great risks is the south of the island due to high population density and the existence of the main hotel plants and the University of St. Georges.

Although in Grenada, where almost half the households in Grenada (47%) are female-headed (UNICEF 2011), there are no empirical evidence about the drought impacts on women. It was pointed out during stakeholder meetings that stakeholder that often the responsibility falls entirely to women, to collect, store, protect, and distribute water such that their workloads are increased. Further, during droughts local agricultural produce is in low supply affecting the livelihood of market vendors who a predominantly women.

G. Drought communication and response actions

The Drought Communication Protocol described in this section incorporates the following three elements:

- Declaration of Drought Conditions
- General Coordination Guidelines
- Specific Communication Responsibilities

The declaration of drought in Grenada which often coincides with that in the Eastern Caribbean helps provide relief assistance for those suffering from drought conditions. Formal proclamations of a national drought can originate from the Office of the Prime Minister. These declarations can be initiated for Agriculture, NAWASA and Carriacou and Petite Martinique independently or collectively. The communication and response actions are based on the National Drought Early Warning and Information Systems Implementation Plan developed by the Ministry of Agriculture. Drought response actions are provided for NAWASA, Agriculture, Carriacou and Petite Martinique and Tourism.

H. Drought mitigation and preparedness

Mitigation are actions and activities that reduce the overall risk to drought and ultimately reduce the severity of drought impacts. These actions and activities should be executed prior to the onset of drought conditions

Mitigation actions have been divided into the following categories:

- Water Resources Monitoring,
- Drought Forecasting and Impact Assessments
- Development of Alternative Water Sources
- Public Education Awareness and Outreach
- Watershed Protection
- Legislation
- Land Use Planning

I. Recommendations

In implementing the GDS&DMP the Goal and Objectives as set out above, shall apply equally to management of the water resource including the use of non-traditional water sources, drought emergency management, and maintaining health of ecosystems. Integrated management of the water sector, including the management of droughts, must be based on sufficient and reliable information; the systematic evaluation of impacts, benefits and costs and; the application of the precautionary principle where appropriate

Priority implementation actions

- Establish the position and Institutionalize the role of the NDRC monitoring and declarations. If the position is not institutionalized, there is strong possibility that in the future that this capacity would be lost;
- Ensure funding for the proposed key rainfall and streamflow monitoring sites and to reactivate appropriate discontinued monitoring sites with long baseline records. Consider a cooperative data repository to better organize and display this information;

Drought Monitoring and Forecasting Recommendations

- Support enhanced monitoring, data collection, and research for appropriate drought related indices that can be used to develop improved drought forecasting tools tailored for Grenada;
- Support a research project that connects the impact on drought sectors with standard precipitation index (SPI). Possibly the continuation of work started by Peters (2012) and the percentile method for Carriacou and Petite Martinique

Drought Impact Assessment Recommendations

- Develop a standardized system to collect and analyse data regarding the social and economic impacts of drought.

Drought Communication and Response Recommendations

- Government Ministries and Departments should follow the communication, coordination, and response actions outlined in Section

Grenada Dry Season and Drought Management Plan

1. INTRODUCTION

1.1. Background

The Island Nation of Grenada, located in the southern Caribbean, is not considered water scarce but its dependence on rainfall increases its vulnerability to future changes in both the occurrence and the distribution of rainfall. This vulnerability is due, in part, to drought, which occurs from prolonged periods of abnormally low rainfall, usually for a season or more. This results in a water shortage for some communities, activities, or economic and environmental sectors, having the potential to severely impact these sectors in a variety of ways. Impacts such as loss of crops and livestock, erosion of landscapes, damage to terrestrial and aquatic wildlife habitats, enhanced wildfires, and economic damage are used to categorise droughts into conceptual and operational terms such as Meteorological; Hydrological; Agricultural; and Socio-economic. A meteorological drought is usually defined on the basis of the degree of dryness in comparison to some "normal" or average amount; Hydrological drought is associated with the effects of periods of precipitation shortfalls on surface or subsurface water supply; Agricultural drought links various characteristics of meteorological or hydrological) drought to agricultural impacts; and Socio-economic drought associate the supply and demand of some economic good with elements of other categories.

During the rainy season, lack of suitable land areas for dams and high runoff during storms result in significant loss of surface water to the sea. On the other hand, low rainfall can lead to reduction in river flows and in turn a reduction in the amount of water that can be physically harvested. In Grenada, there is a lack of storage, both in terms of raw water and treated water capacity, which does not allow for bridging supply gaps caused by long dry spells or after heavy rainfall events. Further, the lack of interconnections between different areas of Grenada's water distribution system leads to inflexibility between supply schemes, which prevents an optimal use of available water resources in certain regions of the island. These factors are challenges to water supply management in dealing with greater rainfall fluctuations and overall reduced precipitation as well as with extreme events (Green Climate Fund 2018). This means that it is unlikely that demand will be met during periods of low rainfall (ECLAC 2011).

In the recent past, Grenada has experienced periods of lower than expected precipitation and hydrological droughts, and consequently, a shortage in water supply. The negative impacts of drought were highlighted during a national awareness seminar on the United Nations Convention to Combat Desertification and Drought in 2001. It was envisaged that this seminar would have raised the awareness among key stakeholders in the water sector and lay the basic guidelines for the development of action plans to combat desertification and drought by highlight priority areas of action (GRENCODA 2001). This, therefore, was the beginning of the conversation on drought and its management.

A severe drought (hereafter would be referred to 'The 2010 Drought') experienced by the Caribbean including Grenada occurred in the last three months of 2009 extending into the first quarter of 2010 (Peters 2012). The 2010 Drought highlighted the vulnerability of these Caribbean islands to droughts. In islands with centralised water systems restrictions on the use of water were enforced because of the drought for the first time in decades: daily water disruptions became common in Jamaica (DREF, 2010) and water restrictions were imposed in Trinidad and Tobago (Rambally, 2010). In St Lucia, water levels in reservoirs fell by 25 cm per day (BBC Caribbean, 2010). The severity of the drought prompted

the International Federation of Red Cross and Red Crescent Societies to deploy intervention teams and allocated US$ 22379 to perform initial damage and needs assessment in Barbados, Grenada, Guyana, St Lucia and Trinidad and Tobago. Further, the 2010 Drought reinforced the call for Caribbean nations to practise more long-term preparation for drought (BBC Caribbean, 2010) and may have been the wake-up call to action in combating droughts.

Following a Drought Monitoring Training Workshop in Jamaica in May 2012 for regional stakeholders, a meeting was held in September 2012, facilitated by the Caribbean Institute for Meteorology and Hydrology (CIMH), to assist Grenada in its efforts to developing a National Drought Plan (GoG 2013) resulting in a Grenada's Drought Monitoring Plan for agriculture. This was followed by discussions on the establishment of a Grenada's National Drought Monitoring and Preparedness Networks and Implementation. The outcome to these initiatives was the Draft Terms of Reference in Drought Early Warning and Information Systems Committee (DEWIS Committee) The Committee was required to coordinate the implementation plans with the Ministry of Agriculture as lead agency with the goal to mitigate the effects of Droughts and Floods in Grenada through Monitoring, Preparedness and Early Warning Systems (GoG 2013).

In 2016, a consultancy was undertaken for Strengthening the Integration of Disaster Risk Management and Climate Change Considerations in the Agricultural Sector. This consultancy produced a draft Agricultural Drought Plan, s step forward in the finalization of a comprehensive Dry Season and Drought Management Plan (DS&DMP) for Grenada.

In 2017, the 13th UNCCD Conference of the Parties (Decision 29/COP13) requested appropriate UNCCD institutions to implement a drought Initiative in the biennium 2018-19. As the operational arm of the UNCCD, the Global Mechanism is mandated to assist countries in the mobilisation of financial resources for activities to prevent, control or reverse desertification, land degradation and drought and takes the lead in assisting countries to develop national drought plans. In this regard, Grenada is to benefit through a consultancy Reference number CCD/18/GM O5. This consultancy is expected to lead to a substantive Drought Management Plan, and particularly incorporating the UNCCD decision which states, among other actions, that the Conference of the Parties (COP) invited all parties to use the Drought Resilience, Adaptation and Management Policy framework to strengthen preparedness and response to drought.

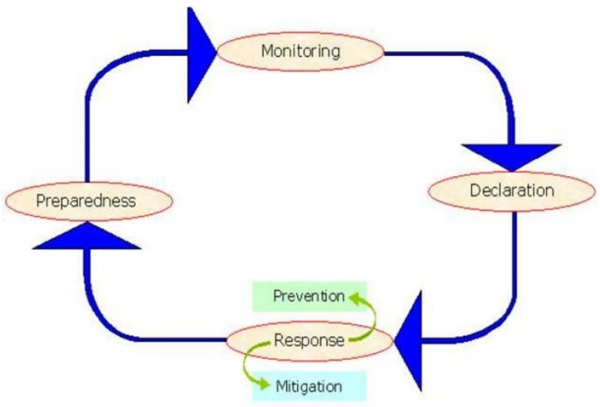


Figure 1.1: Drought Management process in Grenada

This drought management plan is central to improving Grenada's drought management system which is a continuous and cyclic process is illustrated in Figure 1.1.

1.2. Purpose and goal

The goal of the Grenada Dry Season and Drought Management Plan (GDS&DMP) is to achieve the greatest public benefit for domestic water use and sanitation in an efficient and equitable manner during severe dry periods such that there is sustainable economic, social and environmental development. The Plan is based on participatory approaches in decision making, the important role of

women in disaster management, and the need to urgently address the adverse impacts of climate change on water resources and assuring social and economic well-being through improved water resources management. The Plan is part of Grenada's initiatives at improving climate resilience in the water sector. The government is commitment to the inclusion of gender in drought management through the "*Gender Equality Policy and Action Plan 2014 – 2024*" (GOG 2014a). Specifically, Government is committed to:

- To transform the goals of economic policy to include gender equality and social justice, and promote the equitable and sustainable economic and social development of men and women; and

- To integrate gender equality into disaster management, climate change and related strategies, as a means of facilitating men's and women's complementary roles in environmental management and building a 'green economy.

The GDS&DMP establishes an effective operating procedures for managing water demand for potable supply and for agriculture in Grenada, Carriacou and Petite Martinique, by evaluating supply options before, during and after a drought related water shortage. Moreover, the purpose of this plan is:

- to provide a coordinated and consistent program and a framework for integrating public and private; sector actions to reduce the impact of human suffering;
- to minimize property losses due to drought;
- to maximize the efficient use of limited water resources under the public water system's control in order to protect the health and safety of the public and the environment;
- to serve as a working guide for the key stakeholder' agencies that have the capabilities and resources to develop effective response and mitigation programs within their areas of jurisdiction;
- to establish a consistent basis for evaluating the severity of drought situations; and
- to identify the lines of communications to allow the smooth flow of information to decision-makers.

The success of this plan is heavily dependent upon coordination and commitment from all levels of government, as well as the private sector. Effective drought planning and mitigation programs can reduce the need for extensive emergency relief expenditures to rebuild local economies, and to reduce conflicts over competition for water during drought. It is necessary that the relevant legislations state clearly the conditions, and regulations for implementing the GDS&DMP during a drought.

1.3. Scope

The GDS&DMP includes a description of historical occurrences, climatological statistics, risk assessments of susceptibility and vulnerability to drought, as well as the identification of potential impacts related to specific geographical locations. The GDS&DMP also emphasizes the identification of pre- and post-drought preparedness and mitigation measures for implementation by government agencies, stakeholders, and the general public.
The Grenada *Dry Season and Drought Management Plan* establishes the following leadership structure:

- The National Disaster Management Agency (NaDMA)
- Grenada Drought Management Committee (GDMC);
- Water Resources Management Agency (to be established in 2019 and housed under the Public utilities regulatory authority, PURC) (*see Appendix C*)

- National Drought Response Coordinator (NDRC); and
- Drought Management Sub-Committees

Participation in the committees is designed to include, but not to be limited to, government ministries and departments and individuals and/or organizations that can best share their knowledge and experience regarding local issues, resources, and priorities for drought response and mitigation

1.4. Objectives

The objective of the Grenada Dry Season and Drought Management Plan is to be prepared for and mitigate against the impacts of future drought events in Grenada. The overall objectives of the plan are

- To implement drought monitoring and early warning systems;
- To assess drought vulnerability and risk in a gender-sensitive manner; and
- Implement measures to limit impacts of drought and better respond to drought.

With that in mind, more specific objectives to meet the needs of the key interest entities are dealt with separately. Here interest entities are taken as NAWASA for general potable water, the Ministry of Agriculture for the agriculture sector, the Ministry of Carriacou and Petite Martinique Affairs (MC&PMA), and the Hotel Association for the tourism sector.

1.4.1. Carriacou and Petite Martinique (C&PM)

Recognising that C&PM has a distinct arid climate which is different to that of the mainland, and the water resource is different to that on the mainland in that C&PM's only freshwater source is from rainwater harvesting it must have a distinct drought plan. The objective would be during severe dry seasons and droughts:

- Provision of adequate public water supply droughts; and
- The minimisation of livestock and permanent tree crop and livestock losses.

Peters (2018) projected the public water demand up to 2050, taking into consideration the impact of climate change and the growth of the services and tourism sectors. The projected water demand is expected to increase from 612m^3/day in 1999 to 867 m^3/day and 888 m^3/day for 2030 and 2050 respectively. This demand would be met by rainwater harvesting and desalination.

1.4.2. Agriculture Drought Management Plan

The National Agriculture Plan considers investment for water storage and efficient irrigation (e.g. drip irrigation) support for farmers and promotion of intercropping and greenhouse production leading to the increase in production acreage (James 2015). **During the dry season farmers rely heavily on NAWASA. However, water from NAWASA is expensive.** During extreme drought conditions farmers do not have access to alternatives (GOG 2017d). Although the source and quantity of water for agriculture is not well determined, the overall objectives of the drought plan could be stated as follows:

- Minimize the debilitating impacts of drought on the agricultural economy;
- Promote maintenance of productive capacity of agricultural land;
- Promote the use of drought risk reduction practices in agricultural production;
- Promote a spatial context of drought risk management;

- Facilitate drought risk for food crop and livestock production:
- Promote Climate Smart Agriculture (CSA); and
- Support timely response, operational continuity and recovery from drought conditions.

Meeting the objectives of the agriculture drought plan is challenged by the general lack of information on agriculture water demand as there are few studies on quantifying the water demand for agriculture in Grenada. In the past water demand for agriculture has been conservatively estimated.

1.4.3. NAWASA (Public water supply) Drought Management Plan

From the Strategic Plan 2016-2021 (NAWASA, 2017), the objectives that speak to drought management by the institution can be listed as:

- Ensure the provision of a consistent supply of quality water the public while adapting strategies to offset the effects of climate change;
- To improve the capability to respond to major disasters (*drought- my inclusion*)

1.4.4. Tourism Sector

The importance of the tourism sector which contributes 5.3% to the Grenadian's GDP is widely accepted. It is also a key sector in terms of the demand for water and is therefore given special treatment in the plan. Demand for tourism water could increase by about 30% by 2050 (ECLAC, 2011). The sector is particularly vulnerable to dry season and droughts as the peak of the tourism season coincides with the annual dry season and peaks with the driest period dry season. The objectives of the Drought Management Plan for the tourism sector are:

- Minimize revenue loss for the business
- Increase operational efficiency
- Promote Grenada as an environmentally safe destination

2. RELATIONSHIP TO OTHER PLANS AND POLICIES

Grenada is committed to the accepted Integrated Water Resources Management approach as the way forward for efficient, equitable and sustainable development and management of the region's limited water resources and for coping with conflicting demands. Further, national climate change documents and strategies rank the water sector as one of those most affected by climate change – this includes the recently finalised National Adaptation Plan (NAP) (GOG 2017c) and the currently updated National Climate Change Policy, 2017-2021 (GOG 2017a). In response, Grenada has participated and benefited from some regional and national programmes which have been initiated to build resilience against the impacts natural hazards including drought. (FAO 2016). Through these programmes, policies and plans to adapt to drought have been developed driven by the desire to effectively manage water resources. However, in many cases, some of these are still in draft form, poorly implemented, or in need of review (FAO 2016), while in other cases some policies and plans are still being developed. Many of the policies and plans elaborate the key elements for drought resilience outlined during the High Level Meeting on National Drought Policy, held in 2013 to promote the development of national drought policies (Magalhaes, 2018).

Despite decades of donor support for the water sector, many Small Island Developing States (SIDS) including Grenada, have failed to make acceptable levels of progress towards achievement of water-related Millennium Development Goals and reduction of water-related risks such as droughts. As shown in Table 2.1, many of the policies and plans in which drought should be treated in a substantial manner are void of this expectation. National drought action plans and strategies should be implemented, not because it is a request of international initiatives like the UNCCD Drought Initiative but because it is the government's interest to guarantee farmers a secure crop or ensure that hotel occupancy is not challenged by the unavailability of water or the citizens' water safety. The following section highlights some of the undertakings in relationship to drought management.

2.1. Some existing policies and plans

Drought management is one element of integrated water resources management and when actions are taken they can result in benefits to enhance water supply during non-drought periods. Hence, the National Drought Management Plan cannot be successfully implemented in isolation of other current environmental and climate change policies and plans or the - Water Resources Master Plan proposed in GOG (2017b). An important Policy which should drive the Drought Management Plan is the National Water Policy which was being reviewed to be ready by March 2019. That Policy, unlike the 2007 version gives more deliberate consideration to Drought Management and lists one of its strategic response as "Adopt measures to reduce the negative impacts of water-related (flood and drought) disasters on the society, the economy and the environment and to reduce the impact of natural disasters on the water sector including the explicit consideration of the impact of and adaptations to climate change'.

In addition, there are a number of policy documents which in one way or another, consider issues of drought in Grenada and contributes to an overall effort for responding to droughts. The most comprehensive effort on drought and dry season management is the draft Agriculture Drought Management Plan put together by the Ministry of Agriculture in 2016. As shown in Section 3, Grenada has been and is likely to be impacted by broadly by droughts. Hence, while the Agriculture Plan is appropriate, a plan that encompasses the other water-dependent sectors would improve the current available draft.

Of note is the Gender Equality Policy and Action Plan (GEPAP) GOG 2014a) which the Government has committed to ensure gender responsiveness in programmes and initiatives to strengthen the economy, reduce poverty and create employment and indicated its preparedness to encourage financial and private sector agencies to promote gender responsive operations and programming. Further, Government recognises and is committed to integrate the different and complementary roles of men and women into policies and strategies on climate change, disaster management.

Table 2.1 summarises the policy development over the years in which drought and its management may have been given some consideration.

Policy documents	How is drought treated?
National Water and Sewerage Authority Act 25 of 1999	The Act gives responsibility to the Authority to provide adequate water except in the case of drought
GOG (2000) Grenada's Initial Communication to the UNFCCC,	Briefly mentioned

Policy documents	How is drought treated?
Grenada, C& PM National Report on the implementation of the United Nations Convention to Combat Desertification and/or Drought (UNCCD) (Thomas 2000)	Drought is mentioned but there is recognition of insignificant progress
National Disaster Plan (GOG 2005)	The plan recognises drought as one of disasters but response to it is not addressed in the plan
Road Map Toward Integrated Water Resources Management Planning for Grenada" (GOG 2007b)	Mentions droughts but goes no further
Grenada Water Policy (GOG 2007a) *Grenada Water Policy 2019*	While the initial Policy It recognised that water resources management plans and water supply and operations plans should consideration the potential impact of natural disasters such as, inter alia, floods, droughts, hurricanes and climate change; the revised Policy now includes drought The Government is committed to overseeing the planning for prevention and mitigation of disasters related to floods and droughts and emergency responses Proposes as basis for action- Reducing vulnerability to natural disasters
Framework for Water Policy Implementation, St. Georges (GOG 2008)	There is no mention of drought in this document
Climate Change Adaptation in Grenada: Water Resources, Coastal Ecosystems and Renewable Energy (UNDESA 2012a)	Recognises that droughts are expected to increase with climate change but gives clear way of responding
Road Map on Building a Green Economy for Sustainable Development in Carriacou and Petite Martinique, Grenada (UNDESA 2012b)	Recommended developing an operational drought monitoring system for the RWH dependent islands Proposed desalination for improving water resources
MODEL WATER POLICY: Water Sector Model Policy and Model Water Act for countries within the Organisation of Eastern Caribbean States (CEHI, 2013)	Proposes the adaptation of measures to reduce the negative impacts of water-related (flood and drought) disasters and to reduce the impact of natural disasters on the water sector including the explicit consideration of the impact of and adaptations to climate change
Country Document on Disaster Risk Reduction for Grenada (GOG, 2014b)	Recognises the risk of droughts, but does not consider the risks associated with it.
Gender Equality Policy and Action Plan (GEPAP**)** (GOG 2014a)	Government committed to ensure gender responsiveness in programmes and initiatives. Integration of the different and complementary roles of men and women into policies and strategies on climate change including drought management.
Grenada Water Sector Review **(GOG 2013)**	Recognizes the greater vulnerability of Carriacou and Petite Martinique
Final Draft Technology Needs Assessment (GOG 2016a)	The document identifies some of the technologies/technique as short-term measures that

Policy documents	How is drought treated?
	can be utilised during droughts but do not address the management of droughts per se.
Agriculture Drought Management Plan – Draft, Ministry of Agriculture **(GOG 2016)**	The draft Plan is the most comprehensive work on drought management planning.
Draft Second National Communication (GOG 2017d)	A detailed section on Adaptation Strategies for Water Resources Management aimed at– Drought Mitigation and Drought Risk Management is included
National Climate Change Policy for Grenada, Carriacou and Petite Martinique (2017-2021) (GOG 2017a)	The policy aims - Reduced water outage times during flooding and droughts. Increased domestic and corporate usage of water conservation/efficiency measures. Reduced incidence of uncompliant surface, sub-surface and coastal water quality.
National Climate Change Adaptation Plan (NAP) for Grenada, Carriacou and Petite Martinique (GOG 2018)	References the draft Drought Management Plan (2016) and recommends its approval and implementation

2.2. Alignment of Plan with other policies

The Drought Plan is one element of an overall water policy and must be aligned and interlinked with other policies and plans that inform or are informed by the National Water Policy.

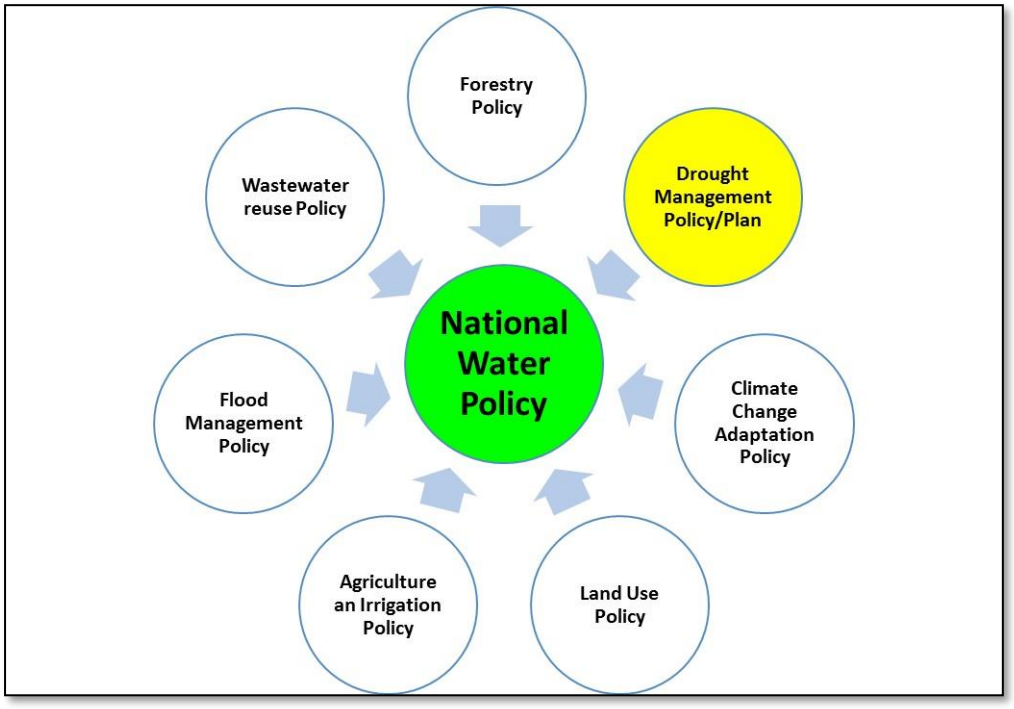


Figure 2.1: Connectivity of related water policies and plans

3. OVERVIEW OF DROUGHT IN GRENADA

Grenada has a land area of approximately 344 km^2, and a population of approximately 111,724 (CIA, 2018). The climate is tropical, rainfall exhibits a bimodal structure with two rainfall maxima (May-June and September-October) separated by what has been termed a mid-summer drought (MSD) (July-August) (Douglas *et al* 2008). The average annual rainfall for mainland Grenada ranges between 1,000 mm and 1,500 mm along the coastal zone, to approximately 4,000 mm in the interior, and which is sufficient to support surface stream flow and recharge of sub-surface aquifers (GOG 2007). The average annual precipitation is 2350 mm, or 799 million m^3. Renewable water resources are estimated at about 200 million m^3/year (FAO 2015). This means that overall, Grenada is not water scarce as per the Falkenmark indicator (Falkenmark et al 1989) since its total renewable water resources is 1887m^3/person. The dependencies of Carriacou and Petite Martinique are drier than the mainland with an annual average precipitation of about 1000mm which is inadequate to support permanent streams. Despite the high annual rainfall in Grenada, severe dry seasons can be experienced from time to time particularly during the months of February to June when less than 175mm of rain may fall during the period leading to agricultural and socio-economic droughts. In the past, the Caribbean, including Grenada, has experienced many destructive impacts of extremes in rainfall due to natural features, including the El Niño Southern Oscillation and sea surface temperature anomalies in the tropical Atlantic (Stephenson *et al*. 2007).

In Grenada, extreme cases of low rainfall have been experienced, particularly in the smaller dependencies over the last century. The severity of dry season and droughts has spatial variation and is generally worst in the dependencies of C&PM. Like on many small tropical islands, drought can affect many economic sectors in Grenada. For example, Carriacou which accounts for 30% of the country's livestock production, experienced 20% and 40% losses due to the drought in 1984 and 1992 respectively (UNFCCC 2000); increase in bush fires which lead to lost wildlife and increased risk of soil erosion and flooding when the rains arrive; reduced crop production and increased domestic food prices by as much as 20%; and the hotel sector which is a high consumer of water is challenged due to the unavailability and or shortage of water which lead to increased guests complaints and ultimately reduction in occupancy rates (Peters 2015)

Peters (2014) in an analysis of dry season precipitation using the Standardised Precipitation Index (SPI) (McKee et al., 1993), reported that extreme dry seasons (droughts) were experienced in 1929, 1951, 1957, 1969,1972, 1982, 1991, 1997 and 2010. This gives a return period for these conditions of about 10 years although a cursory evaluation of the available data suggests an increased frequency of extreme dry seasons since the 1970s.

3.1. Historical Occurrence

Grenada experienced 10 droughts since 1900 (see Table 3.1), according to Collymore *et al*. (2016), who based their findings on annual water balance, flow accumulation, mean annual temperature, soil drainage and moisture supply capacity information. Sufficient rainfall during a period indicates that the difference between rainfall and reference evapotranspiration is positive.

Table 3.1: Drought years in Grenada (Collymore, Little and Spence Joint Venture 2016)

Year	Impact
1904	Severe drought
1905	Severe drought
1970	Lack of sufficient rainfall for 5 months
1971	Lack of sufficient rainfall for 5 months
1972	Lack of sufficient rainfall for 6 months
1973	Lack of sufficient rainfall, for 8 months
1974	Lack of sufficient rainfall for 5 months
1975	Lack of Sufficient rainfall for 5 months
1994	Lack of sufficient rainfall for 6-7 months. Tourism belt affected by lack of pipe borne water.
2009-2010	Severe drought. In 2009 a 24-year lowest annual rain fall total recorded. Seventeen percent decline in banana production.

While research on droughts in Grenada is limited, the observations therein are consistent with reports of increase in the intensity and frequency of droughts in the region, due to global climate change (Cashman, 2014; FAO 2016) and climate variability. Further, anecdotal evidence shows that in recent times, such episodes of severe dry season and droughts resulted in extreme stress to the existing water supply system of NAWASA and leading customer dissatisfaction and economic losses.

3.2. Historical treatment of drought

During The 2010 Drought, NAWASA developed a framework for the management of the island's water resources. Further, a National Emergency Action Committee chaired by NADMA and comprising key stakeholders was created. However, once the severe conditions had passed, it was back to the status quo. Nonetheless, Grenada's formal effort to address issues related to drought could be said to have begun 1997 with its participation in the creation of the UNCCD. Notwithstanding its commitment to the convention, according to Thomas (2000), by 2000, very little was done in meeting the following stated objectives:

- Give priority to combating desertification and mitigating the effects of drought and allocate adequate resources;
- Establish strategies and priorities within the framework of sustainable development plans and/or policies to combat desertification and mitigate the effects of drought;
- Address the underlying causes of desertification and pay attention to socio-economic factors contributing to desertification processes;
- Promote awareness to facilitate the participation of local populations in efforts to combat desertification and mitigate the effects of drought; and
- Strengthening of appropriate existing relevant legislation, enacting new laws and establish long-term policies and action programmes. (Thomas 2000)

Grenada's Initial Communication to the UNFCCC (GOG 2000) recognised the negative potential impacts of climate change on the precipitation regime and the consequential increased severity of dry seasons and droughts were highlighted. In 2007, Grenada published its "Road Map toward Integrated Water Resources Management Planning". The Road Map embraces the concept of Integrated Water

Resources Management. The Global Water Partnership defines IWRM as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP 2011). The IWRM approach has been accepted by the United Nations as the way to achieve efficient, equitable and sustainable development and management of limited water resources (http://www.un.org/waterforlifedecade/iwrm.shtml). In this context, the Road Map did not address dry season and drought planning, although it mentions that, at the time, one of the issues facing the country's water resources management was the planning for water in disasters such as hurricanes, flooding and drought (GOG 2007). Most recently, the draft Second National Communication (GOG 2017d) included a detailed section on Adaptation Strategies for Water Resources Management aimed at– Drought Mitigation and Drought Risk Management.

The time has come when the reactive and post-hazard management approach from the past needs to be replaced in which with more proactive, risk based approaches of disaster management. This requires multifaceted considerations and the involvement of a variety of stakeholders, and, from a drought management policy perspective, capacities in diverse ministries and national and regional institutions are needed. In this regard, Grenada benefits from The Caribbean Drought and Precipitation Monitoring Network (CDPMN) (Caribbean RCC 2010) was launched in 2009 under the Caribbean Water Initiative (CARWIN) to support equitable and sustainable Integrated Water Resources Management. The CDPMN is led by the Caribbean Institute for Meteorology and Hydrology (CIMH), the World Meteorological Organization's Regional Climate Centre (RCC) for the Caribbean. Although drought and the general precipitation status are monitored at the regional scale, the work of this network would complement national efforts in responding and mitigating against drought.

To date, the efforts to reduce Grenada's vulnerability to droughts have yielded limited success, perhaps due to inadequate infrastructure, lack of reliable data of spatially variable rainfall and the absence of genuine integrated water resources management (IWRM). Nonetheless, there are renewed interests in drought as a natural disaster and efforts are being made to enhance drought monitoring at the national level. For example, in the ongoing preparation of Grenada's second communication to the UNFCCC which has been mandated to include work in the areas of the UNCCD and CBD as they relate to climate change (GOG 2015), it is expected that the final output would be consistent with the current UNCCD Drought initiative. There is therefore, optimism for Grenada as it embraces the new UNCCD drought initiative of 2018. The overall outcome of the initiative in which Grenada's vulnerability to dry season and drought is addressed would be the provision of an efficient and sustainable water supply during extreme dry seasons and droughts.

3.3. Understanding droughts

3.3.1. Types of Drought

Drought is a normal occurrence in most, if not all parts of the world, regardless of climate (Sivakumar & Wilhite, 2002). However, its "creeping" nature (Tannehill, 1947), high spatial magnitude and variability relative to other disasters, the lack of structural damage (Wilhite, 1993), and absence of a precise definition, have made it one of the most complex and least understood of all natural hazards (Hagman, 1984). Drought, like "bad weather" is a relative term. The relative nature of drought, the fact that a low rainfall period in a tropical environment can be the equivalent of a high rainfall period in a semi-arid environment, makes the definition of drought difficult (Smith et al., 1992). Nonetheless, generally speaking, drought can be defined as "the consequence of a natural reduction in the amount of precipitation received over a period of time…"(Wilhite, 1993). Defining drought depends on regional differences, needs and disciplinary perspectives (NDMC, 2006). Drought definitions may be categorised into conceptual and operational terms. Operational definitions attempt to identify the

onset, severity and termination of drought episodes. Wilhite and Glantz (1985) defined droughts in terms of four basic approaches to measuring drought: Meteorological, Hydrological, Agricultural and Socio-economic. The precise timing of droughts is difficult to predict, making it difficult to prepare for them and to manage properly (Smet and Moriarty, 2001). This difficulty increases as the complexities and uncertainties introduced by climate change are realised. Nonetheless, unlike some other natural disasters, drought events evolve slowly in time, making it possible for effective drought mitigation provided that timely monitoring of a potential drought is available (Cancelliere *et al.,* 2006).

For the purposes of this plan, the definition of drought is accepted as defined by the International Strategy for Disaster Reduction***, is***

> ***a "deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors***." (UN/ISDR. 2009).

Following are brief summaries of the classification of droughts.

3.3.1.1. Meteorological

Meteorological drought is based solely on precipitation, and can succinctly be defined as a lack of precipitation over a region for a prolonged time period (Farrell, *et al*, 2010; WMO, 2006). The specific value of the deficiency, and what time period constitutes "prolonged" usually varies based on location and specific users (UN/ISDR, 2009).

3.3.1.2. Hydrological

A hydrological drought is a period of below average surface or subsurface water flow, which has detrimental impacts on reservoirs, lakes and groundwater. This kind of drought can occur as a result of a lack of precipitation, or depletion due to multiple uses, such as irrigation and flood control etc. (UN/ISDR, 2009). An important characteristic of hydrological drought is its lack of a direct correlation with precipitation; while precipitation does have an impact on surface and subsurface flow, other factors, such as the multiple competing users of water resources (irrigation, hydroelectric power etc.) play a major role (WMO, 2006). As a result of these competing uses, the onset of a hydrological drought typically lags the reduction in rainfall (meteorological drought) that contributes to a reduction in surface and subsurface flow.

3.3.1.3. Agricultural

Agricultural drought links the effects of hydrological and meteorological drought to agricultural impacts, such as crop yield, and soil moisture content (CapNet-UNDP 2015). More specifically, it can be described as the unavailability of soil moisture and its inability to support crop growth (WMO, 2006). Assessing the drought susceptibility of crops depends on weather conditions, the biological characteristics of the plant species, the stage of growth, pests, and the properties of the soil. Agriculture is usually the first economic sector to be affected by drought.

3.3.1.4. Socio-Economic Drought

Socio-economic drought links the "supply and demand of some economic good or service" with the impacts of the first three types of drought. For example, when the water demand of a hotel cannot be met by NAWASA and consequently has to refuse guests or when low river flow forces hydroelectric power plant operators to reduce energy production.

3.3.2. Drought Impacts

3.3.2.1. Global Impacts

Globally, the impacts of drought make it one of the costliest natural hazards, due mainly to its wide spatial extent. The impacts of drought have high environmental, economic and social costs. Depending on its severity and duration, drought can devastate crops and forests, lead to shortages of food for livestock and wildlife, increase the risk of wildfires, and have a negative effect on local and regional economies. Wilhite (1993) highlights several of these impacts in the United States, where, for example, US $3.9B was spent in 1988 for drought relief, and in South Africa, where R 2.5B was spent between the mid-70s and mid-80s. Drought and associated high temperatures led to major crop and vegetation failure in the Murray-Darling Basin in 2002 in Australia (Karoly, Risbey, & Reynolds, 2002). In Jamaica, persistent water shortages and restrictions have seen several public protests and roadblocks, disrupting traffic flow and business operations.

3.3.2.2. Impacts of Drought in Grenada

Although the impacts of drought in the Caribbean have not been as dramatic as in some other parts of world, the region is not exempt from the negative impacts of drought (Peters 2015). A FAO study reported that the Caribbean faces significant challenges in terms of drought (FAO 2016). It was pointed out that the region already experiences drought-like events every year, often with low water availability impacting agriculture and water resources, and a significant number of bush fires (FAO 2016).

Lower than expected precipitation in Grenada and its dependencies are not uncommon. It is to be noted that although Grenada does not have a large land mass, the severity and impacts of drought varies as do precipitation. For example, in the Northern part of the main island and C&PM with the lowest rainfall, the severest impacts of droughts are usually experienced. On the other hand, the mountainous interior where precipitation is highest is least affected. In the past, C&PM with their decentralised-rainwater harvested water supply systems were most vulnerable during extreme dry season and droughts as water deficit had to be met through the importation or barging of water to the islands. On the mainland, it is easier to redistribute water. Recently, to mitigate against water shortages in the future, the RWH supply is now being supplemented by desalination.

Existing information on economic impacts of droughts in Grenada is scarce and perhaps incomplete and unreliable. Nonetheless, 'The 2010 Drought' highlighted the impacts of drought on the islands. The impact was more severe in the dependencies (Peters 2015). The Global Water Partnership (2015) provides a list of the general impacts of drought, many of which have been observed in the most recent drought in Grenada reported for Grenada (Peters 2015).
While there are no specific research data on the impact of droughts on women and girls, the stakeholder consultations during the preparation of this plan revealed that as a demographic group, women and girls have been impacted severely during droughts. For example, they miss work in order to take care of children when schools are close due to lack of water; late for work or need to leave work early in order to cope with water shortages; experience compromised personal hygiene; spend extra time sometimes losing sleep in order to collect water from emergency tanks or late at nights when water pressure improves; and the burden of taking care of the sick family members, which is typically done typically by women and girls, is greater.

Some of the main impacts associated with Droughts in Grenada are summarised in the Table 3.2 below.

Table 3.2: A summary of the impacts experienced by Grenada from severe dry season and droughts

General categories of Impacts	Observed Impacts

Economic	• Decreased production in agriculture, forestry, tourism and financial activities that depend on these sectors e.g. National Marketing and Importing Board (NMIB)
	• Damage to the tourism sector as visitors stay away voluntarily or hotels inability to accommodate guests. Specific impacts were:
	  ○ Unreliable water supply
	  ○ Increase water shortages at the facility
	  ○ Increase costs of water due to the high costs of trucking
	  ○ Increased complaints from guests
	  ○ Loss of ornamental plant and garden stock
	  ○ Loss of onsite production of fruits and vegetables production
	  ○ Closure of the water tubing business or site visits to water falls
	• Increase price of water to consumers who depend on water trucks
	• Increased operating costs to NAWASA
	• Reduced revenue to NAWASA. Water production in individual plants reduced by 20% to 60% (NAWASA 2010)
	• Pressure on lending institution as borrowers are unable to meet their commitments
	• Improved opportunities for private water truck
	• Unemployment due to reduced labour demand in agriculture tourism and industry
	• Temporary closure of schools and other public places
	• Stealing of water from both public supply and private sources
	• Health and safety difficulties due to poor air quality and reduction in the quality of sanitation

Social	• Temporary closure of schools and other public places • Stealing of water from both public supply and private sources • Health and safety difficulties due to poor air quality and reduction in the quality of sanitation • Loss of confidence and tensions between the affected customers and NAWASA • Inequity in the supply with wealthier and or politically connect communities given priority • General inconveniences in the community

Environmental	• Reduced flow in surface water sources and reduced groundwater recharge of up to 65% (Peters 2015) • Reduction in the quality of surface water flows • Damage to the ecosystems, wetlands and biodiversity (increased soil erosion particularly when the first rains arrive after the drought • Poorer air quality due to increased dust in the air • Increase in the number and size of bush fires

4. ORGANISATION AND ASSIGNMENT OF RESPONSIBILITIES

The management of disasters generally require the participation of all sectors of the society. Although the state has a leading role, success is more likely when everyone buys into the initiatives, particularly those at the grassroots. Moreover, it must be cognizant that The Drought Management Plan must address the conflicting interests of all subsectors, fairly and equitably, based on limited availability of water. For example, the public water provider's priority in a point in time would constrain the provision of water for farmers while at the same time, the provider may be pressured to meet the needs of the tourism sector which is a key economic sector in Grenada.

During droughts, women are children are the collectors of water. Moreover, women who often have a management and leadership role at the household are impacted greater than men as they carry out their daily activities in mitigating negative impacts on the family. The Grenada Drought Management Plan therefore recognizes the vulnerability of women and girls and takes special measures to involve them in drought management efforts.

4.1. Key stakeholders

It is now widely recognized that there is a strong relationship between gender equality and disaster resilience, and the importance of this relationship to the achievement of the Millennium Development Goals (MDGs). Moreover, it is also recognized that women and men are affected by drought differently, and that gender inequalities diminish women's capacity to cope with drought. During times of water scarcity or drought, when water must be accessed from community faucets, water trucks, irrigation ditches, rivers and wells, women's responsibilities in sourcing and allocating water for domestic use tend to be significantly increased (GOG 2017d).

The Gender Equity Policy and Action Plan (GEPAP) 2014 – 2024 (GOG 2014a) commits the Government to *"recognise and integrate the different and complementary roles of men and women into policies and strategies on climate change, disaster management and natural resource development* … including droughts). Hence, it is necessary to include women's and men's voices, needs and expertise equally in disaster risk reduction (DRR), and recovery policy and programming.

Therefore, it is important, that while different sectors may have specifically tailored plans, the national plan must be through consensus building. It is particularly important that women have an equal place in decision-making in the development and implementation of the drought plan. As a starting point the following is suggested.

Stakeholder groups are identified according to Agriculture. The current Agriculture Drought Management plan identified a number of stakeholders including:

a. **National Water Resource and Sewage Authority (NAWASA)** – responsibility for management of water and sewage service in Grenada, Carriacou and Petit Martinique. Legislations governing the Authority includes the national water and Sewage Authority Regulation, 1993 and the National Water and Sewage Authority Water Services Regulations, 1993.

b. **National Disaster Management Agency (NaDMA)** – Overall responsibilities for national and sectoral disaster risk management, including drought, drought response coordination;

c. **Agricultural services and extension agencies** – provide technical support to agriculture for sustainable livelihoods and food production. Support also related to drought management, drought management education;

d. **Grenada Meteorological Services** - provide hydro-meteorological data and

e. **Grenada Environmental Department** - establishes relationships between state of the natural environment and water resource availability

f. **Agricultural production associations–** source of information on relationship between water resource availability and crop and livestock production, impact assessment

g. **Agriculture-based private sector agencies** – form forward and backward linkages with the agricultural sectors and are thereby directly impacted by production reduction in agriculture.

h. **In-country regional and international agriculture development agencies** – sources of drought risk management support to agriculture through technical cooperation, grants etc.

i. **Grenada Fire Services** – provide fire management services to mitigate impact of drought-induced bush-fires.

j. The Grenada Police

(GOG 2016)

In addition to the above the following are included as key stakeholders for completeness.

k. Caribbean Youth Environmental Network

l. National Women's Organisation (GNOW). Can monitor decision making

m. Hotel and Tourism sector representation as a significant water consumer

n. **Inter-Agency Group of Development Organisations (IAGDO)** deals with gender issues at the grass root, working with women in the disadvantaged communities

o. **Ministry of Carriacou and Petite Martinique Affairs** ensures that the special consideration required for these islands are considered

p. **Ministry of Social Development and Housing (Gender and Family Affairs**) have a greater understanding of women issues and ensures that gender-sensitivity is considered in decision-making

4.2. Drought Management Committee (DMC)

In planning for droughts, the Minister under whose portfolio water falls will require support and advice as well as, would need to delegate certain oversight and coordination responsibilities. In this regard, the DMC will appointed by the Minister and would provide support to the Minister as well as having the role of creating a conducive environment for the overall implementation of the Drought Plan. It would fulfil the role of providing coordinated, multi-sectoral, policy-level planning and decision-making for the water sector and ensures that during periods of drought, the water sector is integrated with other sectors of government, economy and society. The DMC will provide policy advisory support on policy-related matters, such as: sector regulations and performance; drought response, financing, planning and development; compliance with national, regional and international agreements and conventions related to drought.

Membership of the DMC will be from the public and private sectors as well as from civil society so that representative stakeholders are involved. Efforts should be made to have a women's representative

or organisations that proactively seek women's interests. The DMC shall, in consultation with key stakeholders, assume responsibility for monitoring climatic conditions, evaluating drought indicators, and consults with stakeholders to issue drought status updates declaring a drought emergency and status updates, and for the necessary coordination direction and management of responses for the duration of the drought. Membership of the DMC will be from the public and private sectors as well as from civil society so that representative stakeholders including women are involved.

The key agencies and institutions being proposed to form this committee are listed below:

- National Disaster Management Agency (NaDMA)
- NAWASA
    - Chairman of the Board of Directors
    - General Manager
    - Director, Operations
- Ministry of Works
- Grenada Meteorological services (GMS) Representative
- Ministry of Public Health
- Ministry of Agriculture Representative
    - Chief Extension Officer
    - Chief Forestry Officer
    - Head of Land Use Division
- Water Resources Management Unit
    - National Response Cordinator
- Ministry of Health
- Media Representative (or Government Information Services)
- Ministry of Carriacou and Petite Martinique Affairs
- Police/ Fire Department
- Ministry of Tourism/Tourism Board
- Grenada Hotel Association
- Inter-Agency Group of Development Organisations
- Ministry of Social Development and Housing (Gender and Family Affairs)

4.3. Monitoring, Early Warning and Information Sub-Committee

The Monitoring, Early Warning and Information Sub-Committee reports to the National Drought Committee, and will be responsible for the development and maintenance of the proposed Early Warning System, timely dissemination of information during drought (including situation reports, onset of drought, and end of drought), and maintenance of the inventory of drought indicators and indices. The proposed members of this committee, with the parameters they are responsible for monitoring, are listed below.

- NAWASA – Reservoir Levels, Streamflow, Groundwater Levels
- Met Services – Precipitation, Temperature, SPI, Evapotranspiration
- Ministry of Agriculture – Crop health, Soil Moisture
- Forestry Division – forestry health
- Fire Division
- Water Resources Management Unit
- Ministry of C&PM Affairs

4.4. Drought Water Supply Sub-Committees

There should be two sub-committees, one for Grenada and one for C&PM. The experiences and vulnerability to drought are different for Grenada and C&PM, particularly having different

precipitation regimes and water supply systems and are treated as different Drought Management areas. The Drought Water Supply Sub-Committees would work with all critical stakeholders to ensure the management of existing resources, and development of new sources (if necessary) during a drought event. This committee would consist of the following members:

- NAWASA Operations
- Ministry of agriculture- land use division
- Ministry of Carriacou Petite Martinique
- Tourism/Grenada Hotel Association

4.5. Drought Monitoring Network

To improve the collection and analysis of appropriate data it is proposed, following the suggestion made in 2013 during discussion on the formation of a Drought Monitoring Network (DMN - Technical Advisory). The concept of the network would be review but it is envisaged that this Working Group would consist of: NAWASA; Ministry of Agriculture; Inter-American Institute for Cooperation in Agriculture (IICA); Farmers Groups; Met Services, MBIA; NaDMA; Inter Agency Group of Development Organisations; Ministry of Environment; and St. Georges University.

The objective of this Network is to manage climatological and hydrological data and from this produce the necessary climate and water monitoring information and forecasts for Early Warning advice.

The scope of work of the Working Groups or sub-committees is envisaged to be:

- Monitoring climate, water and soil moisture resources. Monitoring should take place at least once monthly basis, hydrological and climatological parameters and other data relevant to drought occurrence. This data shall include but not be limited to: rainfall, river water levels, and groundwater availability provided by the Water Resource Management Agency; precipitation and evapotranspiration provided by the Grenada Meteorological Services; water production and supply provided by NAWASA; statistics relating to wildfires and forest fires provided by the Department of Forestry; and crop statistics provided by the Ministry of Agriculture.
- Forecasting information on drought (and flooding as indices and indicators can monitor and forecast both extremes)
- Standardizing the equipment used for data collection
- Ensuring that the data format is standardized
- Assisting with maintenance of data collection sites and equipment
- Working towards 100% real-time data collection
- Conducting Annual inventory of sites and equipment
- Networking with local and regional agencies (Caribbean Environmental Health Institute, CIMH, St George's University, and University of the West Indies)
- Conducting research to assist with Integrated Water Resources Management
- Assisting with combating the negative impacts of climate variability and extremes, and climate change.
- Developing and expanding the implementation of Geographic Information Systems in the local capacity to communicate drought information
- Coordinating the collection and dissemination of data

4.6. National Drought Response Coordinator (NDRC)

A designated person should be given the task of Drought Coordinator. Preferably, that person could be the leader of the proposed Water Resources Management Unit (WRMU). The NDRC will make the determination if a Severe Water Supply Shortage exists based on trigger levels.

4.7. General public

In many small islands, it recognized that observational knowledge of on-the-ground conditions has proved to be invaluable to drought monitoring. It is therefore important for organised citizen input to information collection be promoted.

Recommendation:

Training for residents in drought recognition and response.

4.8. Organizational Framework Schematic

The implementation of the plan would be largely the responsibility of the Water Resources Management Agency (WRMA) as part of its coordination and information function as show in Figure 4.1 below. The WRMA, through the Drought Response Coordinator would have responsibility of coordinating the activities of the plan and advise the Drought Management Committee on all relevant issues of an ongoing drought.

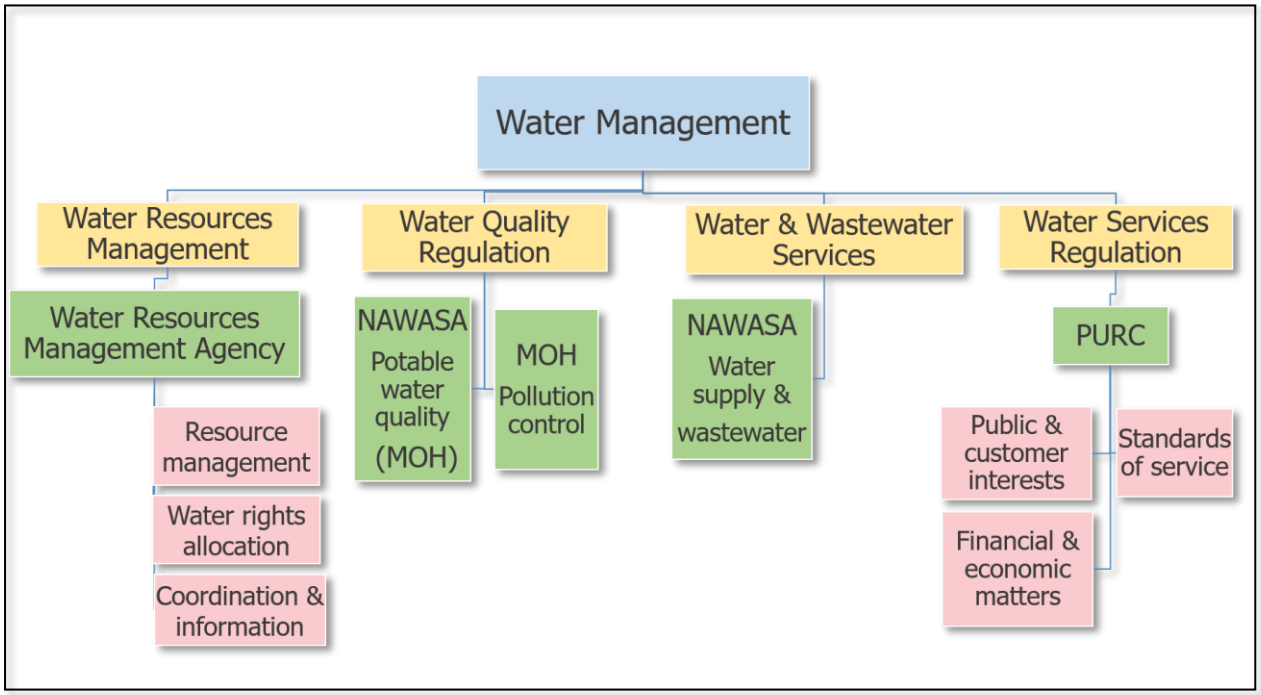


Figure 4.1: Water Management structure in Grenada (source: National Water Policy)

The institutional and functional framework for the Plan can be characterised as triangular, consisting of three sets of inter-related functions; (A) Plan Direction and Coordination, (B) Regulation and (C) Services Provision are illustrated in Figure 4.2.

A proposed organizational functional framework to be overseen by Drought Management Committee through a reporting mechanism using sub-committees and their compositions are:

(1) Monitoring

- Water Resources Management Agency;
- Ministry of Agriculture;
- Ministry of C&PM Affairs;
- Met services, MBIA;
- *Any other relevant agency or individuals may be incorporated*

(2) Risk assessment

- Water Resources Management Agency
- Ministry of Agriculture
- Ministry of Tourism
- Ministry of C&PM Affairs
- Fire Department
- Inter-Agency Group of Development Organisations
- *Any other relevant agency or individuals may be incorporated*

(3) Mitigation and response

- Fire Department
- Water Resources Management Agency
- Ministry of Agriculture
- Ministry of works
- *Any other relevant agency or individuals may be incorporated*

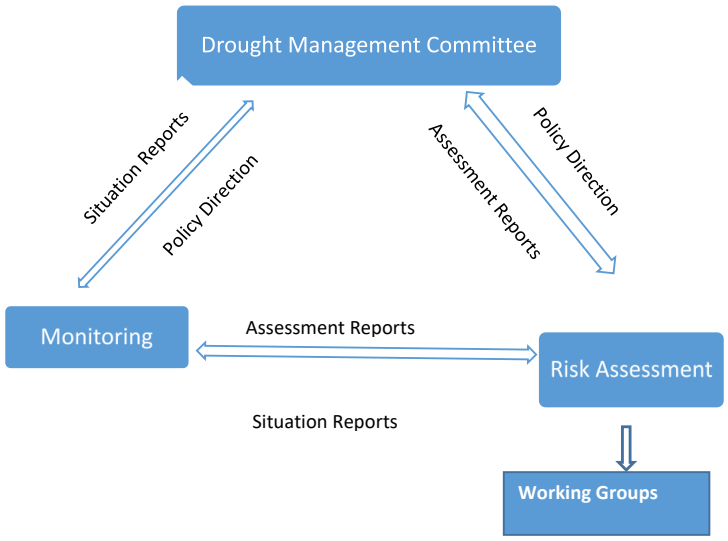


Figure 4.2: Functional Framework for Drought Management

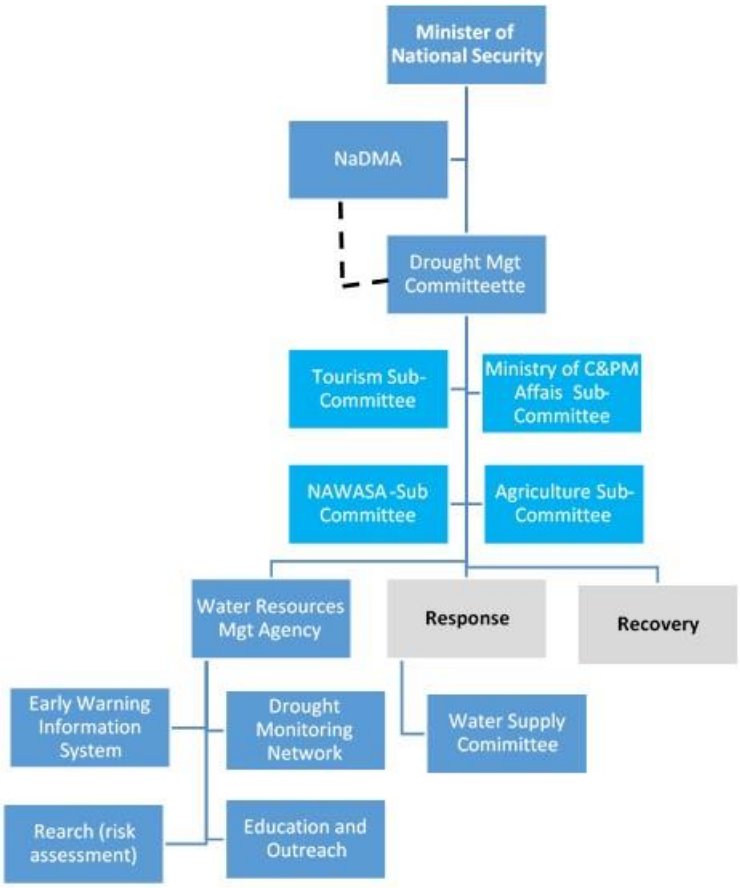


Figure 4.3: Drought Management Structure

5. DROUGHT MONITORING, FORECASTING, AND IMPACT ASSESSMENT

Drought is a regional phenomenon with characteristics differing from one climate regime to another, particularly in a chain of small islands such as those of the Caribbean. Drought monitoring and forecasting are important components of preparing and mitigating for drought, albeit challenging for an island such as Grenada. Through monitoring drought indicators, scientists are able to describe drought consistently through different times, locations, and impacts. Being able to forecast drought allows for advance warnings that help prepare sectors for the adverse effects of drought. The following sections describe available drought monitoring and forecasting systems Caribbean

5.1. **Data monitoring tools**

Monthly SPIs for stations with long data sets (this is limited)

Streamflow data (few good streamflow data, lack of stations)

Soil moisture observation or modeled data

Timeliness of information

Local drought monitoring criteria

An absence of good data a number of basic triggers could be used to identify that a drought may be in progress. Heim (2015) suggest some of these triggers for the Pacific islands. These are considered applicable for Grenada and its dependencies and are listed below.

Precipitation:

- Monthly precipitation greater than a set minimum →no drought;
- Monthly precipitation less than a set minimum for two or three months →drought;
- Monthly SPIs;
- Monthly percent of normal precipitation (this is not useful if the normal is too much different from the minimum precipitation drought trigger);
- Weekly precipitation to meet water supply needs (monthly minimum/4); and
- Two or three weeks of no rain or below weekly minimum →drought onset

Impacts

- Water supply gets low or runs out
- Crop damage
- Wildfires
- Low stream flows

In tropical islands such as Grenada, precipitation data is more important than temperature for monitoring drought, since temperature ranges are usually small.

5.2. Drought monitoring in the Caribbean

Droughts can be characterized based on their severity, location, timing and duration (Svoboda & Fuchs, 2017). The use of drought indicators and indices provides a method of identifying the aforementioned characterizing criteria, and was among the earliest scientific attempts made at the prediction and development of early warning systems. In countries or states where drought is monitored, experts consider on a weekly or monthly basis, how recent precipitation totals compare to their long-term averages; check temperatures, moisture levels in soils, and water levels in streams and lakes; and observe for indicators of drought such as vegetation stress. They use all this information to establish consensus for drought categories and provide this information in maps and charts which can be used for decision making by various stakeholders. These maps and charts represents those experts' best judgments of regional-scale drought conditions which can be validated by partners in the field.

5.2.1. Examples of Drought and Dry Season severity index in the region

Over the last decade, initiatives at drought forecasting and monitoring have been emerging. In Jamaica, the Jamaica's Meteorological Service made its first official drought forecast using a Climate Predictability Tool (CPT) to predict a high probability of below average rainfall in the coming three months (IPS 2016). The tool provides a Windows package for constructing a seasonal climate drought forecast model, producing forecasts with updated rainfall and sea surface temperature data. With this tool, farmers plan their planting around dry periods while the National Water Commission (NWC) has a guide to implement its island-wide water restrictions.

In Trinidad and Tobago, the Trinidad and Tobago Meteorological Service (TTMS) sets out a methodology for determining the onset, duration and severity of a dry spell or meteorological drought. It uses the Standardised Precipitation Index (SPI) to monitor and estimate dryness and wetness on different timescales, and is a measure of relative dryness and wetness compared to the long term average rainfall for a particular timescale. Specifically, a 2-month SPI for a given station is compared with the

same 2-month SPI at the same station for all the years on record. Thresholds, as established by the TTMS are shown in Figure 5.1

SPI Values	Level of Severity
-2.0 and less	Severe Drought
-1.5 to -1.99	Drought
-1.25 to - 1.49	Moderate Dry Spell
-1.0 to - 1.24	Dry Spell
-0.99 to + 0.99	Near Normal
+1.0 to + 1.49	Wet Spell
+1.5 to + 1.99	Moderate Wet Spell
+ 2.0 and more	Severe Wet Spell

Figure 5.1: Level of drought severity using SPI values for Trinidad and Tobago (reference!!)

In St. Lucia two indices (Figure 5.2) are used as a drought monitor. This monitor is based on a network of rain gauges and is simple to use.

Standard Precipitation Index (SPI)	
+3.00 and above	Exceptionally wet
+2.00 to +2.99	Extremely wet
+1.25 to +1.99	Very wet
+0.75 to +1.24	Moderately wet
-0.74 to +0.74	Near normal
-1.24 to -0.75	Moderately dry
-1.99 to -1.25	Very dry
-2.99 to -2.00	Extremely dry
-3.00 and below	Exceptionally dry

Deviation from Normal (DfN)	
Positive	More rainfall than average
Around 0	Normal
Negative	Less rainfall than average

Both indices are calculated on a monthly basis.

Figure 5.2: St. Lucia Drought Monitor
(http://www.drmonline.net/drmlibrary/droughtsaintlucia/monitor/index.htm)

The Caribbean Drought & Precipitation Monitoring Network (CDPMN) through its monthly Caribbean Drought Monitor publication provides a regional outlook of precipitation and drought conditions using the SPI. Grenada contributes data for the preparation of these outlooks and benefits as they are the best available information on current drought conditions. For example, Figure 5.3 shows a precipitation outlook for the participating territories.

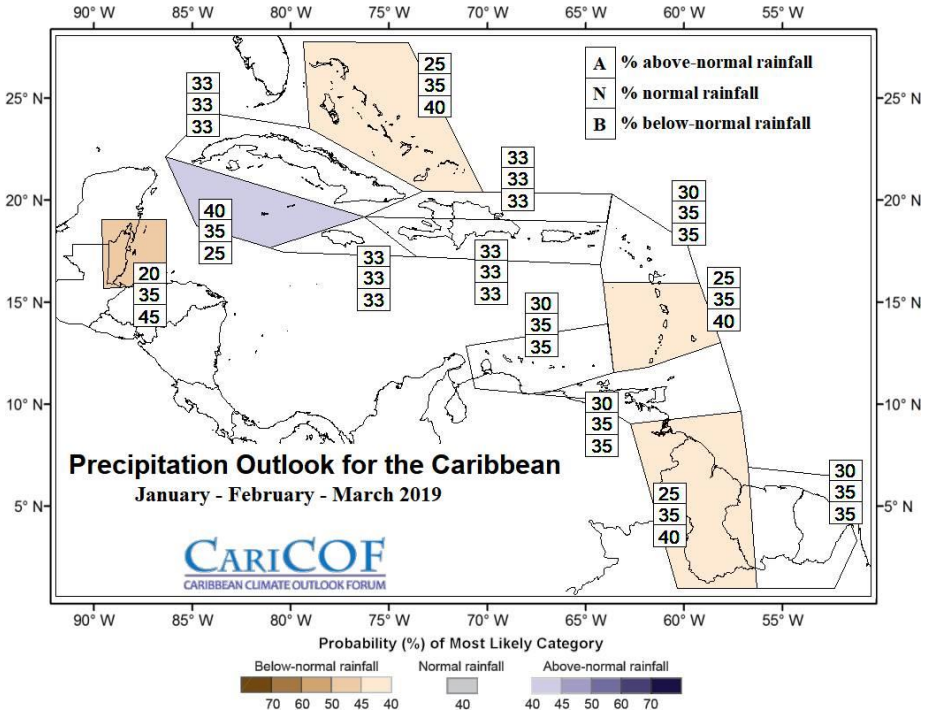


Figure 5.3: A typical CDPMN Precipitation outlook

5.2.2. Drought and dry season severity index for Grenada

5.2.2.1. Drought monitoring for Carriacou and Petite Martinique

Given the ongoing initiatives in the region towards drought monitoring, there are opportunities for improved national monitoring if other monitoring tools, perhaps less rigorous, are utilised recognising the limitation of relevant data. Consideration must also be given to existing tools developed locally. For example, Peters (2012) proposed a monitoring and early warning matrix for RWH supply, using six-month SPI and household cistern storage sizes (*See Figure 5.4*). The tool is a consumption guide for households for various cistern sizes. Triggers for household actions can be given for periods of two months. This too, could be further developed. In utilizing this tool, women in the household who typically monitor the levels of water in the cisterns could have the responsibility of monitoring levels in cisterns.

For small islands such as Carriacou and Petite Martinique, White et al (1999) suggested the use of the decile method and that prediction of the onset of severe dry times be made when the accumulated rainfall first drops below the 40 percentile level. This method should also be explored for Carriacou and Petite Martinique

SPIs Consumption Advisory Plan				
	Cistern size	**6-month SPI < -1.2**	**4-month SPI< -1.0**	**2 –month SPI < -0.8**
September	Small	Conserve level I	Watch	Warning
	Medium	Watch	Normal	Normal
	Large	Normal	Normal	Normal
October	Small	Conserve Level I	Warning	Warning
	Medium	Conserve	Watch	Normal
	Large	Normal	Normal	Normal
November	Small	Conserve Level II	Conserve Level I	Watch
	Medium	Conserve Level I	watch	Normal
	Large	Watch		Normal
December	Small	Conserve Level II	Conserve Level I	Warning
	Medium	Conserve Level I	Conserve Level I	Normal
	Large	Warning	Watch	Normal
January	Small	Conserve level II/Supplement	Conserve level II/Supplement	Watch
	Medium	Conserve Level II	Conserve Level II	Warning
	Large	Conserve Level I	Watch	Normal

Normal = no change in consumption required

Watch = household to closely monitor levels in cistern

Warning = household to prepare for shortages

Conserve Level I = recycle where possible, no watering on lawns

Conserve Level II: recycle, use pit latrines

Supplement: use of truck borne well water for non-potable use

Figure 5.4: Consumption monitor for RWH cisterns in C&PM

Recommendation:

Provide incentives for the purchase of cistern level recorders

Provide training on monitoring and recording cistern levels in Carriacou to women in the household

5.2.2.2. Drought monitoring for Ministry of Agriculture

The Country Document on Disaster Risk Reduction for Grenada (Charles, 2014) reports that The Land Use Division of the Ministry of Agriculture provides a 3 month forecast for drought and precipitation. Further, attempts have been made to integrate this forecast with the NaDMA operations with limited success while the Meteorological Office has not a part of the drought management system. Notwithstanding, in addition to Peters (2012) tool, the Ministry of Agriculture has suggested in its draft Agriculture Drought plan a monitoring tool (Table 5.1) based on impacts and observed general conditions to determine levels of severity. The categorisation reflects existing drought conditions with a 3 to 6-month timescale. It also recognises that water emergencies can occur at different levels of drought if the dry spell is particularly prolonged or if water storage capacity is insufficient to meet demand

Drought level	Possible Impacts
Abnormally/Slightly Dry	*Going into drought*: • short-term dryness slowing planting, growth of crops or pastures or mild dryness over a longer period *Coming out of drought:* • some lingering water deficits • pastures or crops not fully recovered
Moderate	• Some damage to crops, pastures in latter parts of dry spell • Streams, reservoirs, or wells low, some water shortages developing or imminent • Voluntary water-use restrictions requested
Severe	• Crop or pasture losses likely • Water shortages common • Water restrictions imposed • Shortages of water in reservoirs, streams, and wells creating water emergencies
Extreme	• Major crop/pasture losses • Widespread water shortages or restrictions • Shortages of water in reservoirs, streams, and wells creating water emergencies
Exceptional	• Exceptional and widespread crop/pasture losses • Shortages of water in reservoirs, streams, and wells creating water emergencies

Table 5.1: Grenada Ministry of Agriculture drought severity levels (Collymore *et al*, 2016)

5.2.2.3. Drought monitoring for NAWASA

The preceding two matrices (tools) satisfy the agricultural sector and RWH water supply in C&PM. Given that the best available data for drought monitoring for the benefit of public water supply are rainfall and reservoir, a proposed matrix for NWASA is shown in Table 5.2 below. This is based on the work by COLE International, and the WASA/WRA in Trinidad and could be refined by NAWASA. It is recognised that streamflow data is lacking, hence the percentage exceedance would only become practical in the future when streamflow measurements improve.

Drought Severity	Drought Response Stage	SPI	Percent of Reservoir Storage	Streamflow Percentage Exceedance

Normal	Normal	0.99 to - 0.99	80 to 100	70 to 79
Abnormally Dry	Pre-Alert	-1.0 to -1.49	65 to 80	80 to 89
Drought	Alert	-1.5 to -1.99	50 to 65	90 to 94
Severe Drought	Emergency	< -2.0	< 50	95 to 98

Table 5. 2: Trinidad and Tobago drought monitor

5.2.3. Challenges to a site specific monitoring system

5.2.4. Recommended drought indices

After analysis of the available data, human capacity and current practices in the region, it is recommended that three tools should be used for monitoring dry season and droughts in Grenada, namely, the tool by Peters (2012) and the percentile method for Carriacou and Petite Martinique; the tool proposed by the Ministry of Agriculture for agriculture on the mainland; and SPI and reservoir level for NAWASA. These tools would be complemented by the Caribbean Drought & Precipitation Monitoring Network (CDPMN) monthly outlook.

Drought Severity	Drought Response Stage	SPI	Percent of Reservoir Storage	Streamflow Percentage Exceedance
Normal	Normal	0.99 to - 0.99	80 to 100	70 to 79
Moderate	Pre-Alert	-1.0 to -1.49	65 to 80	80 to 89
Severe	Alert	-1.5 to -1.99	50 to 65	90 to 94
Extreme	Emergency	< -2.0	< 50	95 to 98

Table 5.3: NAWASA/Grenada Drought monitor

5.3. Impact Assessment

Drought events can have varying effects on different sectors and stakeholder groups. They have direct impacts on domestic water supply and on water-dependant economic sectors, such as irrigated agriculture, livestock production, agro-industry, and other economic activities dependent on water supply or precipitation. Measuring these impacts are not always straightforward, as while direct impacts are simpler to handle, indirect impacts can present challenges in assigning a dollar value. For example, the impacts on the natural ecosystems are difficult to value in economic terms. Furthermore, the cost of the measures implemented to mitigate, prevent or alleviate impacts of drought can also be attributable to the economic cost of the drought (Garrido, 2014).

Impact assessments are important in that they examine and attempt to quantify the consequences of a given event. For example, in the Agriculture and Commerce sector, direct impacts such as reduced crop yields, livestock losses, and reservoir depletion often lead to secondary and cumulative impacts, such as reduced profits, increased feed costs, forced sale of land or assets, and physical and emotional stress.

Being able to detect drought impacts in the early stages can help prevent the situation from turning into a crisis. In addition, having documented drought impacts can help support funding requests for mitigation projects that will reduce the impacts of future events. Drought impact assessments can be

accomplished through the careful collection and documentation of anecdotal impact data. Anecdotal data, combined with indices (forecasts or technical information), can create a more comprehensive understanding of drought-induced losses. This type of qualitative information is available from a variety of sources, including newspapers, personal interviews, government agencies, and photographs.

Water use and impacts of drought are not gender neutral. In many places women and girls are often worst affected. In the case of Grenada, although research data is not available on the different groups such as men, women, ethnic minorities, young and old, more women than men tend to be employed in the tourism sector, take care of school children when schools are closed due of water shortage or respond to household inconveniences, particularly those related to sanitation, during periods of severe water shortages.

Unfortunately, no gender-disaggregated data for disaster risks in Grenada is currently available. This is a significant gap because evidence from around the world has established that the vulnerability of women to disasters and that the increased risk associated with gender inequality and the limited representation of women in disaster responses are often not adequately considered.

RECOMMENDATIONS

Undertake gender analysis, social mapping, gender impact assessments, and gender responsive approaches in utilizing, managing and preserving water during droughts.

Ensure approaches to disaster risk reduction and management which take into account the differential impact of natural disasters on women and men and the differential approaches necessary for recovery and building resilience of communities.

6. DROUGHT RISK AND VULNERABILITY

6.1. Definitions

In any region, the risks associated with drought are a product of both the region's exposure to the event and the vulnerability of local society to drought.

Here we define vulnerability as the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards, including land degradation and desertification (ISDRD). This could be represented mathematically as: **Vulnerability (V) = Exposure (E) + Sensitivity (S) – Adaptive Capacity (AC)** where AC refers to the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to mitigate the impacts.

Hazards such as droughts are potential damaging phenomena that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption and environmental degradation (ISDR).

Risk entails the combination of the probability of an event and its negative consequences, hence Drought (Disaster) Risk refers to the potential loss of lives, reduced health status, livelihoods, assets and ecosystem services in connection with drought, which could occur to a particular community or a

society over a specified time period in the future (UN-ISDR, 2009). Mathematically, **Drought risk = Vulnerability (V) x Hazard (H).**

Due to its small land mass, most of Grenada, except the higher central forested areas and C&PM experience drought simultaneously. For water supply, residents C&PM who rely primarily on rainwater catchment are at the highest risk to drought. The densely populated southern part of the mainland is with highly commercial and tourism infrastructure is also at high risk during droughts. Grenada's agriculture is mostly rain-fed and irrigation is limited to small areas of vegetable production. Livestock production which is highly concentrated in C&PM is also at risk and is first in the country to be impacted by drought. Finally, for the environment, public health, and safety sector it is beneficial for understanding areas at risk from the environmental hazards of drought such as bushfires.

An understanding the threats from potential drought hazards on population, infrastructure, and the environment along with understanding the vulnerabilities of drought allows for improved planning in advance of drought scenarios. When the different sectors at risk to drought are recognized, specific projects can be implemented prior to the onset of a drought to mitigate potential impacts.

Drought risk and vulnerability and their assessments are complex issues and could be influenced by social and technical factors, for example, engrained perceptions, human and technical capacities. A better understanding the risk of drought impacts will assist in proactive drought management practices that are more effective than reactive, crisis based approaches of the past.

6.2. Challenges and Perceptions

6.2.1. General perceptions

During a drought, there is great interest in solving the problems it creates. However, in the period after the event there is a tendency is to move on to other priorities. During periods of abundant water, drought issues capture neither public interest nor media attention. Government, in general, limited its programs to providing direct relief to drought victims where possible. This may involve providing water-resources information, technical assistance and financial relief for the costs incurred by the drought, for example some compensation to farmers. NAWASA's traditional approach is to reduce the daily demand for water. In Grenada and other SIDs, drought planning appears to be given a low priority because of the unpredictability of drought, the limited resources for planning, and government's ad hoc programs that provide disaster relief in times of crisis. Actions of decision makers are often driven by the perception that little can be done to reduce the impacts of drought before they occur and that the costs would be borne by the victims.

6.2.2. Technical capacity

Other challenges relate to human capacity and data acquisitions. In a small country such as Grenada, with limited human capacity, many of the individuals who are identified through their organisations to represent them, in addition to their regular job activities, are often involved in multiple competing activities. As a result, plans fall by the wayside not because of lack of commitment but due to burn-out from meetings and other formal sessions. The extent of this problem would be explored through stakeholder consultation.

Recommendation:

Training for key institutions in the data analysis for the computation of SPIs

6.2.3. Data

Data for developing a site specific and robust tool for monitoring drought in Grenada is constrained by the quality of the data available. The two institutions collect relevant data: Ministry of Agriculture, Met Services and NAWASA. The available historic precipitation data for different locations in the country is often discontinuous and often the quality is suspect. Currently, there are *** stations where daily precipitation data is collected while there are *** stations which are no longer functional but where some historic data are available. The availability of streamflow is sparser. Streamflow data is currently being collected for *** sites while discontinuous data are available for *** sites which are no longer functional. Overall, NAWASA has highlighted one of the weakness of its operation is that there is inadequate data collection and analysis to support operation decision making processes (NAWASA, 2017)

The gap in data and its analysis has been recognised and recently the draft Water Policy proposed the establishment of a Water Resources Unit which would be charged with the gathering of data, investigations, monitoring, assessment and evaluation of water resources, water uses and water demand (GOG 2007a). It will be responsible for resource management, allocation, coordination and pollution control as well as inter-ministerial and cross-sector coordination of water, land, coastal areas and public health issues (GOG 2007a). To facilitate the work of the Unit, a National Water Information system is to be developed under the Water Policy Implementation Plan (GOG 2007c).

Recommendation:
Upgrade the network of raingauges around the country, including C&PM and install streamflow gauges on the main rivers
Provide training in data collection and management

6.2.4. Drought risk areas

In 2007, CEHI undertook mapping exercise for water deficit and analysed the spatial pattern of water availability given a number of consecutive 'dry' months. The maps (Figure 5.1) show different zones subject to greater water stress. These water deficit zones provide a picture of drought vulnerability which can be useful in the planning process.

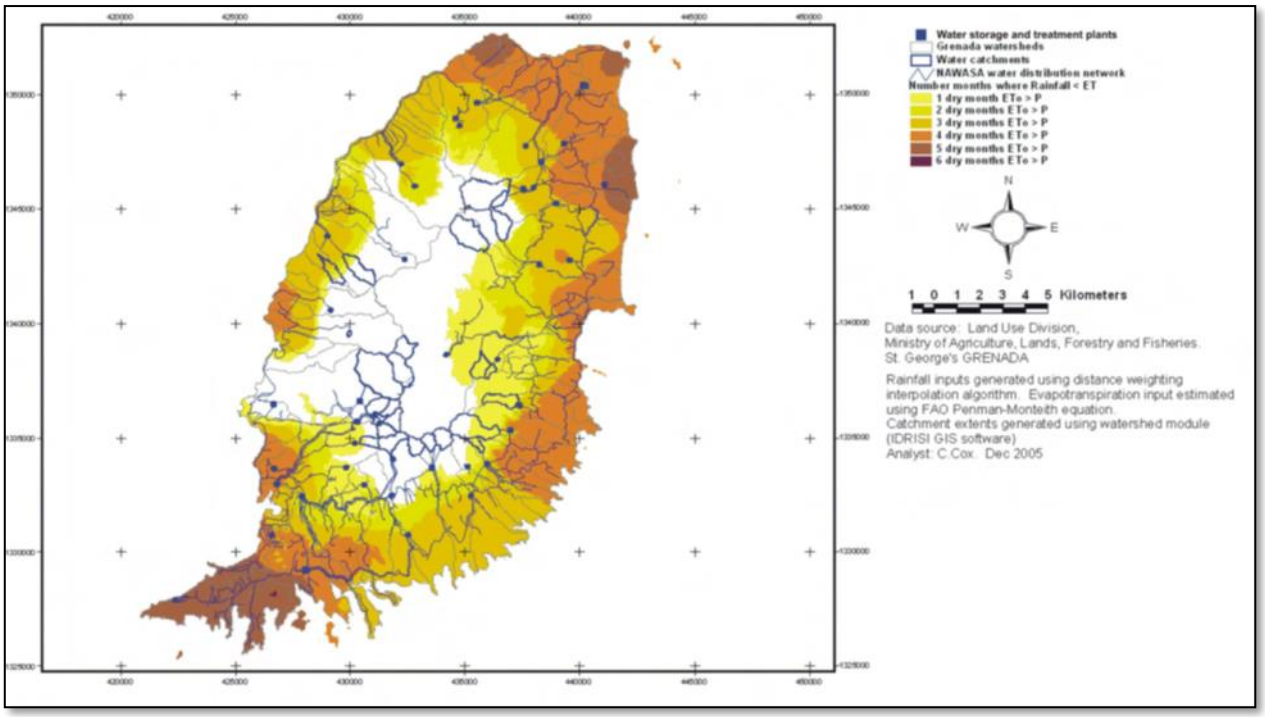


Figure 6.1: Water stress areas in Grenada

The areas of greatest risk to the public water supply and environment, public health and safety sectors is in C&PM. This exists throughout all stages from moderate, severe, and extreme drought. The other area with great risks is the south of the island due to high population density and the existence of the main hotel plants and the University of St. Georges which has an average student population of about 8,000. The northeast of the island with its low rainfall and high farming population is also at high risks

6.2.5. Drought risk women

Women and men experience, perceive and identify risks differently. Although in Grenada, where almost half the households in Grenada (47%) are female-headed (UNICEF 2011), there are no empirical evidence about the drought impacts on women, it was pointed out during stakeholder meetings that stakeholder that often the responsibility falls entirely to women, to collect, store, protect, and distribute water such that their workloads are increased. Further, during droughts local agricultural produce is in low supply affecting the livelihood of market vendors who a predominantly women.

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Recommendations

Measure and document the impact of drought change on vulnerable communities. Data should be consistently disaggregated by age and gender

Use community development organisations such as Grencoda to carry out PARTICIPATORY CAPACITY & VULNERABILITY ASSESSMENT (PCVA) for droughts

6.2.6. Risks to NAWASA

Drought risks are a major concern to NAWASA which is likely to be exacerbated by Climate Change. The 2010 Drought revealed some of the weaknesses in its systems. A number of its assets are highly

susceptible to drought-like conditions including water treatment plants ponds and wells. Low rainfall results in a low rate of recharge for the groundwater wells in the Chemin watershed, the location of the most productive wells (HR Wallingford, 2017).

Recommendation:
NAWASA should determine what level of drought resilience it considers appropriate and make the necessary investments in order to respond to future droughts

7. DROUGHT COMMUNICATION AND RESPONSE ACTIONS

7.1. Drought Communication Protocol

Successful implementation of the GDMP depends largely on the timely dissemination of clear and precise information to affected stakeholders and the public at large for periods preceding, during, and following a drought event. Four entities in the drought leadership structure are identified as having key communication responsibilities during normal, drought, and recovery periods. These entities are: NAWASA, Ministry of Agriculture, Ministry of Carriacou and NaDMA. Each of these stakeholders has specific roles within the recommended communication protocol, which provides for the necessary coordination and dissemination of drought information to stakeholders, and the general public. The Drought Communication Protocol described in this section incorporates the following three elements:

- Declaration of Drought Conditions
- General Coordination Guidelines
- Specific Communication Responsibilities.

7.2. Declaration of Drought Conditions

The declaration of drought in Grenada which often coincides with that in the Eastern Caribbean helps provide relief assistance for those suffering from drought conditions. Formal proclamations of a national drought can originate from the Office of the Prime Minister. These declarations can be initiated for Agriculture, NAWASA and Carriacou and Petite Martinique independently or collectively. CDPMN Outlook and the SPIs for Grenada and Carriacou would be used to inform NAWASA and the Ministry of Agriculture to initiate declarations. The National Agricultural Drought Task Force would declare an agricultural drought based on the drought matrix in Section 5.2.2.2.

The authority for NAWASA to declare a drought condition is provided by Section 9 of SRO of 1993: Water Services Regulations for the use of water in case of shortage.

These proclamations should be designed to address sector-specific impacts and to raise public awareness of local drought conditions. Declarations may be issued for purposes of seeking voluntary water conservation and/or implementation of mandatory water conservation measures at the household or farm level.

7.3. Communication and Coordination Guidelines

The communication and response actions are based on the National Drought Early Warning and Information Systems Implementation Plan developed by the Ministry of Agriculture. In implementing the communication and response actions, NAWASA, Ministry of Agriculture, Ministry of Carriacou and NaDMA should utilise the " Guide note to gender sensitive communication" (UNDP 2018). In addition, cable tv providers should be encouraged to provide public service in carrying drought related news during the showing of popular cable programmes.

7.3.1. Drought Early Warning and Information Systems

The overall goal of communication and coordination guidelines in this plan is to contribute to efforts to mitigate the effects of droughts in Grenada through provision of early warning, and public education and awareness information. To facilitate the smooth functioning of the DMP, the Drought Early Warning and Information Systems (DEWIS) Committee would have responsibility for coordinating the communication function of the DMC. It would undertake leadership of monitoring, forecasting and development and dissemination of information on drought and the ultimate development and implementation of a Grenada Drought Management Plan.

From time to time, it would review and update existing legislation as it relates to droughts on all corresponding agencies/departments (example: NAWASA, Ministry of Agriculture) to ensure harmonization to develop a Drought Act. Water saving devices and rain water harvesting policy…

This committee would be comprised of the following institutions: Ministry of Agriculture (Lead Agency); Meteorological Services; National Water and Sewerage Authority; NaDMA; Farmers 'Representative; Fire Department of the Royal Grenada Police Force), Media Representative, Government Information Systems; and Grenada Chamber of Commerce.

Reporting Requirements –This Committee should report to the Permanent Secretary of the Ministry of Agriculture, who ultimately reports to cabinet, a copy of which is sent to NaDMA.

7.3.2. Awareness, Education and Outreach Committee (AEOC)

The AEOC would have the responsibility to develop and implement a Drought Education and Awareness Plan in keeping with the DMP. It would consist of: NaDMA MBIA Meteorological Service; NAWASA; Ministry of Agriculture; Farmers' Representative; Media Workers Association of Grenada (MWAG), Government Information System (GIS), Ministry of Education; Chief Education Officer, Friends of the Earth Grenada (FOEG)
More specifically the committee would develop:

- An Education Plan, which includes Education to schools through curriculum and CXC syllabus
- Outreach programme to all stakeholders, including the general public
- Utilization of disaster framework from existing community groups e.g. NaDMA, District Disaster Management Committees, Red Cross, St. George's University Knowledge Bowl, Grenlec Debate
- Dissemination of analysed data and forecast information emanating from the MET Department
- Interpretation and dissemination of forecast information
- Lobbying the national authorities' support for the Committee's effort
- Public awareness on water usage and controls
- Training of trainers programmes for education and outreach giving due consideration to women
- Dissemination of analysed data & forecast in a format that is easily understood by the public.
- Promote public awareness of men's and women's complementary roles in the sustainable development and drought issues.

7.3.3. Terms of Reference for committee

- Implement all Education plans through fliers, training programmes on television and radio, Press Releases, Community Group meetings, popular theatre, churches;
- Incorporate the plan into Schools curriculum; 4H, Girls Guide and Boys Scouts, Essay competitions;
- Facilitate Stakeholder Analysis;

- Promote and encourage cooperation among Stakeholders; Ministries, Non-Governmental Organisations (NGO), and other relevant agencies;
- Periodical reporting to the DEWIS Committee;
- Monitor and evaluate effectiveness and progress of the programme;
- Web information portal to disseminate information; and
- Update web portal on a regular basis to provide real time information.

7.4. Drought Response Actions

The National Water and Sewerage Act gives the Authority (NAWASA) the responsibility to provide a satisfactory supply of potable water for domestic purposes among others unless prevented by drought reduced rainfall or other disasters (GOG 1999). The current legislation need to be amended to make the Drought Management Plan effective, but is adequate to begin the implementation of the DMP. In the case of a drought the NDRC on behalf of the DMC will make the determination if a Severe Water Supply Shortage exists based on trigger levels. Water uses that are regulated or prohibited under and updated Ordinance or the Water Policy would be considered to be "Non-Essential" and continuation of such uses during times of water supply shortages would be deemed to constitute a waste of water that may subject the offender(s) to penalties and/or including discontinuation of service. To reduce non-essential water demand, regulations and restrictions on the delivery and consumption of water would be adopted by the Drought Management Committee These restrictions are keyed to the declared drought phase.

In selecting, designing or implementing response actions, all efforts must be made to incorporate women in a meaningful way. In many single parent homes in Grenada, women are primary breadwinners who also have to play the socializing roles of both mother and father in providing material and emotional support to children, as well as to elderly or feeble relatives who are part of their households. They are usually resourceful however, they may break down when both material and emotional support for them to cope during extreme water shortages are not adequately provided.

The sections that follow describes actions that should be taken for different phases of droughts. A summary of these actions are available in Appendix A.

7.4.1. **Domestic water supply /NAWASA**

The implementation of the Drought Plan NAWASA should integrate supply and demand strategies through an adaptive Shortage Response Planning Framework that includes both supply augmentation as well as demand reduction measures. Integrated supply and demand strategies are necessary because the uncertainty of climate change may introduce a new normal in average annual surface water flows, requiring a need for long-term reductions in demand. The Plan applies a Shortage Response Framework that is a progressive series of supply and demand actions designed to proactively prepare and respond to shortage impacts.

Two water use reduction strategies that are influenced by the availability of supplies relative to demand are recommended. The first strategy is improved efficiency which results in gradual reductions in water use without adversely impact customer lifestyles or business opportunities. Ideally efficiency programmes should be implemented during normal situations but may be accelerated during droughts or as the probability of shortages increase.

The second strategy, demand curtailment, can be viewed as an urgent reduction of water demand necessary to mitigate supply shortfalls. Programmes for this strategy can be structured to minimize customer impacts and avoid measures that impose severe impacts on a customer's quality of life and/or the local economy. If demand curtailment becomes necessary, allocation would be based on balancing water demand with available supplies; first targeting water use that provides the least value to customers and the community at-large. For example, targeting leakage and waste would be considered before discretionary uses as deemed necessary. Only in the most pressing situations would essential uses get targeted for curtailment. Figure 7.1 illustrates the shortage response planning framework

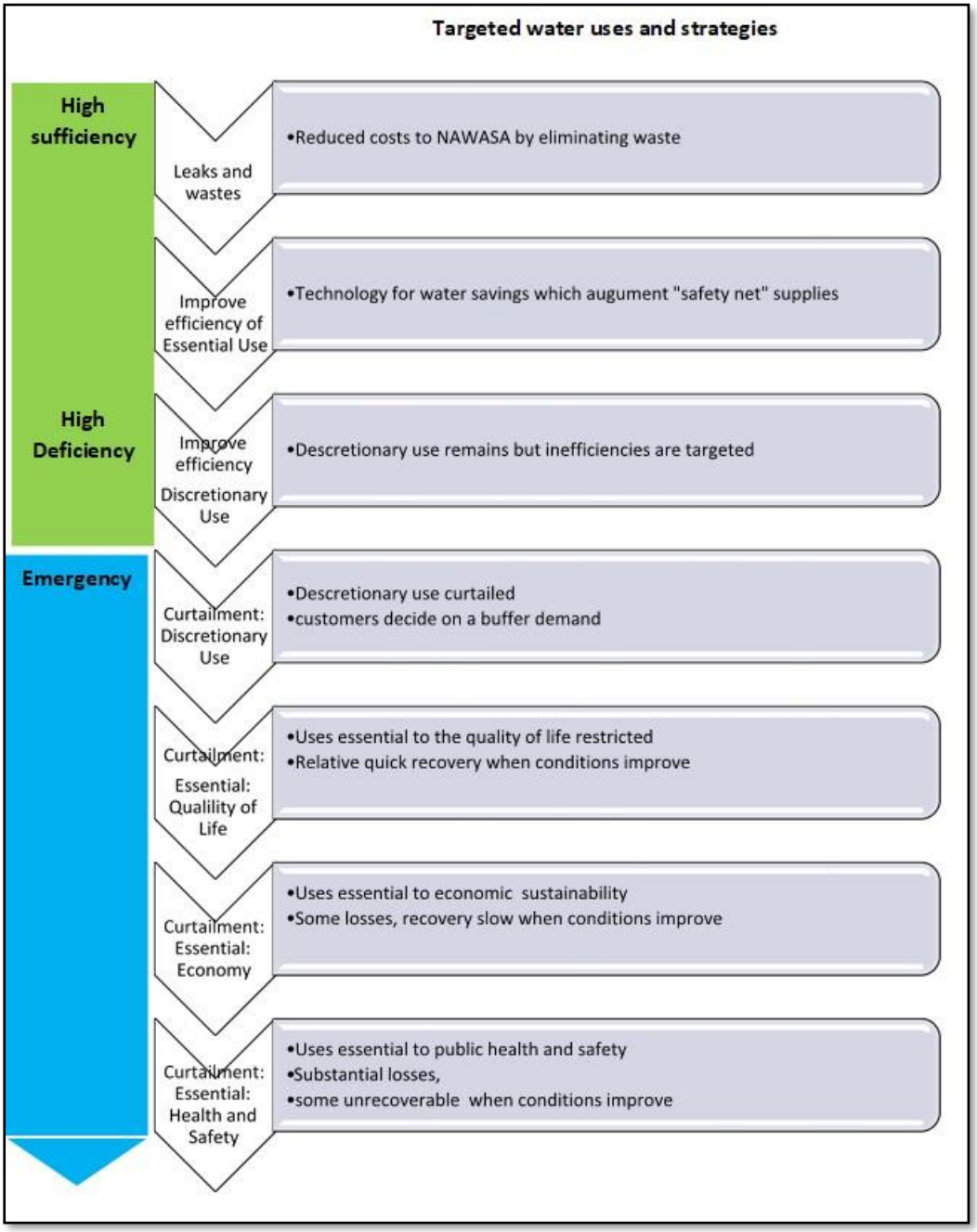

Figure 7.1: A shortage response framework

Recommendation:

7.4.1.1. Moderate Drought Phase Goals and Restrictions:

The National Drought Response Coordinator (NDRC) will make the determination if a moderate water supply shortage exists based on trigger levels. Upon this determination, the Water System will seek voluntary reductions from its customers in the use of water for all purposes and voluntary reductions on using water during certain peak water demand periods. The goal during a Moderate Drought Phase is to achieve at least a reduction of 20% in residential water use and 15% in other water uses such as commercial, industrial, institutional and irrigation; and a reduction in overall water use of 15%. To accomplish these goals, the Water System will use the following metrics: Reduce average domestic water use to at minimum an average of 130 gallons per customer per day or 8,000 gallons per household per month. The above goals will be accomplished by:

- Increasing water storage capacities and rehabilitation of wells for sustainable use of groundwater resource
- Issuing a Proclamation to be released to local media, and/or its customers that Moderate drought conditions are present and Voluntary Conservation Measures are in-place.
- Publish the proclamations in the local newspapers, radio and television station of general circulation in the service area of the water system that the voluntary conservation measures are in-place in the water systems.
- The following Voluntary Water Conservation Measures that will be in force until lifted by the Drought Management Committee:

Voluntary Water Conservation Measures to be Implemented during the Moderate Drought Phase:

- Eliminate the washing down of sidewalks, walkways, driveways, parking lots, tennis courts and other hard surfaced areas;
- Eliminate the washing down of buildings for purposes other than immediate fire protection;
- Eliminate the domestic washing of motorcycles, motorbikes, boats, cars, etc.;
- Eliminate the use of water to maintain fountains, reflection ponds and decorative water bodies for aesthetic or scenic purposes, except where necessary to support aquatic life
- Reduce watering of lawns, plants, trees, gardens, shrubbery and flora on private or customer property to the minimum necessary. Encourage outdoor watering to be done during off-peak hours.
- Reduce the amount of water obtained from fire hydrants for construction purposes,
- Discontinue fire drills or for any purpose other than fire-fighting or flushing necessary to maintain water quality;
- Cease water service to customers who have been given a 10-day notice to repair one or more leaks and have failed to do so.
- Intensify maintenance efforts to identify and correct water leaks in the distribution system.
- Cease to install new irrigation taps on the water system.
- Continue to encourage and educate customers to comply with voluntary water conservation.

7.4.1.2. Severe Drought Phase: Goals and Restrictions:

The NDRC will make the determination if a Severe Water Supply Shortage exists based on trigger levels. Upon this determination, the Water System will seek mandatory reduction in the use of water for all purposes and mandatory restrictions on non-essential usage and restrictions on times when certain water usage is allowed. Specifically, the goal during this phase is to achieve at least a reduction of 25% in residential water use, 20% in all other water use categories, and a reduction in overall water use of 20%. To accomplish these goals, the Water System will use the following metrics:

Goal

The water reduction goals during a Severe Drought Phase is to achieve a reduction of average water use by domestic customers to 20 gallons per person per day.

The above goal will be accomplished by:

- Issuing mandatory water restrictions through a proclamation by the Drought Management Committee through the relevant governmental body.
- Provide notification to the water customers by routine publication in a newspaper, radio and Television ads and public broadcasting in the service area of the water system.

The following Mandatory Severe Drought Water Conservation Measures that will be in force until lifted by the Drought Management Committee:

Mandatory Water Conservation Measures to be implemented during the Severe Drought Phase

Eliminate the washing down of sidewalks, walkways, driveways, parking lots, tennis courts, streets and other hard surfaced areas;

- Eliminate the washing down of buildings for purposes other than immediate fire protection;
- Eliminate the domestic washing of motorcycles, motorbikes, boats, cars, etc.;
- Eliminate the use of water to maintain fountains, reflection ponds and decorative water bodies for aesthetic or scenic purposes, except where necessary to support aquatic life
- Reduce watering of lawns, plants, trees, gardens, shrubbery and flora on private or customer property to the minimum necessary. Encourage outdoor watering to be done during off-peak hours.
- Reduce the amount of water obtained from fire hydrants for construction purposes,
- Discontinue fire drills or for any purpose other than fire-fighting or flushing
- Cease water service to customers who have been notified of leaks and have failed to repair them.
- Intensify maintenance efforts to identify and correct water leaks in the distribution system.
- Cease to install new connections to the public water supply system.
- Control landscape irrigation by the utility's customers by staggering watering times
- Continue to encourage and educate customers to comply with mandatory water conservation

7.4.1.3. Extreme Drought Phase:

Upon this determination of an extreme water supply shortage, the NDRC will seek mandatory reduction in the use of water for all purposes and mandatory restrictions on non-essential usage and restrictions on times when certain water usage is allowed.

Goal

To achieve at least a reduction of 30% in residential water use, 25% in all other categories of water uses and a reduction in overall water use of 25%.

To accomplish these goals, the Drought Management Committee will use the following metrics:

Specifically, the goal during a Severe Drought Phase is to achieve a reduction of residential water use by the utility's customers to 100 gallons per household per day or 5,000 gallons per household per month

- Provide written notification to the customers and routinely publish in a newspaper of general circulation in the service area of the water system the Severe Conservation measures that the customers are requested to follow during Moderate Drought conditions.
- Eliminate all landscape irrigation by the utility's customers.
- The following Mandatory Extreme Drought Water Conservation Measures that will be in force until lifted by the Drought Management Committee

Mandatory Water Conservation Measures Implemented During the Severe Drought Phase

- Eliminate the washing down of sidewalks, walkways, driveways, parking lots, tennis courts, streets and other hard surfaced areas;
- Eliminate the washing down of buildings for purposes other than immediate fire protection;
- Eliminate the domestic washing of motorcycles, motorbikes, boats, cars, etc.;
- Eliminate the use of water to maintain fountains, reflection ponds and decorative water bodies for aesthetic or scenic purposes, except where necessary to support aquatic life
- Eliminate filling or maintaining customer or private swimming pools;
- Reduce watering of lawns, plants, trees, gardens, shrubbery and flora on private or customer property to the minimum necessary. Encourage outdoor watering to be done during off-peak hours.
- Reduce the amount of water obtained from fire hydrants for construction purposes,
- Discontinue fire drills or for any purpose other than fire-fighting or flushing necessary to maintain water quality;
- Limit irrigating golf courses and any portion of their grounds that use finished water
- Cease water service to delinquent customers who have been given notice to repair one or more leaks and have failed to do so.
- Limit expanding commercial nursery facilities, placing new irrigated agricultural land in production, or planting or landscaping when required by site design review process.
- Intensify maintenance efforts to identify and correct water leaks in the distribution system.
- Cease to install new connections on the water system.
- Control landscape irrigation by the utility's customers by staggering watering times
- Continue to encourage and educate customers to comply with mandatory water conservation
- Provide a truck delivery service
- Install Public Water Tanks in badly affected dense communities
- Monitoring compliance of prohibitations

7.4.2. Agriculture

Agriculture is at high risk to droughts. The actions to be taken are stated in the draft Agriculture Drought Management Plan (Collymore *et al*. 2016), and the key ones are included here for completeness of the national plan. There is no separation of drought levels as these could be found in the Agriculture Drought Plan. Following are the key actions required during any drought situation:

- Provide relevant and accessible drought preparedness and management information to agricultural producers
- Facilitate community-based interventions/initiatives for water conservation and drought management in agricultural communities;
- Facilitate extension interventions for promotion of drought resistant crop varieties;
- Consistent monitoring of soil moisture and design of drought early warning;
- Dissemination of drought status update and strategies for impact reduction to agricultural producers;
- Enforcement of water use restriction to agriculture sector;

- Promote use of water conservation measures such as drip irrigation, organic mulching and greenhouses;
- Institutionalization of a mechanism for timely and accurate drought impact assessment; and
- Development of incentive mechanism for farm-level drought mitigation.

7.4.3. Carriacou and Petite Martinique

During droughts there is competition for water between domestic and livestock uses, In C&PM. Livestock production is particularly vulnerable. This vulnerability has increased in recent times with the increase practise by farms to have their animals on the loose and the closure of communal pastures which provided a secured area where fodder was available during severe dry seasons and droughts.

There is need to urgently revitalised these practices by;

- Establish a management system for managing public water sources;
- Rehabilitate existing communal cisterns;
- Enforcing regulations that requires farmers to control their animals; and
- Establishment of communal pastures with rainwater ponds

At the declaration of a moderate drought the Ministry of Carriacou should:

- Activate boreholes and dug well by
- Use communal cisterns in villages
- Increase the storage facilities for the desalination system
- The Ministry of Carriacou and Petite Martinique Affairs to provide truck delivery service

7.4.4. Tourism

The tourism sector which can be considered to be mainly the hotel industry is highly dependent on NAWASA for its water supply, hence generally the actions taken by NAWASA during droughts would directly impact on the hotel sector. As the tourism sector is a major sector that would be impacted by droughts, some response actions are included for this sector. Already, a number of hotels have invested in water conservation and alternative sources of water such as reuse of grey water for toilet flushing and landscape irrigation and desalination on an as needed basis. Nonetheless, general actions that can be taken include:

- Undertake comprehensive audits the water efficiency of hotels/guesthouses;
- Upgrade bathrooms with more water-efficient showers, toilets and faucets, install rainwater harvesting systems and recycle greywater for cleaning, laundry and gardens;
- Control and reduce water consumption;
- Educate and build awareness for our employees;
- Raise awareness among customers;
- Treatment of wastewater (greywater) for toilet flushing and landscape irrigation; and
- Installation of desalination plants to be used during severe dry seasons and droughts.

8. DROUGHT MITIGATION AND PREPAREDNESS

8.1. Drought strategies

Mitigation are actions and activities that reduce the overall risk to drought and ultimately reduce the severity of drought impacts. These actions and activities should be executed prior to the onset of drought conditions. Further mitigation activities should be long-term and ongoing supported by adequate funding. Some of these activities such as legislative actions, drought plan updates, and the development of water conservation and other public awareness programs are generally long-term in nature. In the past, in Grenada mitigation actions have been mostly knee-jerk actions or crisis management in approach and short lived.

Drought mitigation requires a proactive approach. The key element to reducing drought impacts for individuals, communities, and the environment is having a coordinated drought preparedness program. To ensure progress, an integrated approach within and between levels of government, and appropriate involvement of local organizations and the private sector is required. An effective drought mitigation plan should thoroughly examine and address the needs of each of the drought impact sectors through risk assessment and prioritization of mitigation activities within key impact sector, and plan accordingly. Mitigation would be most effective if there are strong commitments for implementing a variety of strategies.
Recommended mitigation actions have been divided into the following categories:

- Water Resources Monitoring,
- Drought Forecasting and Impact Assessments
- Development of Alternative Water Sources
- Public Education Awareness and Outreach
- Watershed Protection
- Legislation
- Land Use Planning

8.1.1. Water Resources Monitoring, Impact Assessment and Drought Forecasting

A proactive approach to drought management requires thorough planning. Consideration should be given to impact assessments from previous droughts (See Section 3.2). Continuous monitoring of the extent and impacts of dry season and drought must be monitored to update the national experiences. This approach would lessen enhance the planning process and the efficacy of implementing drought mitigation strategies.

The monitoring and assessment of drought impacts to stakeholders, society, the environment, and the economy have not been limited to one or two academic papers (Peters 2015). In this case, impacts included crop and livestock loss estimates, the number of applications for drought-relief assistance, number of incidents and areas burned by wildland fire and their associated loss estimates, and revenue losses. Comprehensive data on the tourism industry or data from government disaster relief funds were not formally compiled. Consequently, it is difficult to quantify the socio-economic effects of drought resulting in underestimated or unreported impacts.

Recognising the historical impacts in Carriacou and Petite Martinique the following recommendation is provided:

Recommendations:

Encourage MC&PMA to develop their own drought plan; and

Encourage the MC&PMA to develop and maintain a water supply inventory of private RWH cisterns can be used during drought-related emergencies, such as for fire suppression.

8.1.1.1. Water Resources Monitoring

A programme for hydrologic monitoring efforts and data collection carried out by NAWASA and the Ministry of Agriculture (Water Resources Unit)

Monitoring activities are essential to preparing drought forecasts, evaluating drought conditions, and for correlating drought conditions with drought impacts.

The existing network of rain gauges should be evaluated and additional gauges should be installed where gaps exist

Stream flow monitoring gauges and reservoir level gauges should be installed. Improved quality and quantity of precipitation, reservoir levels, stream flow and other water resource data from multiple sources would allow for a better understanding of what mitigation projects need to be

8.1.1.2. Drought Forecasting

- Encourage the monitoring the development and occurrence of El Niño/La Niña events by CIMH;
- Support research on climate change impacts to drought in the region;
- Support research on short term and seasonal drought forecasting in Grenada;
- Explore the use of new technologies to develop improved drought forecasting tools tailored to Grenada; and
- Train citizenry in drought recognition.

8.1.1.3. Data Collection and Dissemination

- Maintain active involvement with the Monitoring, Early Warning and Information Sub-Committee. This will facilitate access to, and the sharing of drought information countrywide;
- Develop a standardized system and methodology to collect and analyse data regarding social/ economic impacts of drought that includes a gender perspective; and
- Explore the use of new technologies to develop improved drought forecasting tools tailored to the Eastern Caribbean which can improve forecasting for Grenada.

8.1.2. Development of Water Sources

The projected water demand for Grenada, is expected to grow due to population growth of 1% per annum; growth in tourism (cruise ship, stayovers, mariners and medical students) and the expansion of agricultural activities. Currently, while 54,600 m^3 of water is available on mainland Grenada per day during the rainy season, yields drop to 31,800 m^3 per day during the dry season. The current gap between demand and yield of 22,800 m^3/day during the dry season indicating the high risk of water shortages that Grenada already faces, in particular during a drought. Moreover, the increase in average temperature due to climate change, and the 21% projected decrease in annual rainfall, will lead to reductions in stream and river flow volumes, increased siltation of dams, reduced groundwater recharge rates and increasingly severity of droughts (GOG 2018). These conditions would affect the quality, quantity and availability of surface and groundwater supplies. Consequently, there is need to

consider as many alternative water sources as are feasible to augment NAWASA's current exploitation of 23 surface and six groundwater supply sources on mainland Grenada dry season.

Although the possibilities may be limited, increasing water storage capacity can help to prevent adverse impacts associated with drought, especially for the water supply and agricultural sectors. Increasing water storage capacity can be especially beneficial for shorter drought periods as it can help to ensure that normal practices can continue. Of note is the Great River watershed is a potentially suitable location for large-scale storm water harvesting (SWH) for potable and non-potable water supply (GOG 2017d). A recent project proposal for a Climate-Resilient Water Sector in Grenada (Green Climate Fund 2018) estimates that NAWASA's annual water production capacity (before losses) would have to be raised by approximately 354 million imperial gallons (1.568.000 m^3) – mainly through increased raw water storage – and treated water storage capacity would have to be added to meet future needs. The proposal also estimated that after 25% of real water losses, NAWASA would supply 1.77 billion imperial gallons (8.046.000 m^3) and approximately 145 million imperial gallons (660.000 m3) of added storage capacity would be needed for servicing temporary peaks in demand due to extreme events or disasters such as droughts or storms.

In C&PM increasing water storage capacity through rainwater harvesting can be especially beneficial for shorter drought periods as it can help to ensure that normal practices can continue. Water storage projects may include constructing water reservoirs that are part of a potable water supply system, as well as open reservoirs for agricultural use. Rainwater reservoirs and ponds can be a primary source of irrigation and can also be used for emergency wildfire fighting purposes. Increasing water storage capacity of RWH reservoirs will help mitigate any future drought impacts on Grenada's local food system.

Water storage projects may include constructing water reservoirs that are part of a potable water supply system, as well as open reservoirs for agricultural use. Reservoirs are an important component of agricultural operations in Grenada since they are the primary source of irrigation. Reservoirs can also be used for emergency wildfire fighting purposes. Increasing water storage capacity of reservoirs in the state will help mitigate any future drought impacts on Grenada local food system.

Recommendation:
Develop a project to enhance household storage capacity by providing incentives to poor households giving priority to female-headed households.

8.1.2.1. Rainwater harvesting

For example, in Carriacou and Petite Martinique, desalination is slowly improving the availability of water to households and it holds great potential for augmenting rainwater harvesting.
Developing new surface, ground water sources and rainwater sources can mitigate impacts in the event of a drought. In particular, the Ministry of Agriculture should develop and broaden the use of rainwater harvesting. The Madigras project of the 1980s could be rehabilitated and similar projects in other parts of the island should be considered.

The overall strategy for the development of water sources includes the following recommended actions:

- Encourage counties to develop and maintain a water supply inventory and map that can be used during drought-related emergencies, such as for fire suppression. The inventory should include existing and alternate sources of water such as dams, reservoirs, and public and private rainwater systems;
- Rehabilitation of wells for sustainable use of groundwater resources;
- Increase in water storage capacities and installation of required connections to the network;
- Encourage major hotels to develop their own drought plan;
- Construction of communal rainwater harvesting systems and ensuring gender equity in their management;
- Provide assistance to female-led households in installing RWH tanks; and
- Provide economic incentives for the development of domestic RWH cisterns.

8.1.3. Increasing Water Conservation and water reuse

An aggressive water conservation program is an essential component of drought mitigation. To ensure that an adequate supply of water is available throughout the year, potable and non-potable water must be used wisely year-round and especially during the dry season. Water conservation should be promoted and practiced within all water use sectors and at the household level.

The re-use of water is not a wide-spread practice in the region but is receiving increasing attention as a response to periodic and longer term water scarcity. The increasing attention being paid to this potential resource needs to be accompanied by appropriate levels of treatment that reflect the different categories and accompanying quality standards required for hygiene and to protect public health. It is important to recognise that women play a particular role in water reuse and water conservation at the household since they generally have the tasks for household sanitation during water shortage.

8.1.3.1. Water Conservation Measures

- Develop and implement a Grenada Water Conservation Plan
- Encourage the key entities farmers, schools, hotels and government departments to develop their own water conservation plan
- All levels of government, the private sector, and stakeholders should be involved in conservation activities and should actively develop new water conservation programs where needed.
- NAWASA should develop and coordinate plans to implement water restriction practices, voluntary and mandatory, if a drought is either imminent or exists.
- Dissemination of information to the public about water conservation measures.
- Development of incentive programs or tax credits for installing water saving fixtures.
- NAWASA can offer free inspections to identify leaking toilets and plumbing fixtures.
- Advocate for building codes to generate long-term water savings
- Support and encouragement of water-conserving irrigation systems, irrigation water management practices, and other water conservation practices, such as windbreaks and cover crops.
- Encourage use of rainwater catchment for outdoor water uses and irrigation.

8.1.3.2. Water reuse

Once, a centralised wastewater treatment plant is operational, implementing alternative water supplies such as recycled water and graywater can also increase Grenada's resilience to drought impacts, particularly in the south of the island. Further

- **Encourage water reuse at the household level. For example, the use of bath and shower water for flushing or external yard cleaning**.
- **Larger hotels should be encouraged to implement water reuse facilities for providing non-potable water for internal use and landscape irrigation**

8.1.4. Desalination

Desalinated water comes from the sea hence this source is not dependent on climate and could be regarded as an 'unlimited' resource. Water availability from this source is limited only by the supply capacity of the desalination plant and the cost of operations. The efficiency of desalination technology and the cost of operation is being reduced which makes it a viable potential source for small islands in the future (Peters 2016).

In Carriacou and Petite Martinique, desalination is slowly improving the availability of water to households and it holds great potential for augmenting rainwater harvesting. During the 1990s, Grenada experimented with desalination with the purchase of 3 plants, one each, for Grenada, Carriacou and Petite Martinique. The failures of these plants have been attributed to poor plant site, lack of distribution infrastructure, mechanical problems, limited storage capacity and lack of enthusiasm by residents to use the water for drinking (UNDESA 2012b). Recently desalination plants have been installed, one each for Carriacou and Petite Martinique. Reports on the performance of the second generation of desalination plants are limited. Nonetheless, available information on the most recent six-month period which are shown in Table 8.1 suggests that there is under-utilisation of the systems since less than 5% of the plants capacities are purchased.

Parameters	**Carriacou**	**Petite Martinique**
Production Capacity (gallons/hr)	2860	1650
Storage Capacity (gallons)	80,000	54,000
Current Average daily Production (gallons)	27,000	13,664
No. of Connections	53	112
Water sale (gallons)	130,000	162,300

Table 8.1: Summary of desalination plants in Carriacou and Petite Martinique (source NAWASA)

Private desalination plants are operational at the St. George' University and at the Sandals resort which produces about 4,1million gallons per month. Such private sector initiatives can be duplicated by some of the larger hotels. This would require investment in desalination plants, particularly in combination with water reuse for larger hotel plants.

8.1.5. Public Education, Awareness and Outreach

8.1.5.1. Public Education, Awareness

Public education is a key element of successful drought preparedness. Educational programs such as workshops, newsletters, public service announcements, press releases, community meetings, school curricula, and interactive participatory decision-making processes can increase awareness of the value of preparing and planning for droughts. As part of this effort, the National Drought Management Committee would develop several public service announcements on drought awareness.

Hands-on training and technical assistance programmes (HTTAP) can help stakeholders formulate and implement plans that incorporate drought planning and mitigation processes. Such programs can help farmers in Grenada decide alternative crops that are drought-resistant crops, construction of RWH systems of their farms, conservation systems. These measures can help farmers implement water management practices and gain a better understanding of the soils and climate conditions in their areas and the types of crops and plants suitable to mitigating adverse changing conditions. In implementing these HTTAPs there is need for an equitable participation of men and women in communities.

A national strategy for promoting public education and awareness should provide abroad understanding about the specific climate-induced limits and challenges regarding the availability of water resources in Grenada and may include the following specific near-term and long-term actions:

- Seek partnerships with private entities and community organizations to support and augment government Public Education and Awareness activities
- Help stakeholders formulate and implement plans that incorporate drought mitigation processes
- Develop drought educational exercise and learning tools that may be incorporated into school science curriculums.
- Incorporate natural resource conservation approaches, such as watershed-based management, into drought-related Education and Awareness activities.
- Communications, awareness and education approach to promote water users' climate resiliency
- Demonstration projects on water saving techniques
- Promote the importance of including drought risk at the local level in watershed-based planning activities
- Strengthening the Collection and Management of Water Resources and Climate Change Data
- Increase public awareness of men's and women's complementary roles in the sustainable development of the country's natural resources
- Encourage the active participation of women, particularly homemakers in public education and awareness activities.

Recommendation:
Engage in community consultations with men, women and youth on the issues of droughts and other disasters

8.1.5.2. Water users outreach

An active and effective conservation outreach program should be maintained as part of efforts to encourage water users to embrace a desert lifestyle, during certain drought or shortage conditions. Enhanced outreach will be necessary to update water users on water supply conditions and provide clear expectations about their water use. This enhanced outreach communicates important ways users may reduce their vulnerability to drought impacts and become more aware of shortage response measures, including voluntary rationing. User outreach may include general messages and/or targeted communication directed at specifics types of customers or water uses. It may utilize traditional or social media platforms.

General Communication The following examples demonstrate how general messages might be altered to suit the different Water Reduction Stages in the regulations. All messaging should consider the role that women have played in the pass in mitigating drought and the household and community level by designing messages that target women, particularly female-headed households.

Water Alert- Messaging

- Raises awareness of watershed conditions, the probability of worsening conditions, and of actions by the Drought Management Committee/NAWASA to avoid an imbalance.

Water Warning- Messaging:

- Updates the public on watershed conditions, the probability of imbalance, and actions by the Committee/NAWASA to augment supplies and/or curtail water use, and
- Initiates a call-to-action for customers to take voluntary measures to curtail water use and reduce vulnerability to future restrictions.

Water Emergency- Messaging:

- Updates customers on watershed conditions and imbalance intensity and duration, and
- Informs customers of any education opportunities, incentive programs, mandatory measures, and surcharges.

Water Crisis- Messaging:

- Updates customers on the severity of watershed conditions and imbalance intensity and duration.
- Informs customers of any education opportunities, incentive programs, and expanded mandatory measures.

8.1.6. Watershed Protection

Protecting watersheds, specifically in the upland forests, is a cost effective and efficient way enhance streamflow and to replenish groundwater. Forests absorb mist increasing water capture more than rainfall alone. The potential for a trend of declining rainfall Grenada makes it even more pressing to protect watersheds. Because the watershed typically spans across multiple private land holdings, partnerships between the Forestry Department and land owners are an effective means to manage these resources. The implementation of the Grenada National Land Policy (GOG 2018) is essential to this Plan

8.1.7. Legislation

The 2008 Review of legislation with respect to the water sector (Sealy-Brown 2008) has made provision for the declaration of a water emergency including drought:

"Section 11(1) Where on the advice of the Director of the Water Resources Agency the Minister is satisfied that by reason of an exceptional shortage of rain, or contamination of water, a serious deficiency of supplies exists or is threatened, the Minister shall forthwith, by order publish in the Gazette, in at least two newspapers in general weekly circulation in Grenada and by any other media declare a water related emergency"

Notwithstanding, new legislation may be required to fund and implement mitigation and response actions. Examples of possible actions include:

- Implementation of water regulations for establishment of Drought Management Committee
- Development of additional water supply and storage for agricultural and livestock purposes;
- Provision of tax credits for agricultural losses due to drought;
- Expansion of current data collection;
- Development of improved forecasting and monitoring tools at the state and local level;
- Creation of incentives to facilitate rainwater harvesting and water storages;
- Delimitating the use of reclaimed water over potable water sources, including the treatment of greywater in hotels for toilet flushing and landscaping; and
- Introducing a Climate-Responsive Water Tariff (Green Climate Fund 2018)

8.1.8. Land Use Planning

Drought risk is directly related to land use, hence, the link between land use planning and drought management should be carefully considered in the review and approval of land use by the state, approvals by the Physical Planning unit particularly the change of land use, for example, from agriculture to housing or commercial uses. Physical plan and zoning ordinances should be amended to incorporate drought management principles.

The following practices may be employed to encourage drought management in land use planning:

- Analyse land use and population growth trends to avoid new residential development in drought prone areas that are high-risk for bushfires;
- Provide Incentives to encourage holistic management practices on farms to enhance soil moisture storage capacity to sustain through periods of low rainfall;
- Encourage that new developments to provide for sufficient water supply and storage facilities; and
- Review water supply development plans to ensure consistency with the Drought Management Plan.

9. RECOMMENDATIONS AND IMPLEMENTATION ACTIONS

The purpose of this plan is to provide a coordinated and consistent program and a framework for integrating public, and private sector actions to reduce the negative impacts of drought and to minimize property losses due to drought. The plan is intended to serve as a working guide for the key stakeholders with responsibilities, capabilities and resources to develop effective response and mitigation programs. Cognisant of the limited resources available and the need to minimise the financial impact of any restructuring should, as far as possible, build on existing structures and best practice. The success of this plan is heavily dependent upon coordination and commitment from all levels of government, as well as the private sector. Throughout the document recommendations and implementation actions have been listed for enhancing Grenada's ability to mitigate and prepare for drought.

In implementing the GDS&DMP the Goal and Objectives as set out above, shall apply equally to management of the water resource including the use of non-traditional water sources, drought emergency management, and maintaining health of ecosystems. Integrated management of the water sector, including the management of droughts, must be based on sufficient and reliable information; the systematic evaluation of impacts, benefits and costs and; the application of the precautionary principle where appropriate.

Following is a summary of suggested recommendations.

A. Priority implementation actions

- Establish the position and Institutionalize the role of the NDRC monitoring and declarations. If the position is not institutionalized, there is strong possibility that in the future that this capacity would be lost;
- Ensure funding for the proposed key rainfall and streamflow monitoring sites and to reactivate appropriate discontinued monitoring sites with long baseline records. Consider a cooperative data repository to better organize and display this information;
- Encourage basic research (possibly school science projects to gather valuable anecdotal information about the impacts of drought;
- Seek cooperative opportunities with local and international agencies and organizations, UNCCD, FAO, IICA, to develop educational workshops and training on options to manage risks, including water conservation techniques;
- Support water conservation and rainwater harvesting as part of increasing freshwater security; and
- Continue to encourage networking through drought committees to build strong collaboration across agencies and communities.

B. Drought Monitoring and Forecasting Recommendations

- Support enhanced monitoring, data collection, and research for appropriate drought related indices that can be used to develop improved drought forecasting tools tailored for Grenada;
- Support a research project that connects the impact on drought sectors with standard precipitation index (SPI). Possibly the continuation of work started by Peters (2012) and the percentile method for Carriacou and Petite Martinique;
- Coordinate communication between government and the private sector on drought impact assessments; and

- NAWASA should establish Emergency Response Plans.

C. Drought Impact Assessment Recommendations

- Develop a standardized system to collect and analyse data regarding the social and economic impacts of drought.
- Encourage collaboration with University of West Indies, St. Georges University and CMIH to organize drought impact reports, such as a project evaluating specific drought stage characteristics for drought impact sectors given the Standard Precipitation Index values.

D. Drought Risk and Vulnerability Recommendations

- There is a need to provide reliable estimates of water availability under different drought scenarios
- Training for key institutions in the data analysis for the computation of SPIs
- Installation of streamflow gauges
- Installation of 'smart' water meters for water for high-volume users of water resources, including those in the agricultural, manufacturing and tourism sectors.

E. Drought Communication and Response Recommendations

- Government Ministries and Departments should follow the communication, coordination, and response actions outlined in Section 7;
- Post-drought evaluations should be documented in reports, coordinated by the NDRC and completed with the cooperation of the drought leadership structure; and
- Update the County Drought Mitigation Strategies as priority projects are completed or changed.

F. Drought Mitigation and Preparedness Recommendations

- Help stakeholders formulate and implement plans that incorporate drought mitigation processes;
- Develop drought educational exercise and learning tools that may be incorporated into school science curriculums; and
- Encourage drought management in land use planning.

G. **Future Grenada Drought Management Plan Updates and Revisions**

The Grenada Drought Management Plan should undergo timely updates and revisions at least every five years. The plan "living" document, which should be utilized and updated to reflect changing conditions, new information, and performance of the proposed leadership structure. The net effect of the HDP implementation will be the effective coordination of people and resources to reduce and minimize drought impacts to Grenada

Appendix B shows a list of potential projects that could be undertaken under the plan.

10. **REFERENCES**

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1. Appendix A: Summary of Drought Response Actions

Drought level	Actions	Responsible Agency/Person
Moderate Indicators: ▪ SPI (-1.0 to -1.49) ▪ Reservoirs storage (65% to 80% of normal) ▪ Streams flows: 80% to 89% Exceedance ▪ Some water shortages developing or imminent	• Issuing a Proclamation to be released to local media, and/or its customers that Moderate drought conditions are present and Voluntary Conservation Measures are in-place.	NDRC
	• Publish the proclamations in the local newspapers, radio and television station of general circulation in the service area of the water system that the voluntary conservation measures are in-place in the water systems.	Awareness, Education and Outreach Committee (AEOC)
	• The following Voluntary Water Conservation Measures that will be in- force until lifted by the Drought Management Committee:	Households
	• Intensify maintenance efforts to identify and correct water leaks in the distribution system.	NAWASA
	• Cease to install new connections on the public supply water system.	NAWASA
	• Continue to encourage and educate customers to comply with voluntary water conservation.	Awareness, Education and Outreach Committee (AEOC)
Severe Indicators: ▪ SPI (-1.5 to -1.99) ▪ Reservoir storage (50% to 65% of normal)	• Issue mandatory water restrictions through a proclamation by the through the relevant governmental body.	DMC
	• Provide notification to the water customers by routine publication in a newspaper, radio and tv ads and public broadcasting in the service area of the water system.	NAWASA

▪ Streams flows: 90% to 94% Exceedance ▪ Crop or pasture losses likely ▪ Water shortages common	• Continue to encourage and educate customers to comply with mandatory water conservation	Awareness, Education and Outreach Committee (AEOC
	• Cease to install new connections to the public water supply system.	NAWASA
	• Increase the storage facilities for the desalination system •	MC&PMA
Extreme Indicators: ▪ SPI (≤-2.0) ▪ Reservoirs (less than 50% of normal) ▪ Streams flows: greater than 94% Exceedance ▪ Major or widespread crop/pasture losses	• Provide written notification to the customers and routinely publish in a newspaper of general circulation in the service area of the water system the Severe Conservation measures that the customers are requested to follow during Moderate Drought conditions.	Awareness, Education and Outreach Committee (AEOC) Ministry of Agriculture NAWASA
	• Enforce Mandatory Extreme Drought Water Conservation Measures until lifted by the Drought Management Committee.	DMC
	• Eliminate all irrigation by NAWASA's customers	NAWASA
	• Provide written notification to the customers and routinely publish in a newspaper of general circulation the Severe Conservation measures that the customers are requested to follow during Moderate Drought conditions.	NAWASA
	• Cease water service to delinquent customers	NAWASA
	• Cease to install new connections on the water system	NAWASA
	• Provide truck delivery service	MC&PMA

2. Appendix B

Water Conservation Projects

For WASA

- Introduction and implementation of a water balance approach to monitor non-revenue water;
- Introducing a GIS-based infrastructure and customer management system to comprehensively reduce non- revenue water;
- Selected replacement of leaking pipes at hot spots identified with the GIS-based management information system; and
- Modifying rate structures to influence consumer water use.

For Customers

- Establish economic incentives for private investment in water conservation;
- Incentivising the use of water-efficient fixtures on residential, commercial and industrial properties.
- Encouraging voluntary water conservation;
- Requiring water users to decrease reliance on ground water and implement conservation practices
- Encouraging voluntary water conservation;
- Improving water use and conveyance efficiencies at the household and at NAWASA levels;
- Implementing leak detection programs;
- Encouraging the use of water conserving plumbing fixtures;
- Conduct water conservation education at local schools;
- Use sprinkler and drip irrigation systems; and
- Invest in drought or salinity tolerant crops;

Water Storage Projects

- Establish economic incentives for household investment in water storage;
- Implement programs to rehabilitate reservoirs to operate at design capacity;
- Where possible construct rainwater ponds in areas at risk to drought; and
- NAWASA -Inventory and review reservoir operational plans.

Source Development

- Forest Rehabilitation for degraded forest areas
- Develop potable groundwater wells where excess sustainable yields are available;
- Undertake water supply vulnerability assessments;
- Undertake stream restoration projects that may improve stream flow and thereby increase available water supply; and
- Inventory self-supplied water users for possible use of their supplies for emergency public water supplies.

Development of Alternative Sources

- Construct desalination plants to provide potable water;
- Explore the feasibility of the new wastewater treatment extended with reclamation facilities; and
- Promote greater use of rainwater harvesting.

Public Education Awareness

- Establish a public advisory committee;

- Include public participation in drought planning;
- Organize drought information meetings for the public and the media;
- Implement water conservation awareness programs;
- Publish and distribute pamphlets on water conservation techniques and
- drought management strategies;
- Organize workshops for farmers on special drought-related topics;
- Prepare a sample ordinance on water conservation;
- Establish a drought information centers at the Ministries of Agriculture and Ministry of C&PM;
- Include the media in drought planning; and
- Establish workshops for farmers in farm management specially to respond to droughts.

Land Use Planning

- Establish water zoning areas
- Consider an area's vulnerability to drought when reviewing general and community plan and zoning amendments;
- Require developers to use non-potable water for landscape irrigation;
- Require developers to practice xeriscaping in landscaped common areas;
- Establish policy and guidelines to match the quality of water supply to an appropriate demand preventing potable uses where lower quality water would suffice (e.g., require only non-potable water for irrigation uses).
- Ensure that new developments have sufficient water storage facilities; and
- Amend existing ordinances to protect water recharge areas and encourage appropriate uses

Watershed Protection and Management

- Engage and coordinate with the Division of Forestry and Wildlife and watershed partnerships across the state to develop best management practices in the forested areas; and
- Implement watershed protection and management plans (e.g., construct fencing to keep out unwanted animals, control invasive species and weeds (for rainwater harvesting ponds),

3. List of technical terms

Aesthetic Water Use	Water use for ornamental or decorative purposes such as fountains, reflecting pools and waterfalls.
Commercial and Industrial Use	Water use integral to the production of goods and/or services by any establishment having profit as its primary aim.
Conservation	Reduction in water use to prevent depletion or waste of the resource
Customer	Any person, company or organization using finished water supplied by the Water System
Domestic Water Use	Water use for personal needs or for household purposes such as drinking, bathing, heating, cooking, sanitation or for sanitary

	cleaning in a residence, business, industry or institution.
Drought Alert Phases	There are four drought alert phases: 1) Incipient Drought 2) Moderate Drought 3) Severe Drought 4) Extreme Drought
Drought Management Plan Administrator	Person responsible for initiating and administrating the Drought Management Plan
Finished Water	Water distributed for use after treatment
Water Use	The terms “water use,” “water user,” and “water customer” refer to finished water use unless otherwise defined
Institutional	Water used by government, public and private educational institutions, churches and places of worship, water utilities, and organizations within the public domain
Irrigation Water Use	Finished water used for gardens, trees, lawns, shrubs, flowers, athletic fields, rights-of-way and medians, etc., to maintain healthy growth.
Non-essential Water Use	Categories of water use other than Essential Water Use. Examples of non-essential water use include irrigation water use and used for washing other than food preparation
Water Supply Shortage	Lack of adequate, available water caused by drought to meet normal demands
Water Rationing	Operation of the Water System in such a manner to intentionally limit water system volumes or pressures to customers to conserve available water

Appendix C