Country Document for Disaster Risk Reduction: **Barbados, 2014**

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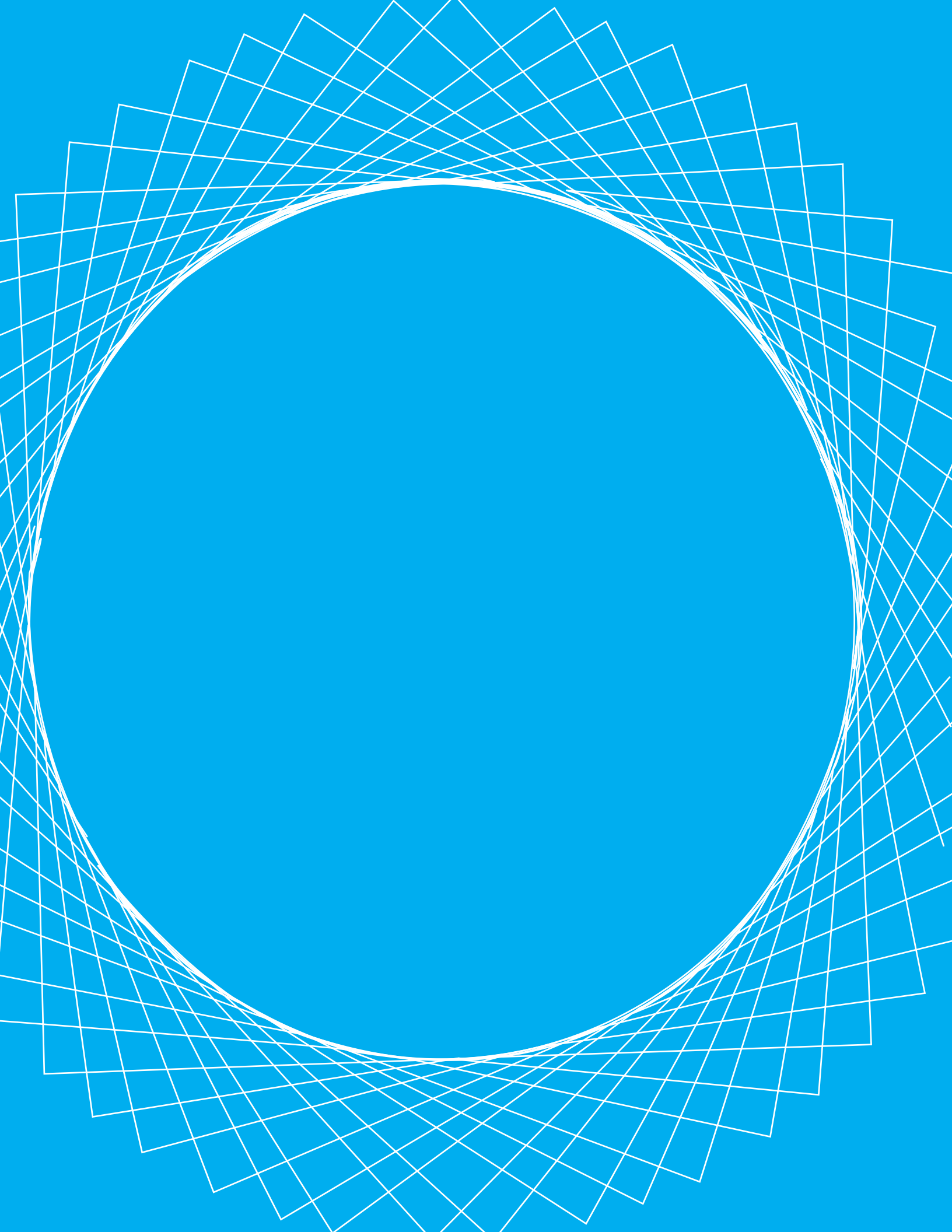

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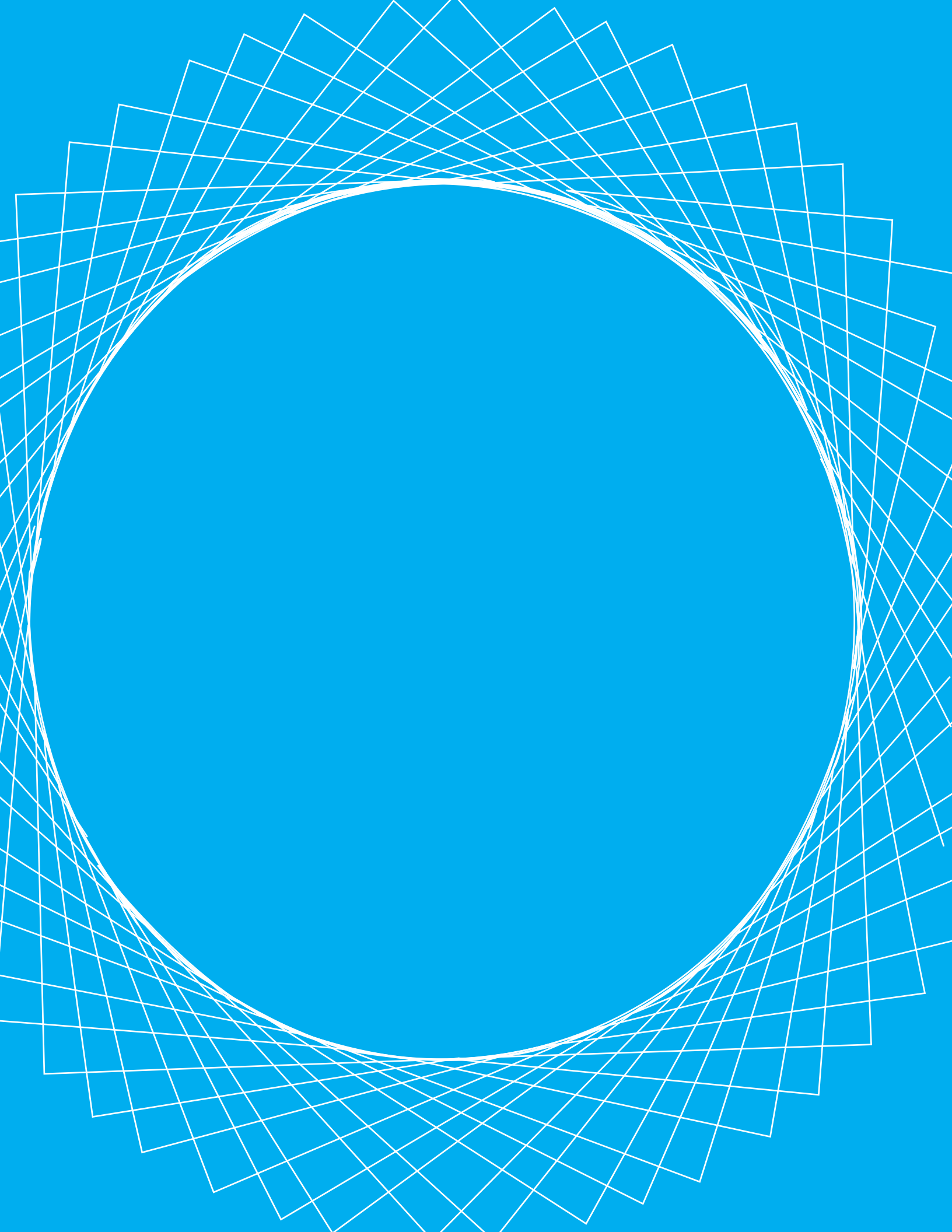

Foreword

Barbados has finally done it! This Small Island Developing State can now boast of a robust reference document which presents a comprehensive view of the status of Disaster Risk Reduction (DRR) in relation to all productive sectors including tourism, health, agriculture and education.

As a disaster management practitioner with over thirty (30) years in the field, it was with great excitement that I read the Barbados Country Document for DRR. I understand better than most the utility of having documented evidence at one's finger tips when it comes to identifying current national priorities and subsequently lobbying for the development and implementation of strategies for reducing disaster risk. Imagine my delight to see *Annex III: Historical Hazard Impacts in Barbados* which included flood, storm and tsunami events dating back to the 1700s.

Since 2003, Barbados through the development of policies, strategies and legislation founded on the principle of Comprehensive Disaster Management (CDM), is implementing programmes and projects aimed at lessening the country's vulnerability to disaster threats. These programmes and projects are however implemented across various sectors and can originate from various government departments, civil society organisations, regional disaster risk reduction institutions, international development organisations and the private sector.

The Barbados Country Document for DRR now articulates in one place the island's achievements in the management of risks and the challenges faced to reduce loss of life, social, economic and environmental impacts. Previously it was quite a tedious process, if not near impossible to obtain complete information for the purpose of systematically analysing disaster risk i.e. the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

The document is therefore poised to guide DRR stakeholders and assist in the streamlining of DRR interventions, investments and decision-making processes at the policy level which will result in ultimately catalyzing the advancement in improving resilience in Barbados toward sustainable development.

I take this opportunity to also acknowledge the foundation which was laid by the first iteration of a Country Document for Barbados in 2012 and whose development was spearheaded by the Barbados Red Cross Society. This second iteration was compiled by Barbadian national, Mrs Danielle Evanson under the supervision of the Department of Emergency Management (DEM). Mrs Evanson has worked with the United Nations Development Programme (UNDP) in the countries of the Eastern Caribbean since 2007 on issues of environmental management, disaster risk reduction and climate change. She holds a Masters in Natural Resource and Environmental Management and is currently the Programme Manager, Climate Change and Disaster Risk Resilience at the UNDP Barbados and the OECS Sub-regional Office in Barbados.

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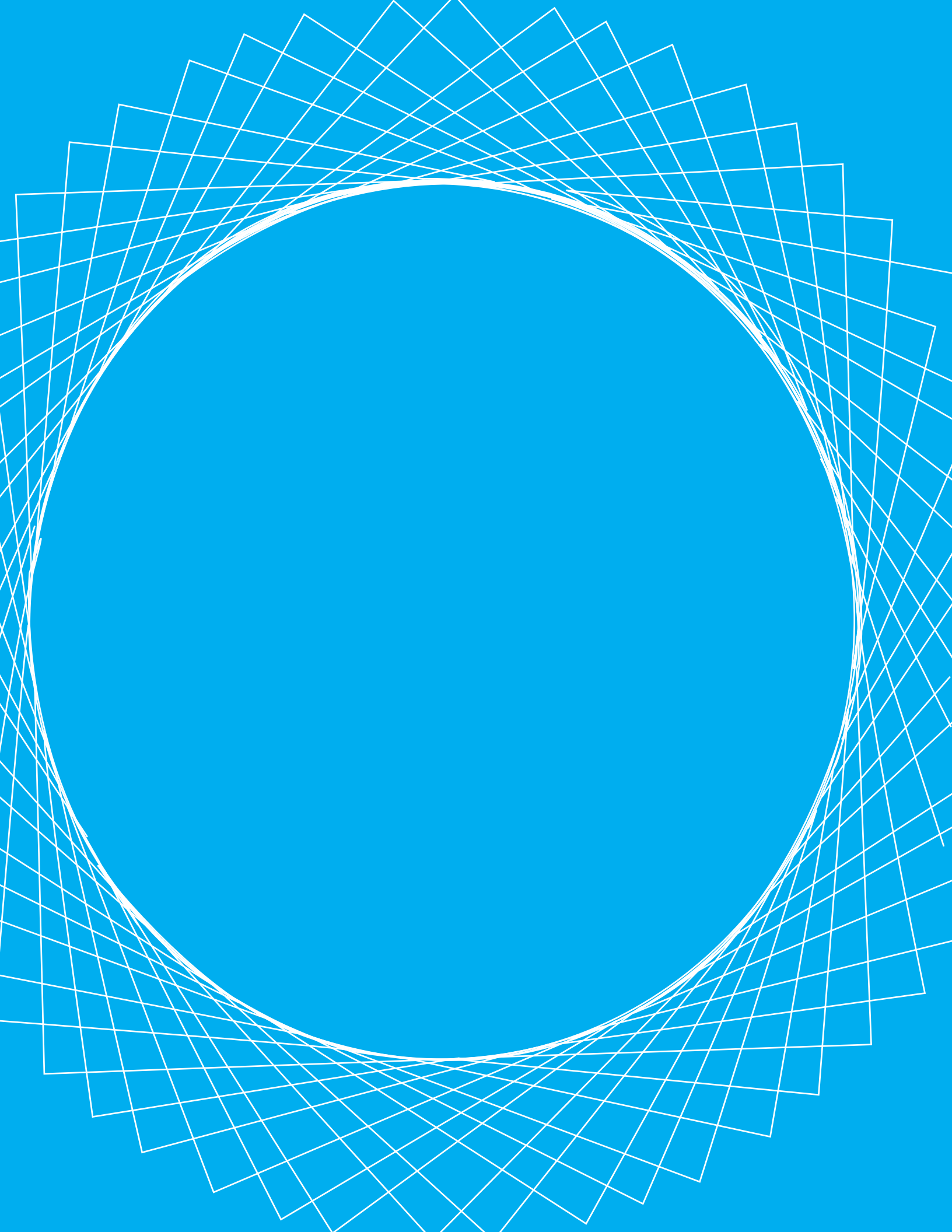


Executive Summary

Crafting a resilient society demands clear understanding of the multi-dimensional spheres of vulnerability, including poverty, natural hazard risk, energy and food insecurity, environmental degradation, poor infrastructure, and weak governance. Some of the critical capacity gaps for addressing drivers of vulnerability in developing countries include availability of robust data and the skills to interpret and apply such data to create sustainable solutions.

Disaster risk reduction (DRR) embodies the "systematic efforts to analyse and manage the causal factors of disaster, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR, 2009).

The Country Document for Disaster Risk Reduction aims to present a comprehensive view of the status of DRR in Barbados, articulating achievements in management of risk; challenges to reducing loss of life as well as social, economic and environmental impacts; and identifying priorities and strategies for reducing risk. The Country Document is a joint guide, validated by authorities, scientific bodies, cooperation agencies and communities, which identifies the major hazards, vulnerabilities and capacities at national and local levels, and guides the organisation of coordinated and complementary action for DRR in priority intervention sectors.

THE CHANGING NATURE OF RISK AND VULNERABILITY

Globally, while loss of lives in disasters is decreasing, risk exposure and economic loss are increasing, especially due to small scale highly frequent events (UNSIDR, 2011). In the face of many challenges, SIDS have made little developmental progress or even regressed, especially in terms of poverty reduction and sustainable development, since the first Earth Summit in 1992. Adverse impacts of climate change pose a significant risk and jeopardise the attainment of sustainability, even their survival and viability (UN, 2012). For the Caribbean, this is revealed in disasters characterised by high economic, social and environmental impact, exacerbated by climate change and climate variability.

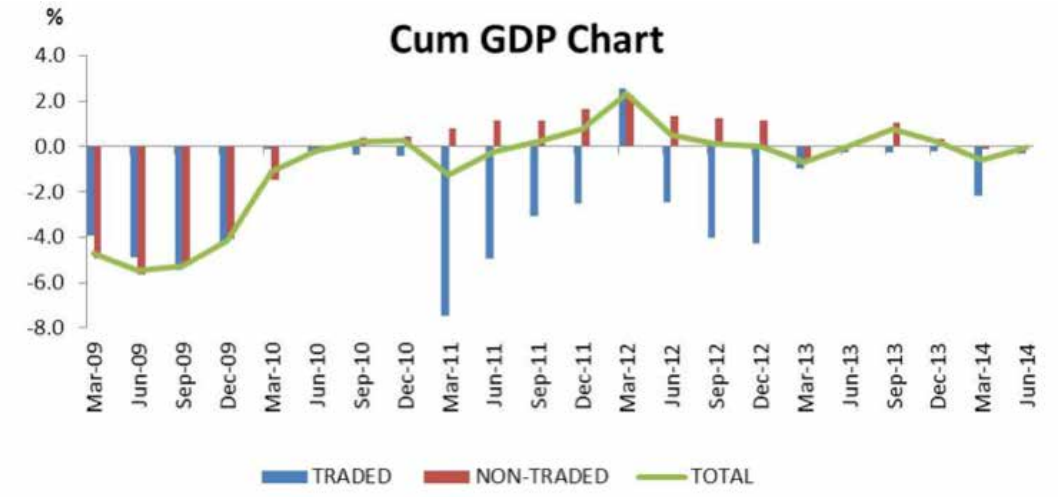
It is evident that human development processes play a major role in the configuration of risk, constructed by growth in socioeconomic exposure and gaps in development. This worsening scenario made apparent the urgent need for a strategic and systematic approach to the reduction of vulnerability to hazards and the risks they generate.

The Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA) articulates as its goal the substantial reduction of disaster losses, in lives as well as the social, economic and environmental assets of communities and countries, and is the international reference framework for DRR public policy. The recently-concluded UN Conference on Small Island Developing States (SIDS 2014) recognised that resilience must be a central tenet of future progress; that DRR is an integral component of sustainable growth of economic sectors such as tourism, agriculture and fisheries; and the interplay of risk reduction and climate change adaptation and their bearing on natural resources, food security and overall development (UN, 2014).

SOCIOECONOMIC CONTEXT

Barbados' resident population is estimated at 277,821[1], of which 47.9% are male and 52.1% female (BSS, 2012), and is among the most densely populated countries in the world with a density of 637 persons per km2 (GOB, 2010). Barbados has been able to control its rate of population growth such that birth rates have declined from 34.1 per 1000 in 1955 to 12.2 per 1000 in 2010 (BFPA, n.d.; PAHO, 2012). This, coupled with economic development, has also contributed to the attainment of an average rate of growth of 0.3% between 1980 and 2008, which has led to a situation where the country has a population growth rate comparable with that of most developed countries (GOB, 2010). However, being in such an advanced stage of demographic transition has implications for the decline of the size of the working population relative to the dependent population.

In 2012, four sectors of the economy contributed to the bulk of real GDP: finance and business services, tourism, government services and transport, storage and communications (GOB, 2012). Barbados experienced steady growth in real GDP over a 6-year period commencing in 2002. However, GDP growth stagnated in 2008 with the onset of the global economic crisis and has since contracted with decreased global output. The economy has contracted by an average of 0.6% annually since then. Growth is closely correlated with that of the UK, and this tourism source market has not recovered from the sharp decline in 2009. Additionally, there is evidence of public sector arrears accumulation, with estimates ranging between 2-7% of GDP (IMF, 2014). The real GDP growth rate[2] in Barbados contracted sharply in 2009 to -4.1% due to the world economic crisis, compared to 5.7% in 2006 and 0.3% in 2008, but recovered to 0.3% in 2010. The provisional figure for 2013 is 0.2% and estimated for the first half of 2014 at 0.0% (CBB, 2014b).



Barbados real GDP growth by quarter for March 2009 to June 2014. (Source: Central Bank of Barbados).

The debt-to-GDP ratio has climbed from under 50% in 2006 to 97.7% at the end of June 2014; including government securities held by the NIS, it increased from about 80% in 2009 to 128% in 2013. Provisional figures for the 2013/2014 year indicate that interest payments absorbed 28.8% of revenues, and the fiscal deficit stood at -12.4% of GDP, compared to 8.8% for 2012/2013 (CBB, 2014b; IMF, 2014).

1 Includes the institutional population (2,513) and estimated undercount (49,115).

2 Defined as the monetary value of all the finished goods and services produced within a country's borders in a specific time period, though GDP is usually calculated on an annual basis. It includes all of private and public consumption, government outlays, investments and exports less imports that occur within a defined territory.

The economy is not expected to grow significantly in 2014, but a gradual, sustainable recovery, driven by the foreign exchange sectors, is expected to begin in 2015 and 2016. Forecast growth rates are less than 0.3% for 2014, 1.2% for 2015 and 2.5% in 2016. A major growth factor is expected to be investment in tourism and infrastructure and other financial inflows totalling $4.5 billion over the next 3 years (CBB, 2014a, 2014b).

Surveys calculate the indigence line[3], poverty line[4] and vulnerability line[5] at US$1,985, US$3,930 and US$4,913 per capita annual income respectively. The poverty rate for female-headed households is 19.4%, as compared to 11.5% for male-headed. In terms of geographical distribution, the Greater Bridgetown, Outer Urban and North and East strata have an above average population that is poor. For youth (15-24 years of age), the poverty rate is 23% as compared to 15% for those over 24 years of age (CDB and GOB, 2012).

Most Vulnerable Groups

The disabled community constitutes 5.1% of the population. There are a number of non-governmental organisations (NGOs) which advocate for and cater to the needs of persons with disabilities (PWD), as well as a number of government agencies, including the National Disabilities Unit and the Barbados Council for the Disabled and its 19 affiliate organisations. The White Paper on Persons with Disabilities[6] among its principles speaks to issues of education, accessibility and transportation, health care and rehabilitation, equal opportunities and non-discrimination, inter alia, however there is no mention of concerns relating to disaster or emergency situations.

The 2010 Country Assessment of Living Conditions (CALC) (CDB and GOB, 2012) revealed that in relation to the labour market, poor households experience higher levels of unemployment and employment in low-paying or part-time jobs (underemployment). Moreover, poor households demonstrated high dependency ratios where earners were outnumbered by non-earners in the household. These high levels of dependency lead to lower per capita income and expenditure, but also increase the burden of care which further curtails participation in the labour market and in education. This is especially the case for female-headed households, which have a greater number of children to care for as opposed to adult non-earners.

Surveys discovered that among the contributors to poor living conditions and to poverty were 'coming from a poor family', high fertility rates, large numbers of children and lack of support from children's fathers, unemployment and low wages, lack of education, and disability. Several respondents also indicated that the recent recession and the high cost of living, especially the cost of food and of high utility bills, were having a serious negative effect on their living conditions, on their ability to meet their basic needs, and to sustain their livelihoods. Compounding this, living in poor conditions and living in poverty have devastating effects on health, on relationships, on treatment by others in relation to social and familial exclusion, and on self-esteem. Many stressed the serious psychological and emotional damage experienced, including stress, anxiety, frustration, helplessness, depression, and powerlessness.

Disasters and environmental degradation impact children's rights to adequate health, standard of living, education, and protection from violence, abuse and exploitation. Children generally also have less developed coping capacities to manage the stress of traumatic situations they may face in a disaster situation. They would also have lesser abilities to escape a dangerous situation, or even to discern a perilous situation or behaviours.

3 Equivalent to the annual minimum cost food basket (MCFB) which is the minimum monetary requirement to meet basic nutritional needs for different demographic groups

4 MCFB plus the minimum monetary requirement to meet non-food costs for the basic needs of an individual

5 An arbitrary amount used to indicate the level of vulnerability to poverty; usually expressed as 125% of the poverty line

6 http://www.barbadosdisabled.org.bb/docs/white_paper_pwd.pdf

With improvements in health care, Barbados has an ageing population. The high ratio of productive population to dependent population (currently 48.5%) is highlighted as a weakness in the National Strategic Plan (GOB, 2005; BSS, 2012). Some key government entities clearly demonstrate a marked passivity of response to older persons' issues and it is evident that the full understanding of the implications of population ageing has not been fully absorbed. Gender and health care issues are not subject to the quality social analysis that would induce definitive changes in approach to policy and creativity in programming that responds effectively to male and female differential needs (Springer, 2012). However, neither the 2011 draft White Paper on Ageing nor the National Report on Ageing analysed the needs of the elderly with respect to emergencies or disasters, with exception of the Fire Safety Programme's smoke alarm installation initiative.

Development Context

With a fragile resource base and an open economy characterised by a narrow range of exports and a heavy dependence on imported goods, Barbados like many SIDS is extremely vulnerable to external shocks. Volatile global prices, removal of preferential trade regimes and dependence on a tourism industry where competiveness is weakening impede the country's capacity to respond and adjust to those shocks.

The Caribbean has the second highest rate of infection of HIV/AIDS after Sub-Saharan Africa. Treatment of HIV/AIDS impacts the cost of health care, provision of social services and the strength of the labour force.

Crime and violence, linked to disparities of income and security, are also of concern and threaten socioeconomic stability. With the Caribbean being a major transhipment route for illicit drugs, there is an associated myriad of related crimes from petty theft to organised crime. Increased crime erodes investor confidence and slows economic growth.

Consistently ranked for many years as the highest in Latin America and the Caribbean according to the Human Development Index (HDI), Barbados is now second only to the Bahamas, with its HDI 0.776 (rank 59 of 187) in the 2014 report, down from 0.825 (rank 38) in the 2013 edition, classified as having high human development.

In terms of inequality in consumption, as measured by the Gini coefficient, Barbados demonstrates the second highest level of inequality in the Caribbean after Antigua and Barbuda. The Gini coefficient for Barbados stood at 0.47 while average Gini coefficient in the Caribbean is 0.38 (CDB, 2011), where a value of 0 represents perfect equality and 1 perfect inequality.

Barbados has achieved or surpassed many of the Millennium Development Goals (MDGs)[7] with universal access to education and health services, free access to HIV/AIDS antiretroviral treatment, and almost 100% access to clean drinking water and improved sanitation (Inniss, 2007). Deaths due to HIV/AIDS continue to decline and maternal health and infant survival are improving (PAHO, 2007; PAHO, 2012).

LEGAL, NORMATIVE AND INSTITUTIONAL FRAMEWORK

There are a range of legal instruments that contribute to the management of disaster risk in Barbados. While the Emergency Management Act Cap 160A is quite comprehensive, integrating responsibilities for coordination and response, the laws governing the operation of other agencies that engage in disaster risk reduction activities

7 The United Nations Millennium Declaration, signed in September 2000, commits world leaders to combat poverty, hunger, sickness, illiteracy, environmental degradation and discrimination against women. The Millennium Development Goals, which stem from the Declaration, define objectives and specific indicators.

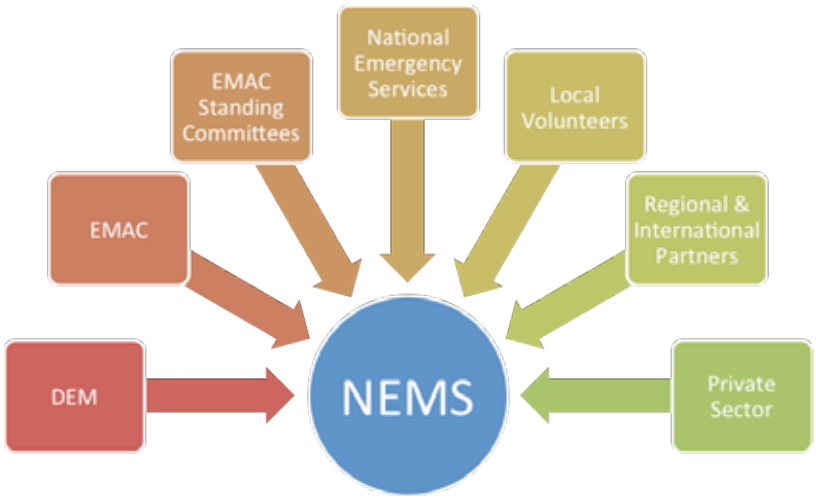
do not speak directly to DRM or the relationship of the field to risk reduction. However, their articles designate authority to address matters of environmental protection, sanitation and land use control, for instance, which are key tools in applying preventive and corrective actions for the reduction of vulnerability and risk. These instruments include:

- Emergency Management Act, Cap. 160A
- Emergency Powers Act, Cap. 161
- Prevention of Floods Act, Cap. 235
- Town and Country Planning Act, Cap 240
- Health Services Act, Cap 44
- Soil Conservation (Scotland District) Act, Cap 396
- Shipping (Oil Pollution) Act, Cap 296A
- Coastal Zone Management Act, Cap 394

The structure of the national disaster management mechanism has facilitated the stimulation of interdisciplinary and inter-sector partnerships and supported the mainstreaming of risk management into the national planning process. The regulatory system presents tools for decision making principally with the aim of avoiding or rectifying vulnerability and risk through e.g. land use zoning, construction guidelines, natural resource management and climate change adaptation. Some of the key provisions include:

- Physical Development Plan and EIA Guidelines
- Water Zoning Regulations
- National Building Code
- Integrated Coastal Zone Management Plan

The National Emergency Management System (NEMS) is a broad-based multi-sector stakeholder mechanism coordinated by the Department of Emergency Management. It is made up of the Emergency Management Advisory Council (EMAC) and its 15 Standing Committees, national emergency services, local volunteers, non-governmental (NGOs) and community-based organisations (CBOs), regional and international partners and the private sector.



Construct of Barbados' National Emergency Management System (NEMS)

According to the Emergency Management Act Part III s7(3), the functions of the EMAC include recommendation of policies, programmes and activities to enhance the emergency management programme and reviewing the work of the Standing Committees with respect to their specialised areas. The Standing Committees are organised by emergency response functions e.g. shelter, emergency telecommunications, public utilities, etc. They are chaired by selected members of the EMAC, who are technical heads of government agencies with responsibility for the execution of national disaster management policy and programmes in their respective areas of expertise (DEM, n.d.).

In 2003, the Barbados government embraced the Comprehensive Disaster Management (CDM) Strategy. This strategy represented a deliberate attempt by the CDEMA Participating States to holistically incorporate all phases of the disaster management cycle (prevention, mitigation, preparedness and response, recovery and rehabilitation) while focusing on promoting and accelerating disaster risk reduction initiatives.

Barbados is also the CDEMA Central Sub-regional Focal Point (SRFP) for the Eastern Caribbean with response responsibility for the countries of St. Vincent and the Grenadines, Saint Lucia and the Commonwealth of Dominica. A regional model SRFP Protocol has been developed by CDEMA and Barbados is in the process of adapting it (DEM, 2010).

Commendably, the NEMS encompasses a broad array of stakeholders which have important voices in the execution of disaster mitigation, preparedness and response. The needs of vulnerable groups appear to be adequately represented through the membership of the Vulnerable Persons Committee, although a comprehensive database of the constituents served by this group is needed. The National Disabilities Unit started such for PWDs since its establishment but it has since never been updated due to lack of technical personnel. Missing is a role for the youth and women. Overall, the special needs of these groups in relation to vulnerability and disasters e.g. in awareness and preparedness, emergency shelter situations, post-disaster recovery and access to education and employment, seem to be overlooked within the policy and planning framework.

Further, the NEMS does not include key sectors besides tourism. While inclusion of every sector within the Standing Committee structure will make it more cumbersome than at present, a mechanism needs to be found to replicate the excellent level of engagement and integration that the tourism sector has found. While the legal requirement for every Ministry, department, etc to complete annual disaster plans exists, the effectiveness of such is limited.

Likewise, the normative framework captures the work of many agencies in various sectors which contribute to risk reduction. Nevertheless, the most glaring problem facing the legal and regulatory framework of Barbados is the number of instruments that remain not promulgated. This makes any adherence to regulations voluntary and obviates any power of the regulatory authorities to enforce or prosecute. Thus this in itself represents a substantial contribution to the perpetuation and creation of vulnerability.

The Emergency Management Act is sound with respect to its coverage of disaster response, duties and powers of the DEM Director and disaster management personnel, and provisions relating to vulnerable areas and public participation. However, the Act does not yet have Regulations, which would among others clarify and govern the roles and responsibilities of the actors in the DRR system. A review of the legislation was conducted and recommendations for updating the Act were submitted to the EMAC in March 2014, which are under review.

The budget allocated to the DEM from central government is dedicated to its administration and operations. Other departments within the NEMS also receive central government resources to execute these functions;

however there is no easily discernible data on the specific allocations to DRR or investments that clearly play a role in reducing risk. Inability to quantify this contribution prevents the economic measurement of the value of investment in DRM, which can be important in attracting private investment or attracting donor funds.

HAZARD THREATS

Barbados is exposed to a wide range of natural and anthropogenic hazards[8], with a high level of risk[9] exposure. As a SIDS, with small size, a densely populated low-lying coastal zone and an undiversified tourism-based economy, these hazards typically put a large proportion of produced capital at risk and often affect the entire territory and economy. Barbados has the potential to be impacted by meteorological, geological and biological hazards. The main natural hazards affecting the country and their frequencies are shown below.

Summary of hazard events in Barbados during 1650-2000 by type (Source: Boruff, 2006)

Hazard Type	Time Period	Events	Return Period
Flooding	1886-2000	34	3.35
Drought	1946-2009	22	2.86
Tropical systems	1786-2010	20	11.20
Earthquake (and felt shocks)	1670-2014	10	34.40
Landslide	1901-2000	8	12.38
Tsunami	1751-2000	7	35.57

The most recent significant impact from a meteorological event at a national scale occurred in 2010 when Tropical Storm Tomás passed just to the south of Barbados. According to data from the OFDA/CRED International Disaster Database, the greatest historical disasters that have affected Barbados in the last decades have been principally storms and floods.

The last major hurricane to have struck Barbados directly was Hurricane Janet in 1955. It originated 600km to the east of Barbados, passing 24-32km south of the island as a Category 3 hurricane, affecting Grenada and then moving along the Caribbean Sea where it reached its maximum Category, 5. Janet caused 38 deaths, damaged or destroyed over 8,000 homes and left 29,000 persons homeless, but the cost of damages was not quantified (Lashley, 2010).

The flood of October 1970 was described as twice as great as that of 1949, and seven times the 1964 event, dumping 584mm of rain in 10 hours, compared to the annual average of 1524-1651mm. The reduced loss of life relative to 1949 was attributed to its occurrence during the day and the absence of high winds (USAID, 1972). The October 2010 floods saw one of the typically flood-prone areas, Chapman Lane in St Michael, affected as in 1970, again attributed to blocked drains (The Barbados Advocate, 2010).

There are less data available on the damage and losses caused by less severe, more frequent extensive hazard events such as flash floods, landslides and drought, the accumulation of which are believed to be more

8 A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009)

9 Disaster risk refers to the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period (UNISDR, 2009)

Historic hazard impacts in Barbados
(Sources: EM-DAT http://www.emdat.be/; USAID, 1972; Lashley, 2010)

Date	Hazard	Lives lost	Persons affected	Economic losses US$'000	Main sectors affected
Aug 1949	Flood	41			
Sept 1955	Hurricane Janet (Cat 3)	38	29,000 8,000 homes		Housing
Oct 1970	Floods	3	200	500	Infrastructure (roads, bridges), fishing, agriculture (soil erosion), electricity, communication
Jul 1980	Hurricane Allen (Cat 3)		5,007	6,000	Fishing, poultry, housing
Nov 1984	Floods		100	2,000	Infrastructure
Sept 1987	Tropical Storm (Emily)		230	100,000	
Aug 1995	Floods	1		5,000	
Sept 2002	Storm		2,000	200	
Sept 2004	Tropical Storm (Ivan)	1	880 531 homes	5,000	Coastal erosion, housing
Nov 2007	Earthquake 7.4	0	1		
Oct 2010	Tropical Storm (Tomás)		2,500	37,000	Housing, electricity, water

significant than the intensive events. While extensive events are globally responsible for only 13% of mortality, they result in 42% of economic losses. Environmental degradation, poverty and unplanned urban development exacerbate these risks. Low levels of investment in DRR and high average annual losses (AAL)[10] would in the long term render a country less capable of absorbing losses from these extensive events (UNISDR, 2013).

Earthquakes and tsunamis are not as recurrent as hurricanes but could inflict significant damage to the island. On 29 November 2007, a 7.4 magnitude earthquake at a depth of 156km off the coast of Martinique was felt in Barbados. On 18 February, 2014 a 6.5 magnitude earthquake was recorded 172km NNE of Barbados at a depth of 14.8km, felt from Martinique to Grenada, and reported as the largest in the Barbados zone since 1980 (USGS; Caribbean360, 2014). The most recent observations recorded for a tsunami impact are from 25 December 1969 with a recorded wave height of 0.46m. The teletsunami[11] of 1755 produced wave heights in Carlisle Bay of 1.5m (NGDC, 2014).

Natural hazards

Tropical cyclones and their secondary effects (strong winds, heavy rain, storm surges and floods) are among the more well-documented hazards for Barbados and surrounding neighbours, and threaten all exposed

10 The estimated average loss per year over a long time period, considering the range of loss scenarios relating to different return periods (UNISDR, 2013).
11 Originates more than 1000km or 3 hours travel time away.

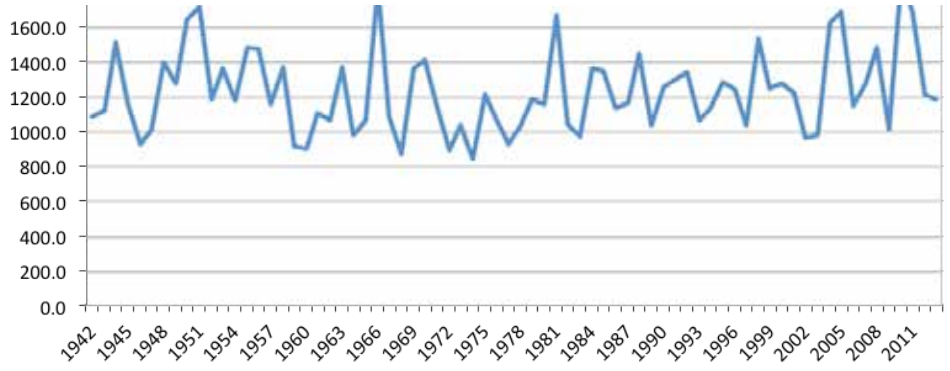
structures, including residential, public and commercial buildings, telecommunications, agriculture, tourism facilities, roads, bridges and utilities (gas, water, electricity). Barbados would be expected to lose more than 80% loss of gross fixed capital formation (GFCF)[12] from cyclonic wind damage from a 1:250 year event; average annual losses (AAL) are estimated at 1-10% of GFCF (UNISDR, 2013).

Flooding in Barbados is caused both by the direct effect of a tropical storm or hurricane, or by the rainfall of the rainy season. Flash floods are not uncommon and result from poor drainage, blocked gullies and/or inadequate storm water infrastructure in many areas of the country. Low pressure systems that bring extended periods of rain or intense rainfall often cause flooding. Some of the areas generally prone to flooding include Speightstown and Gibbes in St Peter; Weston and Holetown in St James; the plains of the Constitution River, Chapman Lane, Bayville and Aquatic Gap in St Michael; and Graeme Hall and Wotton in Christ Church.

Among the factors increasing exposure to floods are: urbanisation, with paved impermeable surfaces reducing infiltration of precipitation into the soil; the inadequate maintenance of the drainage systems; poorly engineered drainage systems with insufficient capacity to carry the amount of water expected; blockage of gullies and drains with garbage.

Drought conditions in Barbados have a frequency of about 3 in 10 years, and are generally correlated with El Niño events. With an arithmetic annual average of 1282.8mm, the data reveal that 5 of the last 30 years have been below 1050mm and similarly above 1500mm. Significantly, these very wet years tend to immediately follow very dry years, having implications for resource and watershed management planning, agriculture, groundwater recharge and flooding. 2010 is currently the wettest year on record at 1885.8mm, which was preceded by 1015.1mm in the drought year of 2009.

The record from 1942-2013 clearly shows the oscillation in rainfall patterns. 1972 was the driest year with 842.8mm. 2002, 2003 and 2009 are among the 15 driest years in the record; 2004, 2005, 2008, 2010 and 2011 are among the 15 wettest. This high fluctuation between extremes within a single decade may possibly be influences of climate change. Given Barbados' classification as a water scarce country[13] and the heavy dependence on groundwater, drought conditions have severe implications for water resource users, particularly in the domestic sector, which uses 60% of all water (GOB, 2001) and the tourism industry as the main economic industry and being very water intensive.



Annual rainfall for Barbados 1942-2013 recorded at Grantley Adams International Airport (Source data: Barbados Meteorological Service)

12 The total value of capital investment by the private and public sectors in a given year (UNISDR, 2013).
13 UN Commission on Water

Small scale landslides are associated with coastal escarpments where undercutting by wave action creates instability. However, the majority of landslide activity is restricted to the Scotland District, where slumps, earth flows, and debris flows are the main landslide types present. Failures occur when the clay soils decrease in strength due to increased pore-water pressure (IDB, 2010a). This may be in direct response to intense rainfall or perched water tables associated with the bedding within the bedrock or older clay-sealed slip surfaces. Ground cracking, scarps, and gully development are some of the consequences of landslides which render land unusable for farming. Roads are often undermined by failing slopes and blocked by displaced slide material. The structural stability of housing is also impacted.

Earthquakes are frequent and therefore the unpreparedness of the population is high, as demonstrated during the 2007 event. The building stock is generally constructed to withstand hurricanes as opposed to seismic activity. Although the Building Code has been recently updated, it does not recommend specifications or materials for reducing vulnerability to seismic hazards. While risk analysis has been undertaken at regional level, it is still useful for informing construction and national regulations. Additionally, there are localised areas of reclaimed land that could present increased vulnerability due to possible movement of sediments and even liquefaction in the event of a major impact.

Barbados is ranked among the top 10 countries in the world in terms of probable maximum loss (PML)[14] of UPC from earthquakes, at approximately 17% for a 1:250 year earthquake, and would be expected to lose more than 80% of GFCF. AAL are estimated at 1-10% of GFCF (UNISDR, 2013).

Anthropogenic hazards

Climate change is a serious and substantial threat to the economies of Caribbean nations, the livelihoods of communities and the environments and infrastructure across the region. In this landscape of multi-hazard risk, changing climate represents an additional stressor and this shifting risk profile will affect the outcome of a wide range of decisions affecting individual, societal and economic well-being. Barbados is already experiencing some of the effects of climate variability and change through damage from severe weather systems and other extreme events, as well as more subtle changes in temperatures and rainfall patterns. Modelling projections for Barbados reported by Simpson et al (2012) predict an increase in average atmospheric temperature; reduced average annual rainfall; increased sea surface temperatures; and the potential for an increase in the intensity of tropical storms.

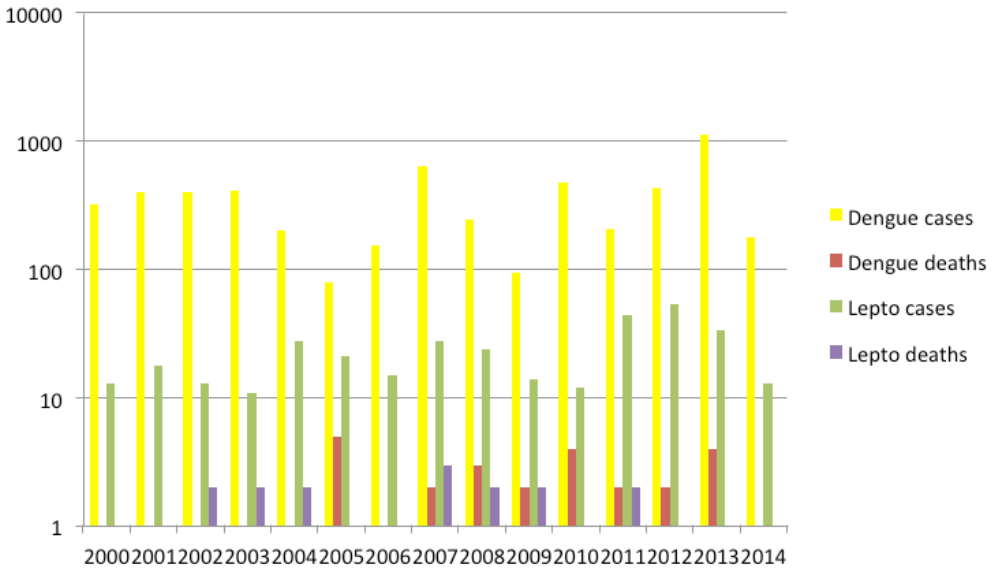
Erosion in the Scotland District during the period 1985-1990 was recorded at its lowest of 2.43t/ha/year (sands) to as much as 760.07t/ha/year (clays). While the geology and climate contribute to land degradation, large scale clearance of vegetation, unsustainable farming practices, extraction of mineral resources and settlements exacerbate the problem (GOB, 2002). The main factor in accelerating land degradation in Barbados is the change in land use. Removal of productive land from agriculture (for residential and commercial use, hotels, and golf courses) has increased the coverage of impervious surfaces, triggering greater surface runoff and flash flooding (Simpson et al, 2012).

Wildfires are typically prevalent during the dry season. They create a number of risks, specifically to human health in terms of respiratory disease e.g. asthma, bronchitis, respiratory irritation and respiratory tract infections; destruction of property and crops; and severe burden on water resources. Extended dry conditions increase the propensity for the occurrence of wildfires, however many are also triggered by open burning of trash in residential areas and by malicious intent.

14 The maximum loss that could be expected for a given return period (UNISDR, 2013).

Emergencies affecting health and livelihoods

Disaster situations present a number of variables which can severely disrupt access to social services, transportation and livelihoods, thereby slowing the recovery and reconstruction process. Simpson et al (2012) note that the occurrence of medium or large magnitude disasters, such as hurricanes or floods, has an effect in the emergence of plagues, diseases and sickness of considerable importance. Flood waters contaminated with faecal matter and urine from infected rats is often associated with and is one of the main causes of post-disaster leptospirosis outbreaks. Large masses of stagnant water can also lead to the spread of water and vector-borne ailments such as cholera and dengue fever; the latter is already endemic in Barbados.



Incidence of dengue fever and leptospirosis in Barbados for 2000 up to September 2014 (Source: Ministry of Health)

Forty-nine cases of the chikungunya virus, transmitted by the Aedes aegypti mosquito (as is dengue fever) and the Aedes albopictus mosquito, have been confirmed in Barbados, with another 200 suspected. The Ministry of Health's testing protocol now focuses primarily on high risk groups – children under 15 years, adults over 60 and pregnant women (Springer, 2014).

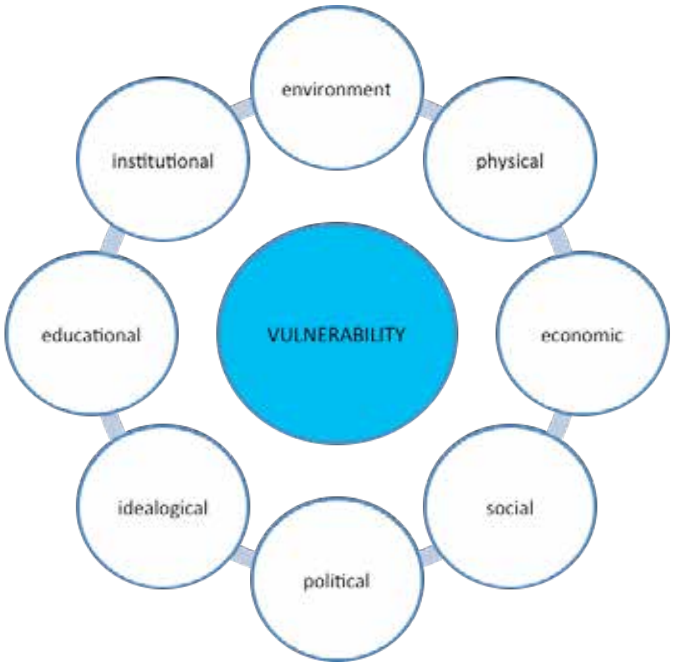
VULNERABILITY

Vulnerability refers to the "characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (UNISDR, 2009). Vulnerability cuts across social, environmental and economic boundaries, and is inextricably related to social processes in disaster prone areas. It typically speaks to the fragility, susceptibility or lack of resilience of a population faced with different hazards (IDB, 2010a). SIDS economies face exceptional disadvantages due to their size, insularity and remoteness, making them susceptible to economic shocks, including natural hazards, to which they are among the most vulnerable globally (Benson and Clay, 2004).

Rapidly expanding development, historical deforestation, and land and coastal degradation are increasing exposure to floods, storm surge and landslides.

Effective, long-term management and protection of forests, watersheds and nearshore marine ecosystems are important for the maintenance of ecosystem services (such as maintaining soil structure, moisture and fertility, buffering wave action, beach accretion and protecting coastal infrastructure) and for the competitiveness of the tourism and agriculture sectors. In Barbados, the Inter-American Development Bank has lent more than US$60 million over the last 20 years for construction of infrastructure to rehabilitate beaches on the tourist-laden west and south coasts. Yet fishing and tourist boats off these same beaches continue to drag their anchors through the coral reefs that provide natural protection (USAID, 2013).

Climate change is likely to increase the frequency and severity of natural hazards and disasters in Barbados, with the potential to affect shoreline stability, the health of coastal and marine ecosystems, the tourism industry and private property. According to data from the Coastal Zone Management Unit (CZMU), the 100-year flood model projects that 6,000 residences along the south and west coasts and 70% of west coast hotels would be affected by the event (GOB, 2010).



Components of vulnerability as proposed by Wilches-Chaux (1993)

Increasing population pressures are also impinging on the adequacy of the current zoning and treatment regimes. Expanding impervious surfaces with greater urbanisation and more housing are reducing the capacity for groundwater recharge. Low precipitation levels coupled with overabstraction foster saltwater intrusion. At present there are no legally enforceable national water quality standards in operation, therefore those of the World Health Organisation (WHO) and US Environmental Protection Agency (EPA) are used.

The quality of housing construction (e.g. building materials, foundation, secure roofing); compromised drainage infrastructure; and occupation of hazard-prone areas are increasing vulnerability to floods, storm surge and high winds.

The housing stock within the country has progressively moved from being dominated by chattel and wooden structures to an increasing proportion of concrete constructions, with recent surveys revealing wood/timber

structures as 23% of the housing stock and concrete at almost 50% (CDB and GOB, 2012; BSS, 2012). However, there is still a predominance of wooden homes within low income communities, which tend to be densely built. These areas tend to be prone to extensive damage from high winds and fire. Over the last few decades there has been concerted effort to incentivise the use of materials such as hurricane straps in new home construction and retrofitting homes and built structures.

Flooding is often a result of inadequate drainage infrastructure, with poorly designed suck wells, infilling of gullies and waterways, and insufficient maintenance. Events in 2008 were attributable to such causes (ECLAC, 2010) and projected stormwater runoff is expected to even further exceed the design capacity of the existing drainage infrastructure (GOB, 2014). Indiscriminate dumping of waste causing blockage of drains and gullies also play a role in triggering flash floods.

High external debt, heavy dependence on imports, rising unemployment and inequality are eroding the ability of the country and communities to cope with hazard impacts, which can gradually make even small events devastating.

With high reliance on the tourism sector (accounting directly and indirectly for 39% of GDP and 50% of total export earnings in 2008 (GOB, 2010)), natural hazards typically hold threat of high costs to replace infrastructure and facilities, both from the public and private purse. Accompanying disruption of travel and communication services present added economic losses as business is disrupted for extended periods (Philips, 2011). In Barbados, figures indicate that in 2007 over 90% of the hotel room stock of the country was located in coastal areas (ECLAC, 2010a), creating high exposure to coastal and hydrometeorological-related hazards, as well as climate change (e.g. storm surge, coastal floods, tsunamis, sea level rise). Beach tourism investment therefore presents a high level of disaster risk, costs of which are shared by the economy and society as a whole, for instance through coastal erosion, pollution, and unemployment during post-disaster reconstruction.

The amount of community cohesion varies greatly from place to place. Generally it may be said that communities tend to be more closely knit in rural areas and low-income areas, and also neighbourhoods where there is an active community centre and/or recreational facilities. Observations suggest that in these areas residents are more likely to use public transportation and engage outside of their homes; hence there are more opportunities to bond and form relationships, forming support networks which are useful in an emergency. Some communities, generally suburban, have neighbourhood watch systems, which build rapport between households, and with the police and other emergency services.

At the time of the CALC survey (2010) employment among men and women was 62.9% and 54.7% respectively. Further, the types of skills possessed by the two groups indicate a likelihood of males being more readily employed in the immediate post-disaster situation i.e. 72.3% of men are trained in agriculture or a skilled trade as compared to 8.6% of women (CDB and GOB, 2012). Conversely, loss of ability to provide for their household may be more demotivating for men than women and may lead to increase in inappropriate coping mechanisms such as drinking, as has been observed in other islands (USAID, 2013). Because there has not been a major impact in Barbados for several decades, there may not have been opportunity for such situations to be revealed. Fortunately this provides opportunity for systems to be put in place to mitigate their occurrence.

Literature suggests that as a consequence of climate change vulnerable groups will be subjected to multiple, simultaneous problems, including widespread loss of employment and production due to abandonment of low-lying areas, food insecurity, health risks and large-scale eco-migration. Resource-dependent, low-income communities are constrained in their capacity to adapt and climate change will increasingly be a key contributor to morbidity, mortality, and continued poverty (USAID, 2013).

The centralised governance system has begun a process of decentralisation with a system of Constituency Councils as a mechanism to address issues of social isolation, political apathy, economic deprivation, and alleviating delays in procedures. Among their core functions are identifying priority needs of the constituency, supporting and building the capacity of local organisations, and executing priority programmes and projects (Department of Constituency Empowerment, n.d.). The role of the Constituency Councils in DRM is not clearly defined, potentially leading to conflicts with the DEOs.

DRM is not a specific subject within the primary or secondary curricula, however elements are integrated in subjects such as geography and environmental science. Public service announcements and information segments are included in all media (television, newsprint, radio, websites, some social media), with the greatest concentration immediately prior to and during the hurricane season.

Insufficient inter-agency coordination is a typical complaint in the arenas of environmental management and disaster risk reduction. Because of the truly multi-disciplinary nature of these fields, the input of a plethora of actors is required, which is often difficult due to insufficient human resource capacities, high staff turnover, or conflicts between personalities impinging on decision-making processes. A comprehensive planning approach is not being implemented by the environmental sector.

Inaccessibility of data from institutions adversely impacts on ability to achieve holistic informed decision-making. Fragmentation of data, location in multiple agencies, and lack of integration and centralisation of data present issues for comprehensive analysis to inform planning. Moreover, the absence of a culture of data collection and management means that often databases may be initiated without sufficient impetus (personnel, equipment and/or technical skill) to maintain and update them.

CAPACITIES

Capacity refers to the "combination of all the strengths, attributes and resources available within a community, society or organisation that can be used to achieve agreed goals" (UNISDR, 2009). Within this context, the goal can be described simply as the reduction in risk or exposure of the population, economy, natural and built environment. Skills are built, strengthened and maintained via multiple mechanisms and at multiple levels – individual, institutional, societal, sectoral – with the objective of realising articulated development goals.

For DRR to be successful, capacities must be developed throughout the entire population, not any select group, agencies or profession. Further, technical capacity development must be coupled with determined functions in the DRR field (UNDP, 2010).

Vulnerability assessments, hazard maps and risk assessments for critical infrastructure are not generally applied to be able to holistically inform development planning. The exception to this is in the Scotland District, for which such exist. Hazard and vulnerability assessments (HVA) and hazard mapping are informing emergency planning and this capacity is being strengthened by the use of current information and communications technology.

Over the years a number of agencies have invested data and information into geographical information system (GIS) platforms to support decision making, including DEM, TCDPO, CZMU and the Lands and Surveys Department, which have been used to some extent to inform decision making. However, the funding to initiate such is often external, with insufficient capacities to maintain the databases over time. Further, with the lack of integration of these data in a centralised national system, they are unable to be comprehensively utilised e.g. in early warning systems (DEM, 2010). Perennially acknowledged as a significant constraint throughout the region, attitudes and protocols regarding collection, storage, management, sharing and ownership of data and

information will need to change. Building resilience and using risk management to aid decision-making where there is uncertainty requires access to the best available data and information. CCCCC (2012) advocates an 'open-source' and 'open-access' attitude to facilitate sharing and optimising use of the best available information by decision-makers.

Priority is being given at present to the actualisation of the CRMP to build resilience to coastal hazards (including those associated with climate change) through enhanced conservation and effective management. The overall objective is to build capacity in integrated coastal risk management in Barbados incorporating disaster risk reduction and climate change adaptation in development planning, control and monitoring of the coastal zone. Components relate to coastal risk assessment, monitoring and management; coastal infrastructure; and institutional sustainability for Integrated Coastal Risk Management. Outputs include hazard, vulnerability and risk assessments and mapping using a multi-hazard approach (IDB, 2010b).

Prior to the start of the hurricane season, the Minister of Home Affairs hosts the Minister's forum, where major stakeholders from the NEMS gather to report on their readiness in terms equipment tested, exercises conducted, plans or SOPs recently updated, etc.

At least one national full scale exercise is conducted annually in addition to the participation in regional and hemispheric simulation exercises. An increase in disaster drills at the primary schools is being experienced. The post-reviews of these exercises usually identify gaps in procedures, resources and training. An exercise design course has been developed for use at national and regional levels and there is a cadre of trainer of trainers who can conduct courses.

The current national early warning system (EWS) principally monitors hydrometeorological hazards and their secondary effects (cyclones, floods, storm surge), with Barbados Meteorological Service providing forecasting and acting as the alerting authority. The Meteorological Service determines the appropriate type of notification (e.g. advisory, watch, warning), and in collaboration with the DEM, notifies the public through the emergency broadcast agencies (television, radio, newsprint, telecommunication companies). Early warning messages are targeted to specific segments of the population.

With the support of the USGS, the government intends to establish a seismic monitoring unit to provide real time data regarding earthquake activity in Barbados and the adjacent regions. Efforts are also underway to incorporate comprehensive audio notification architecture into the EWS. However, the financial resources to maintain and upgrade the EWS are limited and maintaining trained personnel is challenging.

In 2010 an assessment was conducted of the capacity of the DEOs to "augment the emergency services planned by the government" as the mechanism is having difficulty adjusting to the realities of managing a large cadre of volunteers, a shift in mandate from disaster relief and response to comprehensive disaster management (CDM), and a general sense of complacency around disaster preparedness in Barbados (Taikaram, 2010). A number of recommendations for the Community Preparedness Programme were advanced as plausible strategies to improving the existing system, as the following diagram shows.

The National Emergency Operations Centre is fully operational, being activated as the coordination centre for response and relief in a national emergency according to established multi-hazard SOPs. The NEOC Operations Group provides technical guidance and resources for effective resolution of emergency situations.

In the event of a hazard impact, a cadre of trained staff from the Barbados Statistical Service, the TCDPO, other agencies and volunteers collect and collate disaster loss data to support decision making in recovery efforts. Unfortunately, disaster loss data is not yet mainstreamed into scientific and financial data streams to facilitate

seamless transition from hazard and risk assessment, to analysis of disaster losses, to decisions on funding for recovery. Moreover, the data are not disaggregated by sex in order to better identify gender issues. There are also disaster information systems within the DEM, CZMU, Lands and Surveys Department, TCDPO, BWA, Barbados Light and Power Company Ltd (BL&P) and CIMH (CDEMA, 2010; DEM, 2010).

National Council for the DEOs

- A volunteer governance mechanism which will assist the DEM in crafting appropriate programmes intended to enhance the capability of the DEO members and the overall community preparedness programme.
- To work with all DEOs to develop a strategic and operational plan of action for the community preparedness programme at the District level.

Community Preparedness Standing Committee

- To further strengthen the institutional framework and capacity of the community preparedness programme and by extension the National Emergency Management System
- Expected to provide strategic oversight of and advice to the community preparedness programme. This may include the identification of project initiatives, programme support and financial resources inter alia which could assist in enhancing the community preparedness programme.
- It will also advise the EMAC in all community emergency management matters as it relates to the community preparedness programme. These matters may include strategic planning, volunteer recruitment, training and awareness, emergency coordination and response at the community level

Community Disaster Management Unit

- To assist the Director in the development, implementation, evaluation and monitoring of the Community Preparedness Programme
- Enable DEM to provide the necessary guidance, management and oversight to ensure that the Barbadian populace benefits considerably from a robust community preparedness programme which will result in an island wide conglomeration of disaster resilient communities

Recommended elements for the restructuring of the Community Preparedness Programme (Source data: Hinds, 2011)

Summary

The availability of high quality, trustworthy data is a quintessential condition for effective management of natural risk. It fuels critical analysis, empowers strategic decision making and drives multi-sector integrated dialogue and planning. While data sharing protocols exist, apathy persists towards facilitating access to data and information by counterpart agencies and the public. For instance, while there are teams collecting post-disaster information, they use different methodologies and collect for their own purposes. While the Drainage Division collects photo documentation of flood hazard impacts, they are not geo-referenced or plotted in a GIS. Conversely, TCDPO uses mobile devices to geo-reference their field data and transmit to the office for upload.

Streamlining of this and various other data collection process to create a culture of consistent and robust data collection and sharing would increase efficiency of operations and simplify coordination mechanisms.

While there is a range of legislation governing environmental protection, natural resource management, sustainable development and emergency management, along with a number of effective institutions, there still remain some inherent constraints:

- Overlap and duplication of the functions of some institutions for monitoring and control (ECLAC, 2010) leads to ineffective implementation and enforcement functions
- Some agencies lack the capacity to fully utilise the established legislative frameworks
- Poor enforcement of existing legislative framework accompanied by weak enforcement capacity (GOB, 2010)
- Limited inter-agency strategic and programmatic planning and information sharing

Inadequate promotion of the building code and setback requirements, poor enforcement of zoning and land use regulations and inadequate public education on and awareness of disaster risk contribute to the perpetuation of vulnerability. A lack of high quality information on disaster risk in Barbados has also been a major constraint to the implementation of CDM (GOB, 2010).

Admittedly, the technical and human capacities within the NEMS face several constraints, particularly within the DEM itself. From the perspective of the coordinating agency, the staff complement includes the Director and Deputy Director, 3 technical Programme Officers, 1 radio operator and 8 administrative staff to cover all designated functions, plus the Director of the Caribbean Tsunami Information Centre (CTIC). A 2010 baseline assessment (CDEMA, 2010) revealed that only 4 of the 13 permanent staff of the DEM were trained in CDM and its implementation. This represents a significant limitation in relevant capacities to effectively utilise available resources (tools, information, funds). For instance, constraints have been highlighted in:

- Meeting the needs of all non-government stakeholders for information and initiatives
- Utilisation of available datasets for planning and management e.g. sea level, beach profiles
- Delivery of required technical input to support integration of hazard impact assessments into the EIA process
- Slow flow of information, irregular updates of the DEM website and social media
- Insufficient training in M&E and results-based management (RBM); and lack of budgeted resources for M&E
- Inadequate information and communication technology (ICT) to meet needs, including GIS software

REDUCTION OF UNDERLYING RISK FACTORS

Given that disaster risk is correlated with social, environmental and economic vulnerabilities, reducing that risk cannot solely be vested in and achieved by the DEM and emergency services. Sector development planning and programmes must address the underlying factors that contribute to risk and exposure.

Risks from natural hazards should be incorporated into economic projections and the work of all sectors because:

- There are high opportunity costs associated with diverting scarce resources to relief and reconstruction
- Disasters can severely impinge the budgetary planning process
- The high demand on international aid diverts these resources from development activities (Benson and Clay, 2004)

The planning and management of settlements has seen incremental improvements, particularly since the Environmental Management and Land Use Planning for Sustainable Development (EMLUP) Study and the subsequent revisions of the Physical Development Plan.

While the EIA process is operational and includes aspects of disaster risk, the results of the EIA do not always lead to the recommended outcome or implementation of all associated conditions and remediation measures. Further, the DEM (2013) reports that the costs and benefits of disaster risk are not adequately accounted for in the design and operation of major projects, particularly by actors external to the country. DRR in the development of critical infrastructure (e.g. schools and hospitals) is also absent as a matter of national policy. The regulation of developments in relation to coastal hazards is within the remit of the CZMU and CZM Policy; non-coastal hazards however are not as efficiently controlled.

The importance of the agricultural sector is increasingly being felt, even though it has declined significantly in its contribution to GDP over the last several decades. To reduce the dependence on imported products, there have been efforts to strengthen the market for local farmers through partnerships with the tourism industry and certification initiatives to ensure retailers can identify and purchase from authentic growers.

Inputs to the industry such as water, electricity and fertiliser, tend to be quite costly, lowering the competitiveness of local products with imports developed in larger economies of scale. The cost effectiveness and sustainability of production are among the main factors that will dictate the viability of the industry and its penetration into local homes as a preferred option. Progress on shaping a more sustainable sector has been mixed. The Agricultural Incentives Programme includes over 100 grants, rebates, capital injections, technical assistance and tax holidays to facilitate development of the industry. There are also over 80 duty free concessions on animals, planting material, machinery and equipment, tools, chemicals, vehicles, generators, etc. Still, some farmers continue to use poor tillage and cultivation practices, and many of the agricultural lands are vulnerable to land slippage. Drip irrigation and the use of solar photovoltaics have been used to improve the cost-effectiveness and efficiency of some operations, but the capital investment needed for these measures is out of the reach of many small farmers. The Agricultural Development Fund and its Disaster Rehabilitation Fund exist to support the evolution or recovery of legitimate agricultural operations, but uptake is varied.

DRR in relation to the planning of critical infrastructure such as schools, fire stations and hospitals is being actively integrated. The most recent schools and fire stations (Blackman and Gollop Primary and the Arch Hall Fire Station) have incorporated DRR/CDM measures, and the plans for a new hospital have taken into account the PAHO Safe Hospital guidelines. However, retrofitting existing structures presents a challenge.

For many other types of major developments such as hotels, ports and marinas, many of the elements of hazard analysis to be considered relate to the coastal or marine environment, and are thus ably governed by the CZMU's development control policies, plans and enforcement procedures (DEM, 2013).

Livelihood security and social safety nets are mechanisms designed to ensure the income and strengthen the resilience of the most vulnerable in a crisis situation. Crop insurance and property insurance, micro finance, micro insurance, and cash transfers are some of the means through which this is accomplished in Barbados. However, the effectiveness of these mechanisms and their breadth of adoption are not clear.

The Building Code is poised to be used as a key instrument in encouraging investment in risk mitigation. For example, financial institutions could require inspection and adherence to the Code as a prerequisite for insurance. Contractors could be required to undertake specialised courses and receive certification to support their implementation of the Code.

DISASTER RISK ANALYSIS

Risk is a function of the potential loss and/or damage based on the exposure to a hazard and the likelihood of its occurrence (e.g. an active volcano) and the vulnerability of assets to be adversely affected by this hazard based on their characteristics (e.g. location of farms on volcanic slopes due to fertile soils). This is typically expressed as:

Risk = Hazard x Vulnerability

The IDB has developed a System of Indicators to measure disaster risk and risk management, designed to evaluate the variables related to the potential impact of extreme events and the capacity of society to withstand such. This System of Indicators has been developed to help to reveal disaster risk in different ways for diverse decision-makers and identify the causes of risk to be able to assess the effectiveness of corrective and prospective mitigation measures.

For Barbados, the analysis clearly demonstrates that the country has insufficient resources to cover losses and/or feasible financial capacity to face losses and replace the capital stock affected. If contingent liabilities to the country were covered by insurance (annual pure premium), the annual investment by the government would need to approach 12% of capital expenditure in 2008 to cover future disasters. It was noted that the most recurrent and isolated phenomena, such as landslides and floods, cause frequent effects at the local level and largely go unnoticed or unquantified. Vulnerability due to socioeconomic fragility showed a general declining trend, and resilience improved slightly. Risk management improvement is primarily attributed to progress in land use and urban planning, environmental protection, overall disaster management and reinsurance coverage. Significantly, performance was incipient in relation to social safety nets and funds response, and there was no progress in budget allocation and mobilisation.

Overall, notwithstanding improvements in many areas, the effectiveness of risk management at the time of assessment was considered incipient, thus requiring improvement in the capacity to anticipate, to cope and to recover. Analysis of the various sub-indicators gives specificity as to the areas needing attention.

Disasters represent non-explicit contingent liabilities, for which government retains most of the risk. If future losses are not incorporated into planning and investment, sufficient budgetary resources will not be available to reduce potential loss. It is clear that economic and social characteristics of the country have substantially been altered since 2008. Consequently, the indicators are currently in the process of being updated through the CRMP. The results should be available by mid-2015.

With an expansion of populations and highly valuable assets in areas of hazard exposure, the nature of risk is changing, and likewise so will the measures to address it need to be amplified. To propel and support such action, the characteristics of such risk need to be defined.

Climate-related hazards (storms, drought, floods, etc) generally show a quasi-cyclical pattern. Historical climatological and hydrological records allow assignment of risk probabilities that can be taken into account

in public and commercial investment decisions. The recurrent nature of these hazards stimulates adaptation measures in economic and social activities, such as housing, agriculture, and water management, at the micro and sector levels. Conversely, from a planning perspective, geophysical hazards can be considered more stochastic and of low and uncertain probability, typically <1% in any given year (Benson and Clay, 2004). However, the damage and disruption can be extremely devastating to power, communications, transport, productive capacity and social infrastructure across the entire country.

A qualitative matrix has been structured to capture the risk as it relates to each hazard, based on the IDB indicators as well as the foregoing research and analysis. The scoring considers the type of impact (social, environmental, economic), whether impacts are on a local or national scale, the frequency of occurrence and whether secondary hazards are generated. The perception of risk is significantly skewed by probability of occurrence, and therefore so is the impetus to pursue mitigation actions. Thus frequency has been weighted more heavily than other factors.

Qualitative analysis of risk for each hazard type

Hazard	Aggregate score (of 80)	Rank
Climate change	74	1
Tropical cyclones	53	2
Flood	52	3
Drought	49	4
Vector-borne disease	49	4
Earthquake	48	6
Land degradation	46	7
Tsunami	45	8
Wildfires	45	8
Groundwater contamination	43	10
Water-borne disease	38	11
Landslide	37	12
Oil spills	35	13

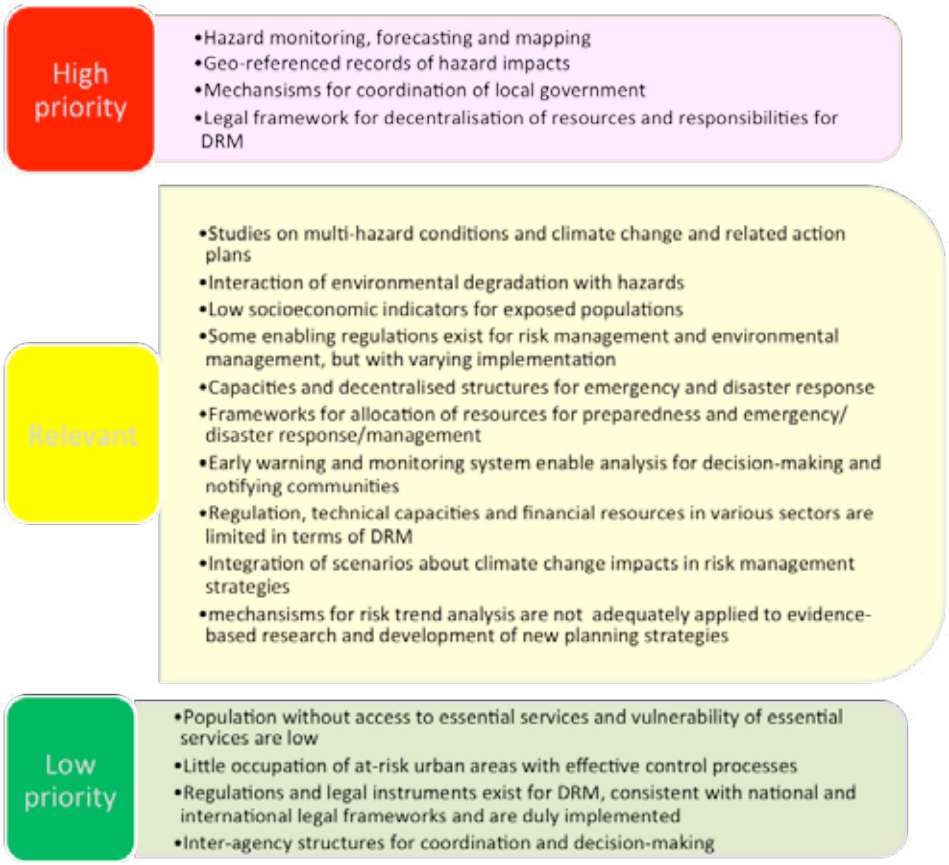
Based on historical impacts and stakeholder experience, the most frequently occurring hazards identified by stakeholders were tropical cyclones, storm surge and floods. Seismic hazards (i.e. tsunamis and earthquakes) have low frequency but very high impact potential; however these have been considered less significant. Drought continues to be underestimated in its potential for devastating impact. Moreover, the attendant and far-reaching effects of climate change hold multi-faceted and potentially overwhelming consequences. However, as Barbados' contribution to greenhouse gas emissions is small, risk reduction will of necessity mainly take the form of adaptation.

STRATEGIC DIRECTIONS FOR DISASTER RISK REDUCTION

DRR has been shown to be one of the more cost-effective development interventions, by saving lives and protecting valuable and scarce resources such as food, livestock and property. Crucially, it also promotes anticipatory and cost-effective responses to climate change risks, which will be progressively required on an accelerating scale (Back et al, 2009). Reducing disaster risk is important to maintain progress in poverty reduction, sustainable livelihoods and sustainable development. Particularly given the current economic situation, Barbados can ill-afford to fall into a situation where public funds must be diverted to relief and reconstruction and serviced through additional external debt. Such actions may lead to the postponement or abandonment of planned investments and projects, reduced public services, and deferment of wage and salary increases and of staff appointments. The short term decline in GDP post-disaster due to slowed economic activity can contribute to depleted foreign reserves, economic instability and uncertainty, deterring investment, more so if the country's credit rating is also depressed (Benson and Clay, 2004).

A number of challenges exist in the area of disaster risk management. Awareness of the need for the more cost-effective preventive approach to disaster risk management is still incipient at most levels of public administration. Addressing these challenges will require a reorientation of the national approach to managing natural hazards and disasters, where integrated disaster risk management is embraced and owned by all sectors. The priorities for disaster risk reduction as defined by stakeholders are shown in the following diagram.

High, medium and low priority areas for disaster risk reduction in Barbados based on stakeholder consultation



Based on the risk scenarios and the high priority areas identified by stakeholders, the following strategic directions have been proposed for advancing DRR in Barbados:

Proposed strategic directions and priority actions for disaster risk reduction in Barbados

Key issues	Proposed actions	Suggested lead agency	Timeframe for completion
Capacities for hazard monitoring, forecasting and mapping are inconsistent across hazards and agencies Lack of adherence of agencies to data sharing protocols Apparent lack of understanding within agencies of usefulness of data to other parties Lack of dedicated monitoring and research personnel Inability to access datasets from multiple agencies for comprehensive analysis and planning Limited compilation capabilities inhibits comprehensive analysis for effective planning	Protocols development for consistent data collection and transformation (Building a culture of information as a public good. Potential for designating specialised research and data collection personnel, and sharing between agencies with similar needs to maximise scarce resources)	Data Processing Department	Jun 2015
	Build a multi-sector hazard monitoring network	Barbados Meteorological Service	Dec 2015
	Mapping of floods and tsunami risk areas and identification of evacuation routes	Coastal Zone Management Unit	Dec 2015
	Education on the functionality and benefits of the DEWETRA platform, such as the capacity to integrate GIS layers, hazard monitoring information and forecast models towards its greater and consistent use	Lands and Surveys Department with support from CIMH	Dec 2015
	Development of guidelines or protocols for integration of data and analysis into specific decision making processes (non-restrictive, non-exhaustive)	Data Processing Department	Mar 2016
Variable tools and methods employed by agency teams in damage and loss assessments Inconsistent methodologies impede comparability of data	Standardise methodology for post-disaster data collection and input of metadata across agencies, including use of geo-ref equipment e.g. the UNDP-implemented World Bank-funded Post-Disaster Needs Assessment (PDNA) project being rolled out across the Eastern Caribbean	Barbados Statistical Service	Dec 2015
	Sharing of best practices and tools among agencies	Town and Country Development Planning Office	Jan 2016
	Training of field operatives on standardised methodology	Lands and Surveys Department	May 2016

Inconsistent capacities across DEOs Absence of clarity on the roles and responsibilities of Constituency Councils in DRM; potential conflict with DEOs Constituency Councils and DEOs are aligned along electoral boundaries, which are not applicable in the context of environmental risk management e.g. watersheds	Instituting regulations for the Emergency Management Act Cap 160A to empower the DEM	Office of the Attorney General	Dec 2015
	Institutionalisation of the new Community Emergency Programme	Department of Emergency Management	Jun 2016
	Modify disaster framework to empower communities to conduct assessments and make decisions at a local level (e.g. as in Speightstown with the flood EWS)	Department of Emergency Management	Jun 2016
	Provide standardised training for community teams to ensure safety and accountability	Barbados Fire Service Ministry of Health Environmental Protection Department	Dec 2016

At a regional level, the following priorities have also been identified, and show strong correlation with the high and medium level actions for Barbados:

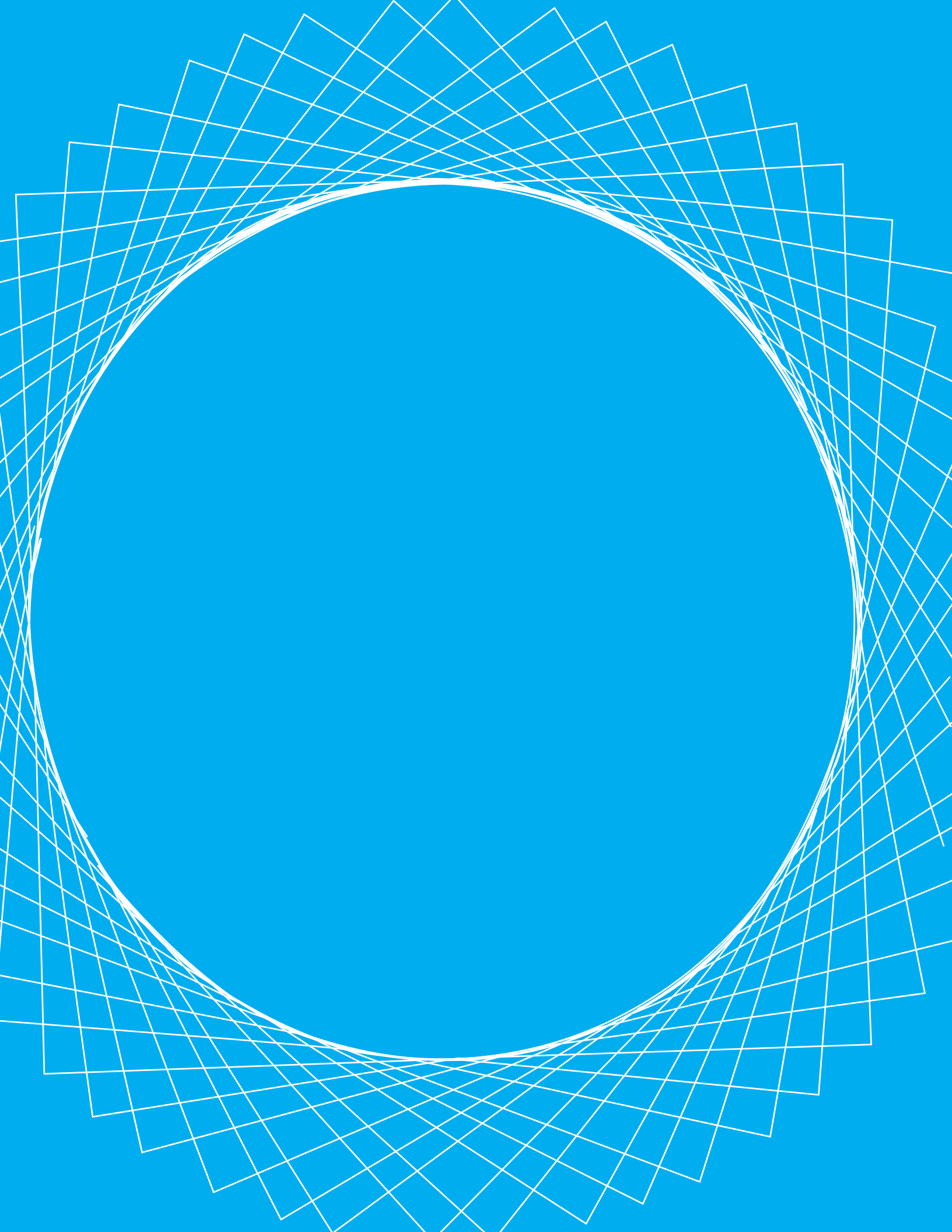
- Strengthening EWS at national and community levels
- Improving understanding and action on seismic risk, particularly in an urban context
- Formalise or improve the national systems for coordination among partners for risk identification and mitigation
- Engage in more joint programmes with private sector participation
- Development or strengthening alignment of laws and policies with regional and international frameworks

CONCLUSIONS

Overall, the state of disaster risk reduction in the country can be characterised as positive, with many areas showing progressive improvements with a strong system of coordination within the NEMS. There are competent technical agencies with mandates that for protection of the environment, public health and land development control. Social policies and protection programmes create a support system for vulnerable groups such as the elderly and the poor.

However, there are limited technical personnel in many agencies. In many cases, the regulatory framework is weak and inhibits the effectiveness of their regulation and enforcement. Although institutional capacities are weak, and government resources severely constrained, the attempts to decentralise functions and decision making have been limited.

Strategic investment in key areas, including strengthening the capacity of technical staff and enhancing inter-agency coordination and strategic planning, enhanced involvement of key economic sectors, adaptation of social policies for vulnerable groups, and emphasis on climate change adaptation will make strides to reducing the risks faced at community and national levels.



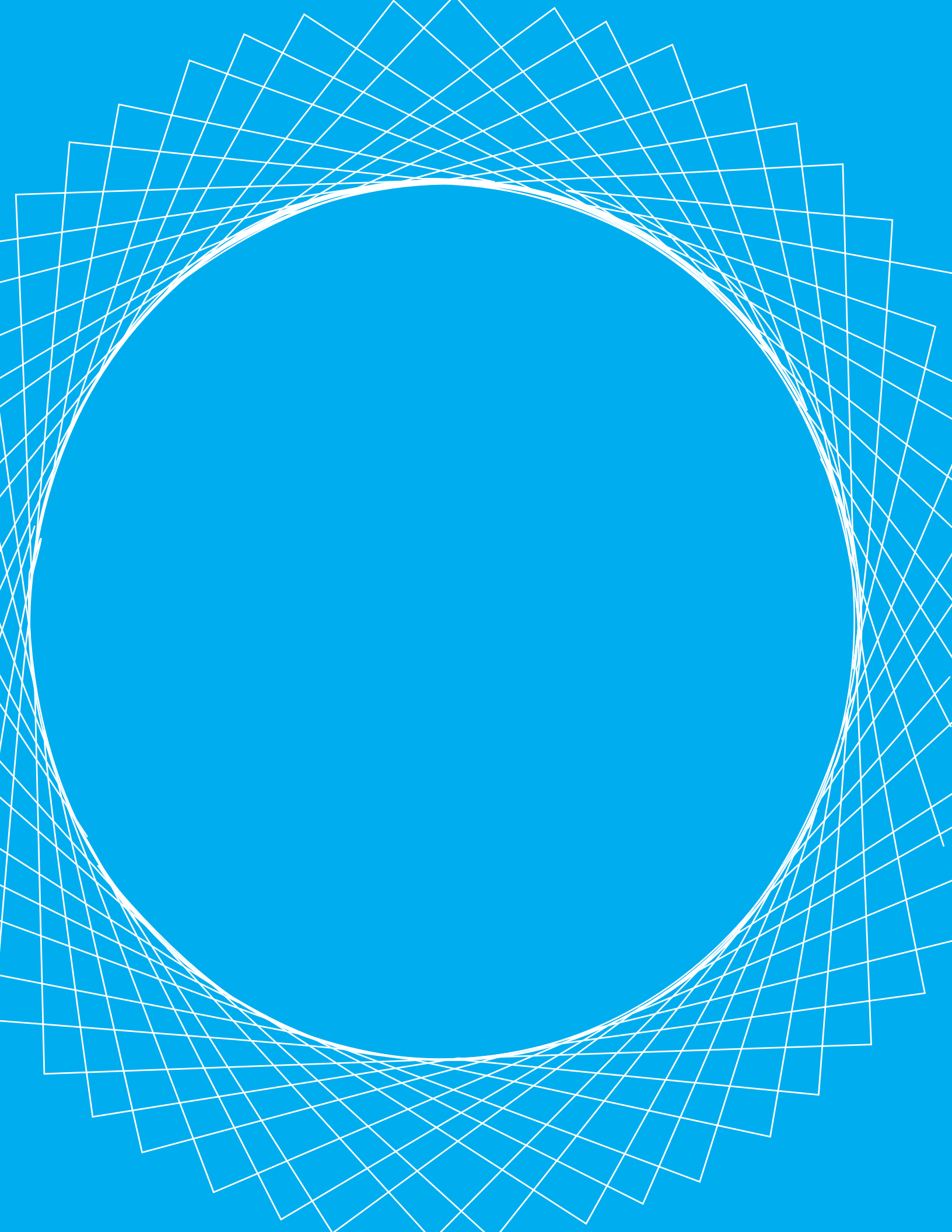
Acronyms

AAL	annual average losses
AMO	Atlantic Multi-decadal Oscillation
ARSB	Amateur Radio Society of Barbados
BADMC	Barbados Agricultural Development and Marketing Corporation
BAS	Barbados Agricultural Society
BBRFS	Barbados Behaviour Risk Factor Survey
BCBRA	Barbados Citizens Band Radio Association
BFCAS	Barbados Food Consumption and Anthropometric Surveys
BFPA	Barbados Family Planning Association
BMC	Borrowing Member Countries
BPOA	Barbados Programme of Action
BWA	Barbados Water Authority
CALC	Country Assessment of Living Conditions
CAP	Common Alerting Protocol
CARIBE EWS	Tsunami and Other Coastal Hazards Early Warning System for the Caribbean and Adjacent Regions
CARICOM	Caribbean Community
CBB	Central Bank of Barbados
CCA	climate change adaptation
CCCCC	Caribbean Community Climate Change Centre
CCRIF	Caribbean Catastrophe Risk Insurance Facility
CDB	Caribbean Development Bank
CDEMA	Caribbean Disaster Emergency Management Agency (formerly CDERA)
CDM	Comprehensive Disaster Management
CDMP	Caribbean Disaster Management Project
CDRT	Community Disaster Response Team
CDRU	Caribbean Disaster Relief Unit
CERMES	Centre for Resource Management and Environmental Studies (UWI)

CIMH	Caribbean Institute for Meteorology and Hydrology
CNCD	chronic non-communicable disease
COTED	Council for Trade and Economic Development (CARICOM)
CRMP	Coastal Risk Assessment and Management Programme
CTIC	Caribbean Tsunami Information Centre
CZM	coastal zone management
CZMU	Coastal Zone Management Unit
DANA	Damage and Needs Assessment
DDI	Disaster Deficit Index
DEM	Department of Emergency Management
DEO	District Emergency Organisation
DFID	Department for International Development
DIPECHO	Disaster Preparedness Programme, ECHO
DRR	disaster risk reduction
ECHO	European Commission´s Humanitarian Aid and Civil Protection Department
ECLAC	Economic Commission for Latin America and the Caribbean (UN)
EIA	environmental impact assessment
EMAC	Emergency Management Advisory Council
EPD	Environmental Protection Department
EU	European Union
EWS	early warning system
FAO	Food and Agricultural Organisation of the United Nations
GAR	Global Assessment Report for Disaster Risk Reduction
GCC	global climate change
GFCF	gross fixed capital formation
GOB	Government of Barbados
HDI	Human Development Index
HDR	Human Development Report
HFA	Hyogo Framework for Action
ICT	information and communication technology
IDB	Inter-American Development Bank
IICA	Inter-American Institute for Cooperation on Agriculture

IMF	International Monetary Fund
IPCC	Inter-governmental Panel on Climate Change
IWRM	integrated water resource management
JICA	Japan International Cooperation Agency
LDI	Local Disaster Index
LEC	loss exceedance curve
M&E	monitoring and evaluation
MCFB	minimum cost food basket
MCM	mass casualty management
MDG	Millennium Development Goals
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NEMS	National Emergency Management System
NGO	Non-Governmental Organisation
NGDC	National Geophysical Data Centre
NIS	National Insurance Scheme
NOAA	National Oceanographic and Atmospheric Administration (USA)
OAS	Organisation of American States
OASIS	Organisation for the Advancement of Structured Information Standards
OFDA	Office for Foreign Disaster Assistance (USAID)
OIE	World Organisation for Animal Health
PAHO	Pan-American Health Organisation
PDP	Physical Development Plan
PML	Probable Maximum Loss
POP	Persistent Organic Pollutant
PVI	Prevalent vulnerability Index
PWD	persons with disabilities
QEH	Queen Elizabeth Hospital
RBM	Results-Based Management
RBPF	Royal Barbados Police Force
RMI	Risk Management Index
ROI	return on investment

RRM	Regional Response Mechanism
SIDS	Small Island Developing States
SRFP	Sub-regional Focal Point
SRC	Seismic Research Centre (UWI)
TCDPO	Town and Country Development Planning Office
TCHWS	Tsunami and Other Coastal Hazards Warning System Project
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNISDR	United Nations Office for Disaster Risk Reduction
UPC	urban produced capital
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USGS	United States Geological Service
UWI	University of the West Indies
WHO	World Health Organisation
WSSU	Water and Sanitation Systems Upgrade Project



1. Introduction

Crafting a resilient society demands clear understanding of the multi-dimensional spheres of vulnerability, including poverty, natural hazard risk, energy and food insecurity, environmental degradation, poor infrastructure, and weak governance. Some of the critical capacity gaps for addressing drivers of vulnerability in developing countries include availability of robust data and the skills to interpret and apply such data to create sustainable solutions.

Disaster risk reduction (DRR) embodies the "systematic efforts to analyse and manage the causal factors of disaster, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR, 2009).

Disaster response and recovery must be framed within a holistic context that incorporates risk mitigation and preparedness in order to be effective. Further, they must be understood from the perspective of the sustainable development goals and challenges within Barbados, impacts of climate change, and diverse technical and institutional capacities.

1.1 Purpose

The Country Document for Disaster Risk Reduction aims to present a comprehensive view of the status of DRR in Barbados, articulating achievements in management of risk; challenges to reducing loss of life as well as social, economic and environmental impacts; and identifying priorities and strategies for reducing risk. The Country Document is a joint guide, validated by authorities, scientific bodies, cooperation agencies and communities, which identifies the major hazards, vulnerabilities and capacities at national and local levels, and guides the organisation of coordinated and complementary action for DRR in priority intervention sectors.

In conducting this process, the expectation from the standpoint of the Department of Emergency Management (DEM) is that it will guide all actors and therefore help to streamline DRR interventions and investments, influence the decision-making process at the policy and strategic levels, and thus catalyse the advancement in improving resilience in Barbados toward sustainable development.

The expected users of this reference document would include:

- National DRR policy and decision makers, specifically the Minister of Home Affairs and the Emergency Management Advisory Council (EMAC)
- National agencies and authorities with responsibility for realising various aspects of risk reduction e.g. the Department of Emergency Management, Town and Country Development Planning Office, Coastal Zone Management Unit (CZMU), Drainage Division, Barbados Meteorological Service, Ministry of Finance
- National focal points for the Hyogo Framework for Action (HFA 2005-2015) and HFA2
- Local civil society organisations involved in DRR e.g. Barbados Red Cross, District Emergency Organisations

- Regional institutions e.g. Caribbean Community (CARICOM), Caribbean Disaster Emergency Management Agency (CDEMA), Caribbean Institute for Meteorology and Hydrology (CIMH), Caribbean Community Climate Change Centre (CCCCC)
- International development organisations e.g. the United Nations System (UNDP, UNISDR, UNICEF, PAHO, etc), EU/DIPECHO, DFID, USAID/OFDA, CHC, IDB, OAS
- Eastern Caribbean Donor Partners Group for Disaster Management (ECDPGDM)
- Universities and other technical and scientific institutions
- Private sector
- Authorities at all levels of government in all sectors

1.2 Objective and Scope

The Country Document allows objective assessment of progress made and of the processes implemented for the reduction of vulnerability and the strengthening of resilience to risks caused by natural hazards. The report provides a snapshot of current efforts in DRR, and should be periodically updated as new information becomes available. The update frequency of the Country Document will depend on Barbados' needs and on the information content. However, it is expected that the country will update the document before its information becomes out of date. This requires that the Country Document not only be flexible, but also adaptable to changing circumstances and to the continuous improvements and innovations. The main objective is that the Country Document becomes the institutional DRR memory of the country.

1.3 Methodology

Led by the DEM, the development of this Country Document took the form of a series of stakeholder consultations and independent research, including the administration of the set of criteria for the identification of key actions for DRR planning in Latin America and the Caribbean, developed by the United Nations Office for Disaster Risk Reduction (UNISDR).

The planning process included identification of key actors by the DEM and preparation of a work plan. Primary and secondary data were sourced, individual stakeholder interviews conducted and the information analysed and compiled. This was followed by circulation of the draft document for review by the DEM and a broader cross section of stakeholders. Additional feedback on the process and the document were obtained through collaboration with partners' consultations (CZMU, CIMH) in September 2014 and the validation workshop on 17 October 2014.

The participants engaged in those exercises are listed in Annex I. The final document was submitted to the EMAC for final approval.[15] A report on the process of application of the set of criteria is included in Annex VII of this document.

15 All values in the document are in United States dollars (converted at 2:1 from Barbadian dollars where applicable) unless otherwise stated.

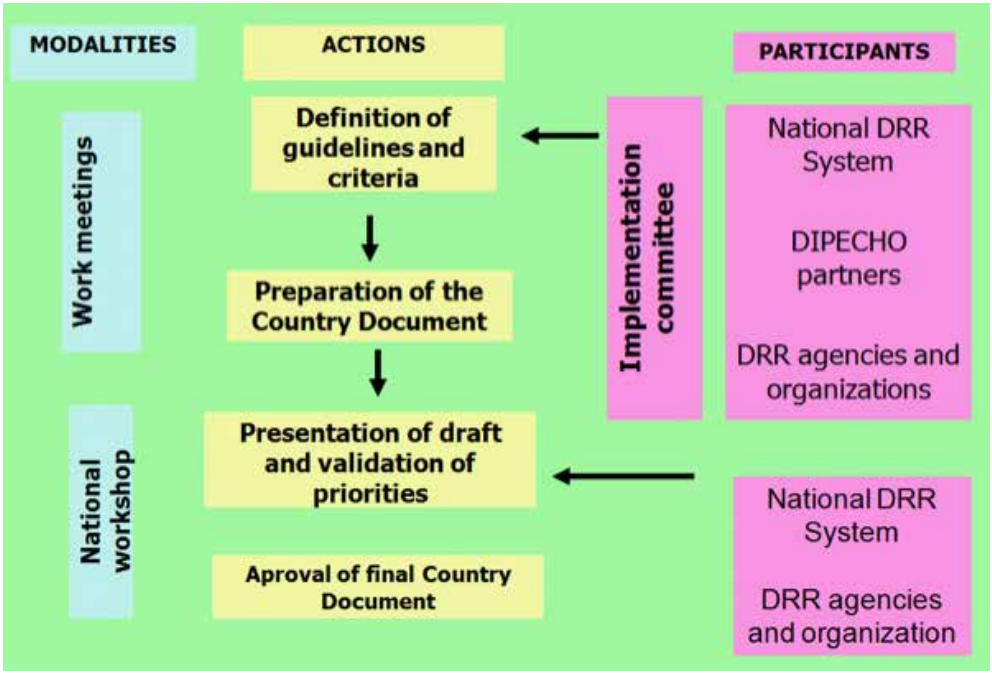
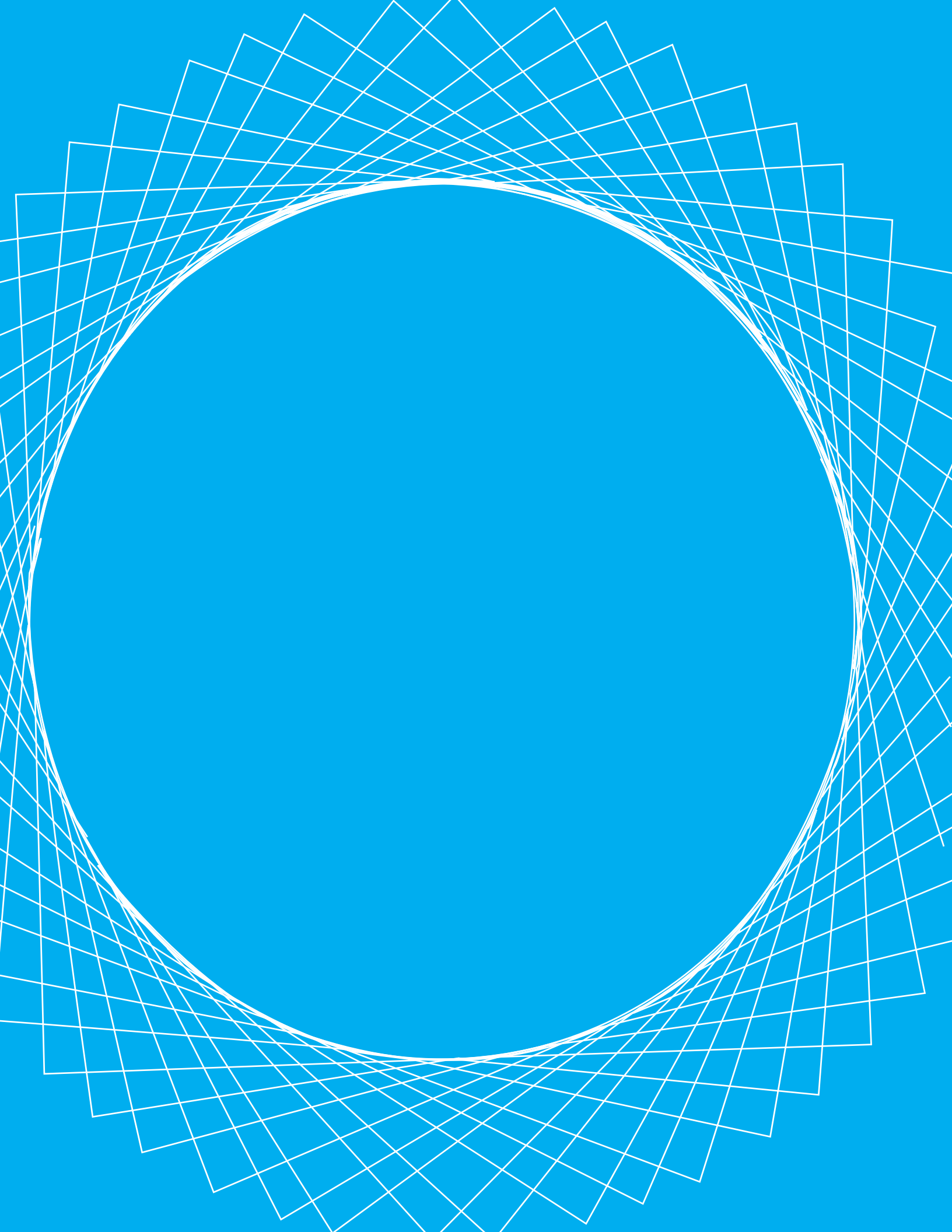


Figure 1: Participatory process for the preparation of a Country Document (Source: UNISDR)



2. International Context for Disaster Risk Reduction

The 2011 Global Assessment Report on Disaster Risk Reduction (UNISDR, 2011) revealed that while loss of lives in disasters is decreasing, risk exposure and economic loss are increasing, especially due to small scale highly frequent events. For the Caribbean, this is exacerbated by climate change and climate variability, leading to disasters characterised by high economic, social and environmental impact.

It is also evident that human development processes play a major role in the configuration of risk constructed by growth in socioeconomic exposure and gaps in development. The worsening scenario made apparent the urgent need for a strategic and systematic approach to the reduction of vulnerability to hazards and the risks they generate.

The Yokohama Strategy and Plan of Action for a Safer World and the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA) were the main outcomes of the 2005 World Conference on Disaster Reduction. The goal of the HFA is the substantial reduction of disaster losses, in lives as well as the social, economic and environmental assets of communities and countries, and is the reference framework for DRR public policy. National, regional and international consultations are currently in progress to craft the post-2015 DRR framework (HFA2) to be finalised at the Third World Conference for Disaster Risk Reduction in March 2015 (also see Figure 47).

Box 1: Hyogo Framework for Action Priorities

HFA 2005-2015 Priorities for Action

1. **Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation**
2. **Identify, assess and monitor disaster risks and enhance early warning**
3. **Use knowledge, innovation and education to build a culture of safety and resilience at all levels**
4. **Reduce the underlying risk factors**
5. **Strengthen disaster preparedness for effective response at all levels**

In this regard, many countries have made significant progress in understanding DRR through social research, the exchange of experiences and the participation of social and political sectors not previously included. They have undertaken important efforts in the implementation of the HFA and toward the achievement of the Millennium Development Goals (MDGs) of the Millennium Declaration[16], particularly those related to poverty reduction and environmental sustainability, by promoting forums, platforms and mechanisms for coordination, collaboration and the exchange of knowledge and experiences in DRR.

As a complementary process, the first World Humanitarian Summit[17] will be convened in Turkey in 2016 to set a new agenda on global humanitarian action, with the aim of building a more inclusive and diverse

16 The United Nations Millennium Declaration, signed in September 2000, commits world leaders to combat poverty, hunger, sickness, illiteracy, environmental degradation and discrimination against women. The Millennium Development Goals, which stem from the Declaration, define objectives and specific indicators.

17 http://www.worldhumanitariansummit.org/

system. The defined areas of focus are humanitarian effectiveness, reducing vulnerability and managing risk, transformation through innovation, and serving the needs of people in conflict.

The international context for DRR is also anchored in global agreements such as the Johannesburg Declaration and Plan of Implementation, the Barbados Programme of Action (BPOA) and Mauritius Strategy for Implementation, Agenda 21, and the Millennium Declaration and the Millennium Development Goals (MDGs), which are driving development aid and agendas worldwide. Global climate change (GCC) has also been recognised as a major threat to the sustainable development of Caribbean countries and Barbados is signatory to the United Nations Framework Convention for Climate Change (UNFCCC).

There should be strong alignment of the HFA2 process with the evolving post-MDG and post-Kyoto processes as the post-2015 international development agenda emerges. As one of the key contributory milestones in the articulation of the post-2015 development agenda, the Rio+20 Outcome Document (UN, 2012) embodies a number of key affirmations and principles, particularly in the context of small island developing states (SIDS).

Specifically, these include identifying critical linkages between natural hazards and/or risk reduction and:

- Sustainable agriculture (crops, livestock, fisheries, forestry, aquaculture) and food security, biodiversity and ecosystem conservation, and resilience to climate change (para 111)
- Integrated and sustainable urban planning and human settlements (para 134-137)
- The unique vulnerabilities of SIDS (para 178-180)
- Sustainable development and poverty eradication (para 186-189)
- Climate change (para 190)
- Capacity building (para 280)

Moreover, global leaders acknowledged that in the face of many challenges, SIDS have made less developmental progress than most other country groupings (e.g. landlocked developing countries, least developed countries), or even regressed, especially in terms of poverty reduction and sustainable development. Adverse impacts of climate change pose a significant risk and jeopardise the attainment of sustainability, even their survival and viability (UN, 2012).

The recently-concluded UN Conference on Small Island Developing States (SIDS 2014) recognised that resilience must be a central tenet of future progress; that DRR is an integral component of sustainable growth of economic sectors such as tourism, agriculture and fisheries; and the interplay of risk reduction and climate change adaptation and their bearing on natural resources, food security and overall development (UN, 2014).

Regionally, the Caribbean Community (CARICOM) adopted in 2001 a Strategy and Results Framework for Comprehensive Disaster Management (CDM) in the region, led by the Caribbean Disaster Emergency Response Agency, which was renamed in 2009 as the Caribbean Disaster Emergency Management Agency (CDEMA) to more accurately reflect the CDM perspective and mandate. Barbados is one of the 18 Participating States of CDEMA and has adopted the CDM Framework.

The CDM Framework has incorporated the principles of the HFA. Its present iteration for 2014-2024 (CDEMA, 2014) depicts the anticipation that a safer and more resilient society will encourage sustainable economic development. It emphasises within its definition of a desired end state resilience in key economic sectors; community resilience especially focused on the most vulnerable groups and gender issues; harmonisation with climate change adaptation (CCA); and resources to achieve the strategy, inter alia. With cross-cutting

themes of gender mainstreaming, climate change, environmental sustainability, and information and communications technology (ICT), the outcomes of the CDM Strategy are:

1. Strengthened institutional arrangements for CDM implementation at national and regional levels
2. Increased and sustained knowledge management and learning for CDM
3. Improved effectiveness of CDM at sector levels
4. Strengthened and sustained capacity for a culture of safety and community resilience in Participating States

National annual work programmes aligned to the CDM Strategy provide a coherent framework for Barbados to work toward achievement of the regional outcomes and HFA Priorities. A CDM Monitor with a system of 24 indicators has been developed to enable the tracking of the progress toward achievement of the targets set for 2016, 2020 and 2024, as well as to the overall goal of the Strategy.

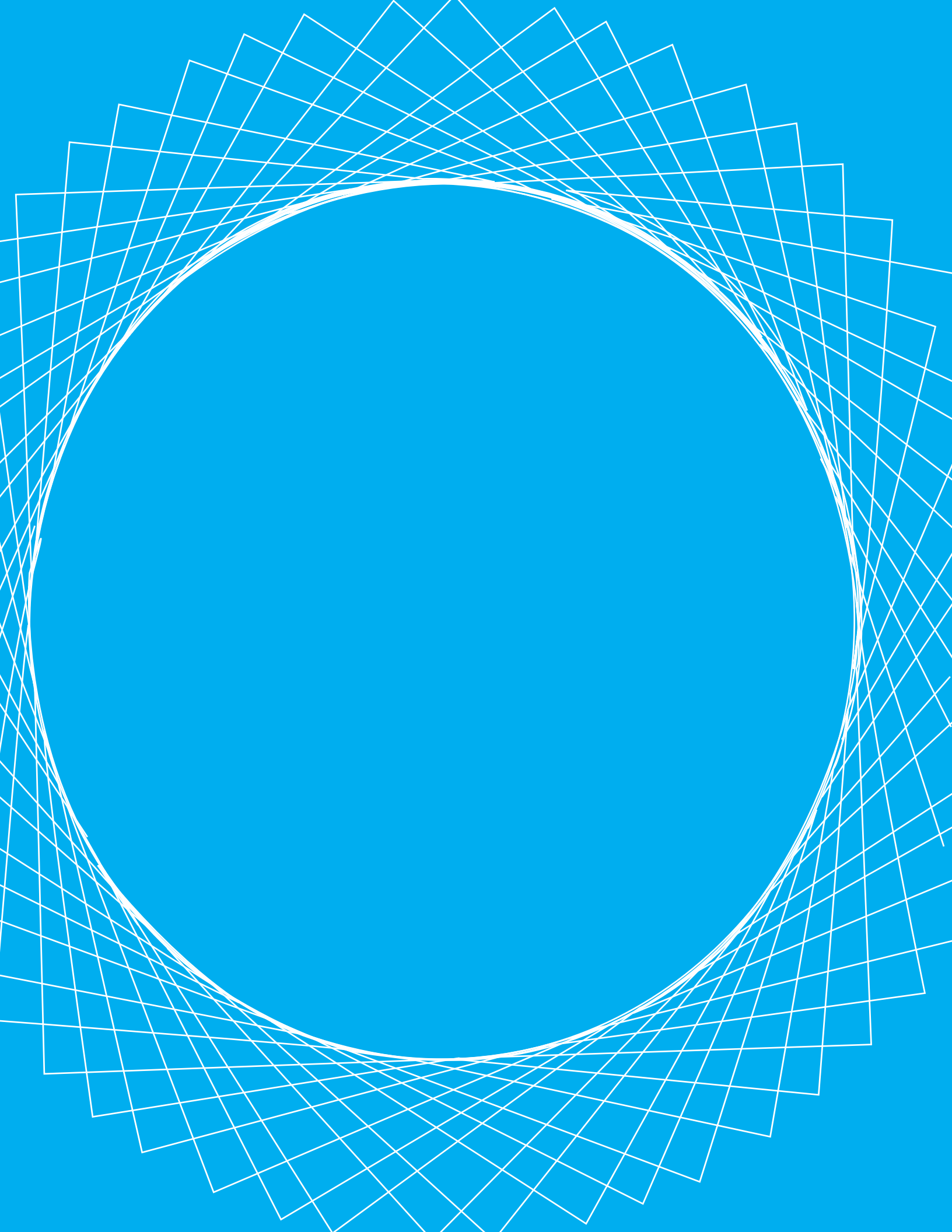
Table 1: Evolution of the international and regional disaster risk reduction process

Year	Strategy/Agreement/Platform
1989	International Decade for Natural Disaster Reduction
1994	Yokohama Strategy and Action Plan for a Safer World
2000	International Strategy for Disaster Reduction Millennium Declaration and Millennium Development Goals (MDGs)[18]
2001	Caribbean Comprehensive Disaster Management Strategy 2001-2006
2002	World Summit on Sustainable Development and Johannesburg Plan of Implementation
2005	World Conference on Disaster Reduction and Hyogo Framework for Action (HFA)[19]
2007	Enhanced Comprehensive Disaster Management Strategy 2007-2012[20] First Session of the Global Platform for Disaster Risk Reduction
2009	First Session of the Regional Platform for Disaster Risk Reduction for the Americas Second Session of the Global Platform for Disaster Risk Reduction Regional Framework for Achieving Development Resilient to Climate Change 2009-2015
2011	Second Session of the Regional Platform for Disaster Risk Reduction for the Americas Third Session of the Global Platform for Disaster Risk Reduction
2012	Third Session of the Regional Platform for Disaster Risk Reduction for the Americas
2013	Fourth Session of the Global Platform for Disaster Risk Reduction
2014	Comprehensive Disaster Management Strategy 2014-2024 Fourth Session of the Regional Platform for Disaster Risk Reduction for the Americas
2015	World Conference on Disaster Risk Reduction[21]
2016	World Humanitarian Summit

18 http://www.un.org/millenniumgoals/
19 http://www.unisdr.org/hfa
20 http://www.cdema.org/publications/CDMFramewkInfoSheet.pdf
21 http://www.wcdrr.org/

The Regional Framework for Achieving Development Resilient to Climate Change (2009-2015) and its Implementation Plan (2011-2021) set forth by the Caribbean Community Climate Change Centre (CCCCC) also establish the direction for the continued building of resilience to the impacts of GCC and low-carbon economies by CARICOM societies. It is clearly linked to DRR, most clearly in Strategic Elements 1, 2 and 4:

1. Mainstreaming climate change adaptation strategies into the sustainable development agendas of CARICOM states
2. Promoting the implementation of specific adaptation measures to address key vulnerabilities in the region
3. Promoting actions to reduce greenhouse gas emissions through fossil fuel reduction and conservation, and switching to renewable and cleaner energy sources
4. Encouraging action to reduce the vulnerability of natural and human systems in CARICOM countries to the impacts of a changing climate
5. Promoting action to derive social, economic, and environmental benefits through the prudent management of standing forests in CARICOM countries.



3. National Context

3.1 PHYSICAL ENVIRONMENT

3.1.1 Geographic location

Barbados is the most easterly island of the Lesser Antilles at the margin of the Caribbean Sea. It is located at 13°10' N 59°32' W, 160km to the east of the Windward Islands archipelago with St Vincent and the Grenadines and Saint Lucia as its closest neighbours and the Atlantic Ocean at its eastern border.

3.1.2 Geology and topography

Barbados has a relatively flat territory with soft slopes in the central region, which includes the highest point of the country, Mount Hillaby, with a height of 336m above sea level. Total area of the country is 432km2, with a coastline 92km long and an exclusive economic zone (EEZ) of 167,000km2.

In the Lesser Antilles it is the only country not formed by volcanic rocks; instead 86% of the country is a terraced karst landscape of deeply fractured and gullied limestone up to 100m thick, with numerous gullies and underlain by a complex underground cave system. It is complemented by other sedimentary rocks that include shales, clays, sandstones and some volcanic ash, Joe's River muds, saline soils and oil deposits. These layers are highly folded and faulted and are very unstable and susceptible to erosion. Large-scale land slippage is common in the Scotland District, where erosion has removed the coral cover. Barbados has mainly residual soils, including clays, which are rich in lime and phosphates. Soil type varies with altitude; thin black soils occur on the coastal plains, and more fertile yellow-brown or red soils are found predominately in the highest parts of the island. (GOB, 2010; Jones et al, 1998; GOB, 2001)

3.1.3 Climate and hydrology

The climate present on the island is characteristic of the Caribbean tropical zone, classified as dry sub-humid environment. Overall average temperature ranges from 24-28°C. Humidity ranges from 71-76%. The rainy season runs between June and November, accounting for about 60% of annual rainfall; while the dry season is from December to May. Average annual rainfall ranges from about 1254-1650mm from low to high elevations. (GOB, 2010)

Most of the precipitation during the rainy season comes from tropical cyclones from the Atlantic Ocean along the Inter-Tropical Convergence Zone (ITCZ). During the dry season, due to a combination of high temperatures with high humidity, intense rainfall with electric activity can happen in the central and western parts of the island. This type of rain normally causes flash flooding and can cause infrastructural damage; while lightning and strong winds can cause fallen trees and damage the electrical network posts or damage rooftops.

Climate regime can be heavily influenced during episodes of El Niño Southern Oscillation (ENSO). El Niño episodes bring warmer and drier than average conditions during the late wet season, and La Niña episodes tend to bring colder and wetter conditions. Barbados lies on the southern edge of the Atlantic hurricane belt and is rarely, affected by hurricanes which occur throughout August to October.

A complex network of ephemeral streams and small water currents descend from the highest parts of the island and flow toward the western coast. These streams are directly related with fractures and weak zones in the carbonated rock that cover the majority of the island and which, as a whole, constitute the most relevant hydrological system of the territory which include surface runoff, infiltration into aquifers and underground caverns and even form some deep currents.

Groundwater forms the main public supply of potable water for the population (98.6%), extracted from large reservoirs within the aquifers. Most aquifer recharge is rapid and takes place only during the wettest 1-3 months of each year. Recharge is 15-30% of average rainfall, depending on elevation. This occurs by discrete infiltration of large volumes of water through highly permeable limestone and infiltration through sinkholes, dry valleys and drainage wells (Jones et al, 1998). For the most part, all ground water extraction wells are located in the sheet water zones as far inland as possible, since ground water quality decreases rapidly to the seaward side of supply wells and the coastline also supports the greatest density of residential and tourism facilities. Total annual average water resources are estimated at 59 million m3, dropping to 45 million m3 in a 1 in 15 year drought. Barbados is classified as one of the world's most water scarce countries (i.e. less than 1000m3/person/year); with abstraction rates being near their maximum, and an ageing water distribution network with high leakage rates. The resident population is augmented by approximately 500,000 stay over tourists and 1.2 million cruise passengers visiting the island annually using these water resources (GOB, 2010). High and increasing demand plus climate change can have deleterious impacts on the sustainability of this resource.

CLIMATE VARIABILITY

After analysis of climate records for the Caribbean region for 1961-2010, Stephenson et al (2014) conclude that overall trends show a warming of surface air temperatures, particularly of daily minimum temperatures, and an increase in the frequency of warm days, warm nights and extreme high temperatures. This analysis also holds true for the Barbados sub-region. They further suggest that although the increase in annual total precipitation amount was not statistically significant, the intensity of daily rainfall and the heavy rainfall events has been definitely rising over the past 25 years. Decadal variability in temperature also displays a correlation with the Atlantic Multi-decadal Oscillation (AMO)[22].

3.2 SOCIOECONOMIC CONTEXT

3.1.2 Population and demographics

As per the most recent census data (2010), the resident population is estimated at 277,821[23], of which 47.9% are male and 52.1% female. Within the productive population (15-64 years) are 187,095 persons; 54,757 are within the 0-14 age group and 35,969 at 65+ years (see Figure 2 and Table 2). This reflects a dependent population size at 48.5% of the productive population, creating a heavy burden on the labour force. The growth rate for the period 2000-2010 was 0.22% (0.2% in 2011 and 0.1% in 2012), projected at 0.20% for 2010-2020, and dropping to 0.06% for 2020-2030 (UN-HABITAT, 2013; GOB, 2012).

18 The Atlantic Multi-decadal Oscillation (AMO) is a north Atlantic sea surface temperature signal that influences decadal scale variability in Caribbean precipitation. In its positive phase, the AMO preconditions the Caribbean for wetter than normal conditions, and vice versa.

23 Includes the institutional population (2,513) and estimated undercount (49,115). Tabulable population totals 226,193, which is used in subsequent statistics.

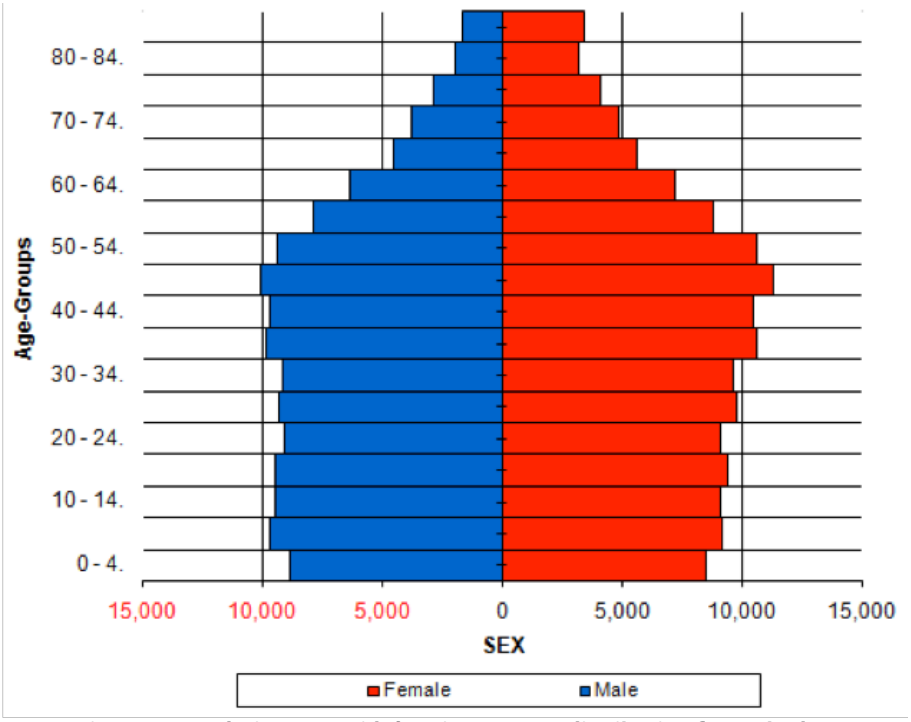


Figure 2: Population pyramid showing age-sex distribution for Barbados (Source: Barbados Statistical Service, 2010)

Table 2: Population distribution of Barbados by age cohort and sex, reflecting youth dependent (orange), productive (green) and elderly dependent (blue) segments (Source data: Barbados Statistical Service, 2012)

Age cohort/years	Number of males	Number of females	Total population
Under 5	7,307	6,955	14,262
5-9	7,974	7,517	15,491
10-14	7,761	7,482	15,243
15-19	7,752	7,715	15,467
20-24	7,357	7,459	14,816
25-29	7,515	7,992	15,507
30-34	7,374	7,902	15,276
35-39	8,023	8,718	16,741
40-44	7,871	8,573	16,444
45-49	8,163	9,253	17,416
50-54	7,657	8,698	16,355
55-59	6,420	7,166	13,586
60-64	5,162	5,862	10,986
65-69	3,674	4,582	8,256
70-74	3,069	3,912	6,981
75-79	2,290	3,262	5,552
80-84	1,572	2,486	4,058
85 and over	1,282	2,474	3,756
Total	108,223	117,970	226,193

Barbados has been able to control its rate of population growth through the successful implementation of a family planning programme since the 1950s, which has seen birth rates reduce from 34.1 per 1000 in 1955 to 12.2 per 1000 in 2010 (BFPA, n.d.; PAHO, 2012). This, coupled with economic development, has also contributed to the attainment of an average rate of growth of 0.3% between 1980 and 2008, which has led to a situation where the country has a population growth rate comparable with that of most developed countries. However, being in such an advanced stage of demographic transition has implications for the decline of the size of the working population relative to the dependent population.

Table 3: Rates of population change for Barbados (Source: GOB, 2010)

	Birth rate per 1000	Infant mortality rate per 1000	Death rate per 1000
1990-1999	13.03	12.1	8.04
2000-2008	13.50	14.0	8.63

Moreover, this trend has significant implications for the planning and delivery of health care services, reflecting a rapidly ageing population that places demands on service delivery, particularly for chronic non-communicable diseases (CNCDs) and rehabilitative services (PAHO, 2008).

CNCDs are the main causes of mortality and morbidity (see Figure 3), creating an associated burden on the economy and palliative care. Confirmed by a 2007 population-based survey of chronic disease risk factors, the 2000 Barbados Food Consumption and Anthropometric Surveys (BFCAS) revealed that the prevalence of overweight and obesity among adult Barbadians to be 55.8% in men and 63.8% in women. Among young adults (18-29 years), the prevalence of overweight and obesity was nearly 30% in young men and over 50% in young women. The 2007 Barbados Behaviour Risk Factor Survey (BBRFS) revealed an increase in these statistics, where 65.2% of the over 25 population was overweight or obese; of the male population 54.6% were overweight, and 74.3% in the female population (PAHO, 2008; PAHO, 2012).

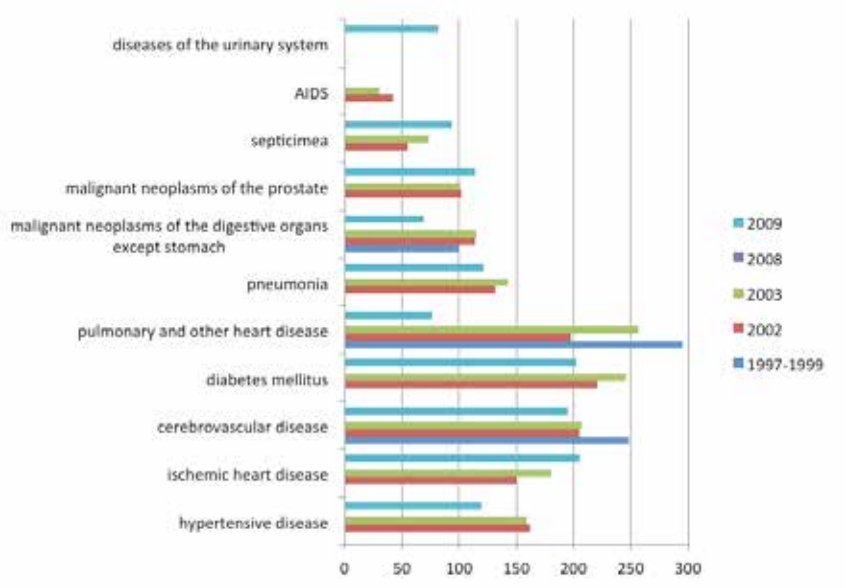


Figure 3: Leading causes of death in Barbados by year (Source data: PAHO, 2007; PAHO, 2012)

According to the BFCAS, 24.2% of men and 37.5% of women stated that they were diagnosed with one or more chronic diseases; for respondents over age 50, the prevalence was 39% in men and 69% in women. In the 2007 BBRFS, about 44% of the population reported having at least 3 risk factors for chronic disease. Further, patients affected by chronic, stabilised or incurable diseases represented 30% of admissions to the Queen Elizabeth Hospital (QEH). The Ministry of Health noted that the population affected by chronic diseases placed increased burden on the acute services at the QEH, and estimates that by 2030, 86.3% of all deaths will be caused by CNCDs (PAHO, 2007; PAHO, 2008; PAHO, 2012).

Barbados continues to attract migrants from other CARICOM countries and further afield in search of better economic opportunities and improved living conditions; some enter illegally. Census data reveal that the migrant population represents 14.5% of the population, of which 45.1% are from CARICOM (BSS, 2010). The increasing population places a strain on limited social, economic and environmental resources. Conversely, like many developing countries with a well-educated and skilled workforce, Barbados has been experiencing human capital flight ('brain drain') as skilled professionals, particularly teachers and medical professionals, seek career opportunities in overseas job markets. The government is faced with the challenge of delivering quality education and health care with significant skills loss in these critical sectors (Inniss, 2007).

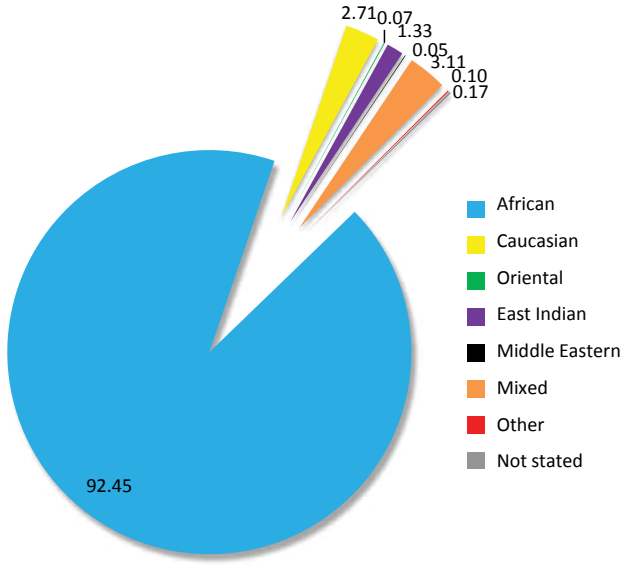


Figure 4: Ethnic composition as percentage of Barbados' population (Source data: Barbados Statistical Service, 2010)

Barbados' socioeconomic development has been marked by increased demand for land for urban and suburban development, and declining area under agriculture. Around 44% of the population lives in urban areas, with an urbanisation rate of 1.07% (see Table 4 and Figure 5). The majority of the population is settled along the southeast, south and west coasts of the island, predominantly in the coastal areas of the parishes of St. Michael, southern St. Peter, St. James, Christ Church, and St. Philip (see Figure 10). These would also be associated with the capital city, Bridgetown in St Michael, with a population of 122,000, and respectively the regional urban centres of Speightstown, Holetown, Oistins and Six Roads. It is believed that the suburbanisation from the Bridgetown area will continue, particularly in the suburban centres of Wildey and Warrens which have seen rapid expansion over the last decade, leading to the gradual increase in densities to the northwest, north and east of Bridgetown, while most other areas will remain relatively constant. Barbados is among the most densely populated countries in the world with a density of 637 persons per km2 (UN-HABITAT, 2013; GOB, 2010).

Table 4: Distribution of rural and urban populations in Barbados
(Source data: UNHABITAT, 2013)

	Estimates and projections				Rate of change (%)		
	2000	2010	2020	2030	2000-2010	2010-2020	2020-2030
Urban (population '000)	103	120	136	149	1.57	1.27	0.92
Rural (population '000)	165	153	143	131	-0.73	-0.72	-0.83
Level of urbanisation (%)	38.3	43.9	48.8	53.2	1.35	1.07	0.85

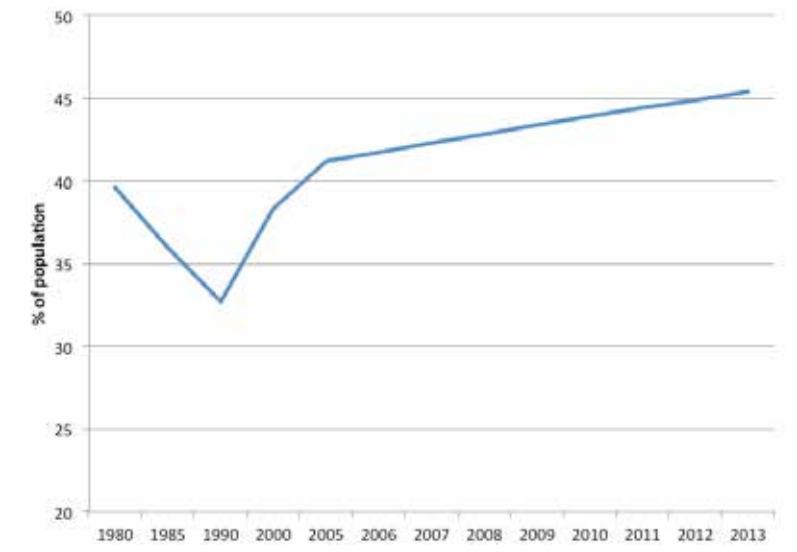


Figure 5: Percentage of population residing in urban areas in Barbados
(Source: UNDP, 2014)

3.2.2 Economic growth and performance

The economy has transitioned to largely service-oriented from being largely agricultural in the 1950s. In addition, it has made the transition to an 'innovation driven' economy as defined by the World Economic Forum. While the services sector, led by tourism, international business and financial services, was the main driver of economic growth, such growth was modest by comparative standards – approximately 3% per annum over the 1995-2010 period (CDB and GOB, 2012).

This shift has also seen a change in the composition of the labour force, with agriculture declining in popularity, particularly among the youth, and as educational attainment has increased there has been more interest in the services, retail and financial sectors, shown in Figure 6 (for data disaggregated by age and sex, please see BSS, 2012 pp.223-227).

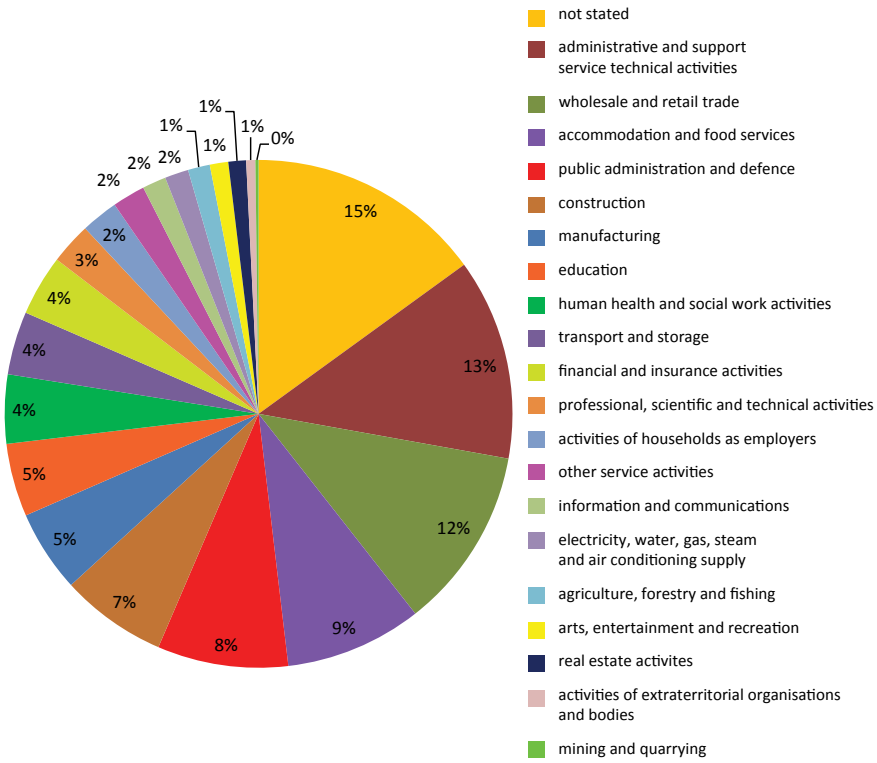


Figure 6: Employed population aged 15 years and over, by industrial group (Source data: Barbados Statistical Service, 2012)

In 2012, four sectors of the economy contributed to the bulk of real GDP: finance and business services, tourism, government services and transport, storage and communications (GOB, 2012). Barbados experienced steady growth in real GDP over a 6-year period commencing in 2002. However, GDP growth stagnated in 2008 with the onset of the global economic crisis and has since contracted with decreased global output. The economy has contracted by an average of 0.6% annually since then. Growth is closely correlated with that of the UK, and this tourism source market has not recovered from the sharp decline in 2009. Additionally, there is evidence of public sector arrears accumulation, with estimates ranging between 2-7% of GDP (IMF, 2014).

The real GDP growth rate[24] in Barbados contracted sharply in 2009 to -4.1% due to the world economic crisis, compared to 5.7% in 2006 and 0.3% in 2008, but recovered to 0.3% in 2010. The provisional figure for 2013 is 0.2% and estimated for the first half of 2014 at 0.0% (CBB, 2014b) shown in Figure 7.

24 Defined as the monetary value of all the finished goods and services produced within a country's borders in a specific time period, though GDP is usually calculated on an annual basis. It includes all of private and public consumption, government outlays, investments and exports less imports that occur within a defined territory.

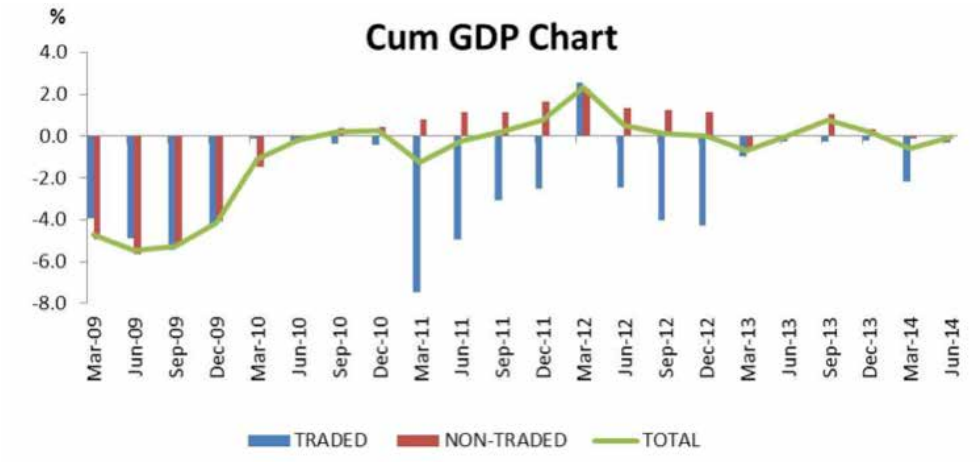


Figure 7: Barbados real GDP growth by quarter for March 2009 to June 2014 (Source: Central Bank of Barbados)

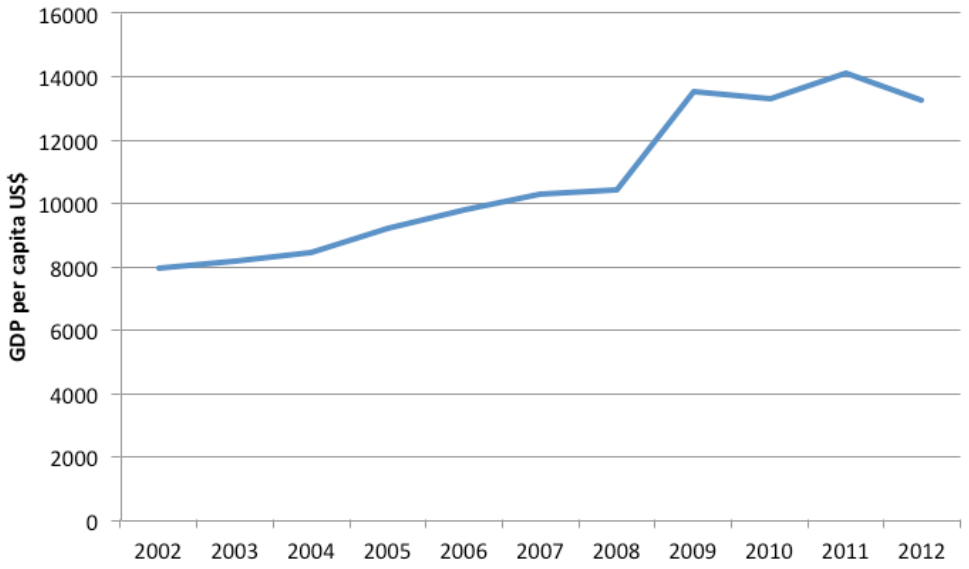


Figure 8: Change in Barbados GDP per capita at factor cost in US$ (Source data: Ministry of Finance and Economic Affairs – Barbados Economic and Social Reports 2002-2012)

Economic activity is estimated to have fallen by 0.4% during the first quarter of 2014, a smaller contraction than the 1.2% in 2013, and close to the average of the previous five years of the economic slowdown (CBB, 2014a), shown in Figure 7. Offshore finance and information services are important foreign exchange earners and thrive from having the same time zone as eastern US financial centres and a relatively highly educated workforce. The government continues its efforts to reduce unemployment, to encourage direct foreign investment, and to explore opportunities for privatising select state-owned enterprises. Latest census data indicates that around 1% of the labour force works in agriculture, 19% in other industry and 53% in services, as shown in Figure 6 (BSS, 2012).

Escalating fiscal and external imbalances prohibit a major fiscal stimulus to temper the impact of the global financial crisis on the national economy. Prevailing weaknesses in the local business climate are

increasingly exposed by the loss of trade preferences abroad and regional market liberalisation; high energy costs exacerbate these problems (IDB, 2009). In an effort to address its fiscal challenges, the government embarked on a new 18-month fiscal consolidation programme in 2013 which included a mix of new taxes as well as expenditure reduction plans. The goal was to reduce the fiscal imbalance from the 11% recorded in 2013 to 6% for the 2014/15 fiscal year. In all, tax measures are expected to contribute to $200 million of extra revenue, about 2.3% of GDP. The remaining 3.0% of fiscal consolidation is expected to be achieved mainly via expenditure cuts (CBB, 2014a).

As a result of the widening fiscal deficit, the net public sector debt to GDP ratio increased from 66.8% in 2013 (provisional) to 72.9% at June 2014 (108.8% gross), while net government debt moved from 80.4% to 83.9%. Central government gross debt has risen sharply since 2009, largely due to slowdowns in tourism and the offshore banking sector as well as rising debt service requirements which resulted in significant reductions in corporate tax receipts and greater interest payments, respectively.

This debt-to-GDP ratio has climbed from under 50% in 2006 to 97.7% at the end of June 2014; including government securities held by the NIS, it increased from about 80% in 2009 to 128% in 2013. Provisional figures for the 2013/2014 year indicate that interest payments absorbed 28.8% of revenues, and the fiscal deficit stood at -12.4% of GDP, compared to 8.8% for 2012/2013 (CBB, 2014b; IMF, 2014).

The economy is not expected to grow significantly in 2014, but a gradual, sustainable recovery, driven by the foreign exchange sectors, is expected to begin in 2015 and 2016. Forecast growth rates are less than 0.3% for 2014, 1.2% for 2015 and 2.5% in 2016. A major growth factor is expected to be investment in tourism and infrastructure and other financial inflows totalling $4.5 billion over the next 3 years (CBB, 2014a, 2014b).

3.2.3 Poverty and unemployment

Surveys calculate the indigence line[25], poverty line[26] and vulnerability line[27] at US$1,985, US$3,930 and US$4,913 per capita annual income respectively. The poverty rate for female-headed households is 19.4%, as compared to 11.5% for male-headed. In terms of geographical distribution, the Greater Bridgetown, Outer Urban and North and East strata have an above average population that is poor. In looking specifically at the youth category (15-24 years of age), the poverty rate is 23% as compared to 15% for those over 24 years of age (CDB and GOB, 2012).

The average unemployment rate for March 2013 to March 2014 was 11.7%, compared with 11.6% in 2012, and 8.7% in 2006. The inflation rate for the 12 months ending in April 2014 was 1.7%, well below the 6.3% averaged in the corresponding periods since 2008 (CBB, 2014a, 2014b). Data for 2008-2014 are shown in Figure 9.

Table 5: Main poverty indicators for Barbados (Source: CDB and GOB, 2012)

Variable	Non-poor households	Poor households
Household size	2.7	3.7
% headed by females	47.0	62.2
Overcrowding %	3.0	11.0
Unemployment rate %	8.9	25.9

25 Equivalent to the annual minimum cost food basket (MCFB) which is the minimum monetary requirement to meet basic nutritional needs for different demographic groups

26 MCFB plus the minimum monetary requirement to meet non-food costs for the basic needs of an individual.

27 An arbitrary amount used to indicate the level of vulnerability to poverty; usually expressed as 125% of the poverty line.

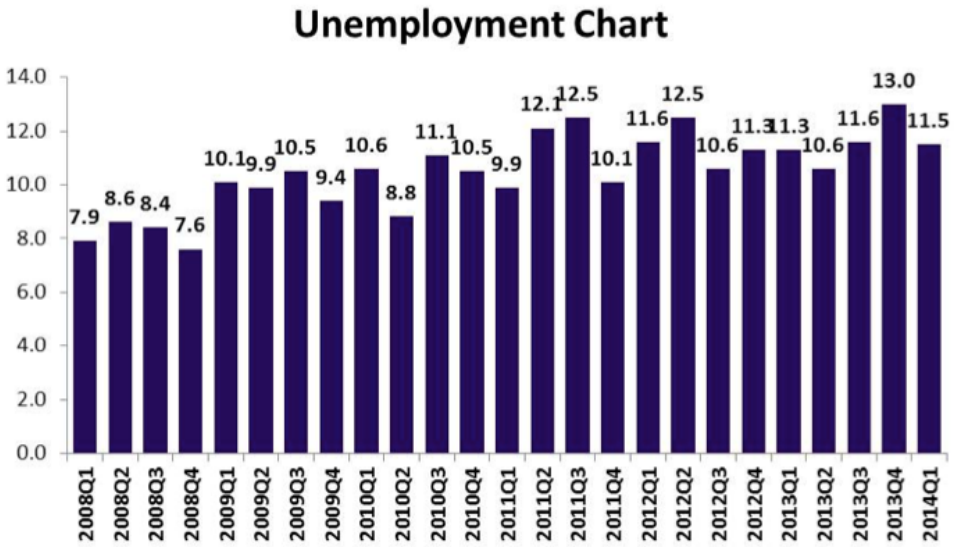


Figure 9: Quarterly unemployment rates for 2008-2014 (Source: Central Bank of Barbados)

3.2.4 Most vulnerable groups

Persons with disabilities

The disabled community constitutes 5.1% of the population. The distribution of these is shown in Figure 10, and the types of disabilities in Figure 11.

There are a number of NGOs which advocate for and cater to the needs of persons with disabilities (PWD), as well as a number of government agencies, including the National Disabilities Unit, established in 1997, and the Barbados Council for the Disabled and its 19 affiliate organisations. The Council, originating in 1976, has as its key objectives:

- To keep under review the work being done for the handicapped and to promote action for the rehabilitation of handicapped persons
- To formulate programmes and to cooperate with all appropriate governmental agencies, regional and international, with regard to the rehabilitation, education, training, employment and welfare of the handicapped
- To foster collaboration between organisations of and for the handicapped and to promote activities for the benefit of such organisations (Barbados Council for the Disabled, n.d.)

Government's annual subvention to the Council increased from US$3,500 in 1997 to US$52,500 in 2000, as the Council continues to strengthen its collaboration with the National Disabilities Unit and the responsible Ministry of Social Care, Constituency Empowerment and Community Development.

The White Paper on Persons with Disabilities[28] among its principles speaks to issues of education, accessibility and transportation, health care and rehabilitation, equal opportunities and non-discrimination, inter alia, however there is no mention of concerns relating to disaster or emergency situations.

28 http://www.barbadosdisabled.org.bb/docs/white_paper_pwd.pdf

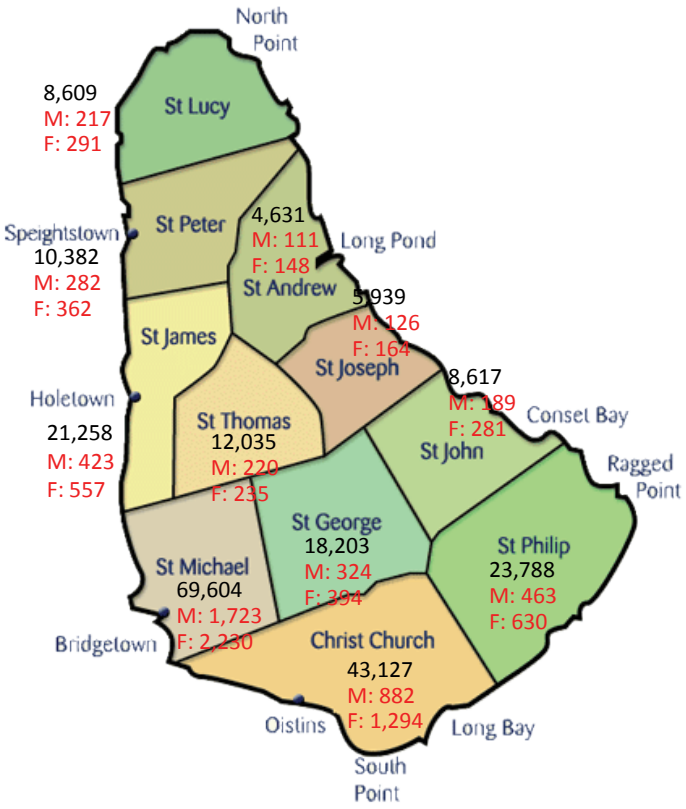


Figure 10: Population distribution by parish (black) and disabled population (red) disaggregated by sex (M/F) (Source data: Barbados Statistical Service, 2012)

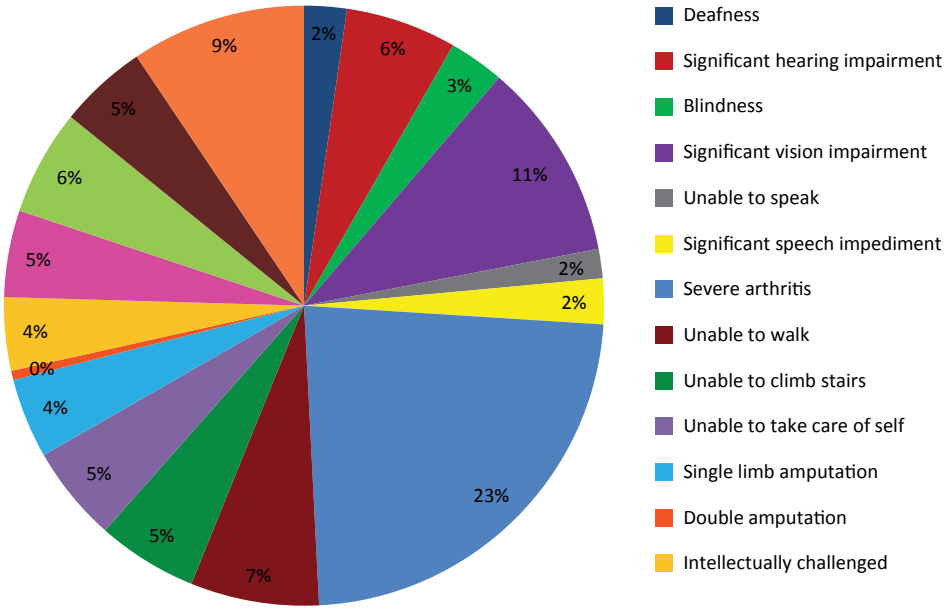


Figure 11: Population with disability or major impairment by type (Source data: Barbados Statistical Service, 2012)

The poor

There are a number of interconnected issues specifically related to poverty, vulnerability and social and familial exclusion. The 2010 Country Assessment of Living Conditions (CALC) (CDB and GOB, 2012) revealed that in relation to the labour market, poor households experience higher levels of unemployment and employment in low-paying or part-time jobs (underemployment). Moreover, poor households demonstrated high dependency ratios where earners were outnumbered by non-earners in the household. These high levels of dependency lead to lower per capita income and expenditure, but also increase the burden of care which further curtails participation in the labour market and in education. This is especially the case for female-headed households, which have a greater number of children to care for as opposed to adult non-earners.

Surveys discovered that among the contributors to poor living conditions and to poverty were 'coming from a poor family', high fertility rates, large numbers of children and lack of support from children's fathers, unemployment and low wages, lack of education, and disability. Several respondents also indicated that the recent recession and the high cost of living, especially the cost of food and of high utility bills, were having a serious negative effect on their living conditions, on their ability to meet their basic needs, and to sustain their livelihoods. Compounding this, living in poor conditions and living in poverty have devastating effects on health, on relationships, on treatment by others in relation to social and familial exclusion, and on self-esteem. Many stressed the serious psychological and emotional damage experienced, including stress, anxiety, frustration, helplessness, depression, and powerlessness.

Following an analysis of the causes of these characteristics of poverty in Barbados, five main issues emerged, namely: a lack of desire to work; a lack of qualification/skills; a lack of opportunities in the labour market; a disproportionate burden of care; and stigma and discrimination (CDB and GOB, 2012).

The homeless have as yet to be accounted for as a distinct group within the disaster management social policy framework, there are some NGOs that are currently developing and implementing programmes targeting this vulnerable group (DEM, 2013).

Children

Disasters and environmental degradation impact children's rights to adequate health, standard of living, education, and protection from violence, abuse and exploitation. Environmental threats such as natural hazards and climate change are expected to negatively impact children and their families with regard to:

- Lost or lowered family earnings in the fisheries, agricultural and tourism sectors
    - Crop failure and the potential effect on nutrition from delayed rains and drought
    - Reduced abundance and diversity of fish and implications for nutrition from rise in sea temperatures
    - Inability to access food and medicines
- Freshwater shortages from drought and changed spatial distribution of rainfall
- Susceptibility to injury or drowning
- Increased vector and water-borne diseases; children typically have weaker immune systems than adults
- Loss of learning time during emergencies while schools are being used as shelters
    - Reduced education opportunities and impact on life choices

- Potential environmental displacement of families in low-lying coastal areas (the majority of the population lives within 1.5km of the coastline)
    - Adjustment to displacement, migration, separation from parents and friends
    - Loss of community, change/loss of identity
- Lack of attention to rights and needs of children in emergency plans and policies
- Rising incidence of conflict fuelled by displaced populations facing shortages in essential items like food and water (O'Garro, 2009; CARICOM, 2008)

Children generally also have less developed coping capacities to manage the stress of traumatic situations they may face in a disaster situation. They would also have lesser abilities to escape a dangerous situation, or even to discern a perilous situation or behaviours.

Globally, there have been initiatives to encourage the active participation of children (under 18s) in efforts to prevent, prepare for, cope with, and adapt to climate change and extreme events. Such approaches emphasise children's ability to engage in DRR activities in their homes, schools and communities, whilst learning about disasters and climate change. They also acknowledge children's role in communicating risks to their peers and relatives, and provide practical and creative ideas to help their families and communities recover from disasters (Back et al, 2009).

The elderly

With improvements in health care, Barbados has an ageing population. This is evidenced by the increase in age of the largest cohort, from 25-29 years in 1990 to 35-39 in 2000 and 45-49 in the 2010 census; a decreasing proportion represented by the 0-15 age group; an increasing life expectancy, currently at 75.4 years (UNDP, 2013); and the most centenarians per capita in the world after Japan (Best, 2005). This high dependency ratio is highlighted as a weakness in the National Strategic Plan (GOB, 2005). The sustainability of the National Insurance Scheme (NIS)[29] has therefore come into question. Pension reform has seen changes where the pensionable age will increase by 6 months every 4 years from January 2006 until it reaches 67 in 2018 (NIS, n.d.). It increased to 66.5 years on 1 January 2014 (NIS, 2014).

While mechanisms, services and benefits facilitated through the National Assistance Board, Ministry of Health, Barbados Association of Retired Persons (BARP) and other agencies are contributing to the overall care of the elderly, including transportation, health services and promotion of active and independent lifestyles, some key government entities clearly demonstrate a marked passivity of response to older persons' issues and it is evident that the full understanding of the implications of population ageing has not been fully absorbed. Gender and health care issues are not subject to the quality social analysis that would induce definitive changes in approach to policy and creativity in programming that responds effectively to male and female differential needs (Springer, 2012). However, neither the 2011 draft White Paper on Ageing nor the National Report on Ageing analysed the needs of the elderly with respect to emergencies or disasters, with exception of the Fire Safety Programme's smoke alarm installation initiative.

29 The social security scheme was set up in 1967 with contributors able to earn benefits in cases of illness, employment injury, disability, maternity leave, unemployment and retirement, inter alia. (NIS, n.d.b)

3.3 Governance structure

3.3.1 Political structure and organisation

Barbados is an independent sovereign state with a parliamentary democracy. Barbados possesses one of the oldest Parliaments and Constitutions in the Commonwealth, with the office of Governor and a Council introduced in 1627, and House of Assembly constituted in 1639. As a constitutional monarchy and a member of the Commonwealth, Barbados recognises Her Majesty Queen Elizabeth II as the Head of State, represented by the Governor General. The country has a bicameral legislature, comprising a House of Assembly and Senate. The social democratic party system is based on universal adult suffrage, with the right to vote at age 18, reduced in 1964 from 21 (The Barbados Parliament, n.d.).

Barbados is divided into 11 parishes and 30 political constituencies. The House of Assembly has 30 members of Parliament (MPs) publicly elected every five years, at a maximum. The Senate has 21 members appointed by the Governor General; 12 on the advice of the Prime Minister, 2 on that of the Leader of the Opposition and the remaining 7 at the Governor General's discretion. Both Houses debate all legislation; however, the House of Assembly may ultimately override the Senate's rejection of Bills, except those amending the Constitution (The Barbados Parliament, n.d.).

The Prime Minister, usually the leader of the majority party and an elected MP, is head of the Cabinet. The Cabinet is responsible for the general direction and control of government business, and initiation of government policies and programmes. The Governor General appoints other Ministers on the advice of the Prime Minister from either House, but they are not necessarily MPs.

The Supreme Court of Judicature consists of a High Court and a Court of Appeal. Judges are appointed by the Service Commissions for the Judicial and Legal Services. Caribbean Court of Justice (CCJ) is the highest court of appeal, based in Port of Spain, Trinidad and Tobago.

3.3.2 Local government and levels of decentralisation

There has been no local government system in Barbados since 1969. In April 1967, the Local Government Council system was dissolved and replaced by an interim Commissioner for local government. In September 1969 all local government services were transferred from the Commissioner to central government and statutory bodies such as the Sanitation and Cemeteries Board (now Sanitation Service Authority) and the Parks and Beaches Commission (now National Conservation Commission). Some structures exist for community consultation including a Youth Parliament, Constituency Councils and a Community Independence Secretariat.

Constituency Councils are comprised of community members selected from nominations from among themselves or community-based organisations. They serve to address issues of social isolation and economic deprivation, inter alia, through identifying priority needs of the constituency, building the capacity of local organisations, and executing priority programmes (Department of Constituency Empowerment, n.d.).

3.3.3 Coordination mechanisms between State and non-State actors

The national architecture for disaster management, which includes key government ministries, departments, the private sector, national, regional and international stakeholders, non-governmental organisations (NGOs) and the community, form the national platform for DRR through the multi-sectorial Emergency Management Advisory Council and its 15 Standing Committees. The CDM Strategy and Framework, including the national work programme, articulates the national disaster risk reduction agenda. Considerable progress has been

made with disaster risk reduction mainstreamed within the Tourism Sector and plans are afoot to achieve this in the agricultural and business sectors (DEM, 2011).

The National Mitigation Council has a framework for involvement of a wide cross section of stakeholders. The active Standing Committee on Coastal Hazards is working with these multi-stakeholders in disaster risk reduction initiatives to reduce hazards along the coast, such as tsunamis, storm surge, winter swells, erosion, sea level rise and oil spills. The DEM is working with the National Climate Change and Adaptation Focal Point and Steering Committee to prescribe climate-related DRR solutions to a myriad of key economic and social sectors.

3.4 Development context

3.4.1 Human development

Consistently ranked for many years as the highest in Latin America and the Caribbean according to the Human Development Index (HDI), Barbados is now second only to the Bahamas, with its HDI 0.776 (rank 59 of 187) in the 2014 report, down from 0.825 (rank 38) in the 2013 edition, classified as having high human development. This is reflected in the component indicators in Table 6 and the trend in Figure 12.

Table 6: Trends in Human Development Indices (HDI) and component indicators for Barbados (Sources: UNDP – Human Development Reports 2000-2014)

Year of HDR Publication	2014	2013	2011	2007	2005	2000
HDI (rank)	0.776 (59)	0.825 (38)	0.793 (47)	0.892 (31)	0.878 (30)	0.858 (30)
Inequality-adjusted HDI	...	...	...			
Gender inequality index (rank)	0.350 (66)	0.343 (51)	0.364 (65)			
Life expectancy at birth (years)	75.4	77.0	76.8	76.6	75.0	76.5
Mean years of schooling (years)	9.4	9.3	9.3			
Expected years of schooling	15.4	16.3	13.4			
GNP per capita (US$)	13,604	17,308	17,966	17,297	15,720	12,001

The HDI is an average measure of basic human development achievements in a country. Like all averages, the HDI masks inequality in the distribution of human development across the population at the country level. GDP per capita in particular is being increasingly criticised as an inadequate measure of development as it disregards issues of poverty, inequality, environmental degradation and special vulnerabilities such as in SIDS, yet continues to be the determinant of which countries are eligible for official development assistance (ODA). Since 2010 efforts have been made to augment the HDI with appended indices to evaluate the contexts of poverty or income inequality and gender inequality.

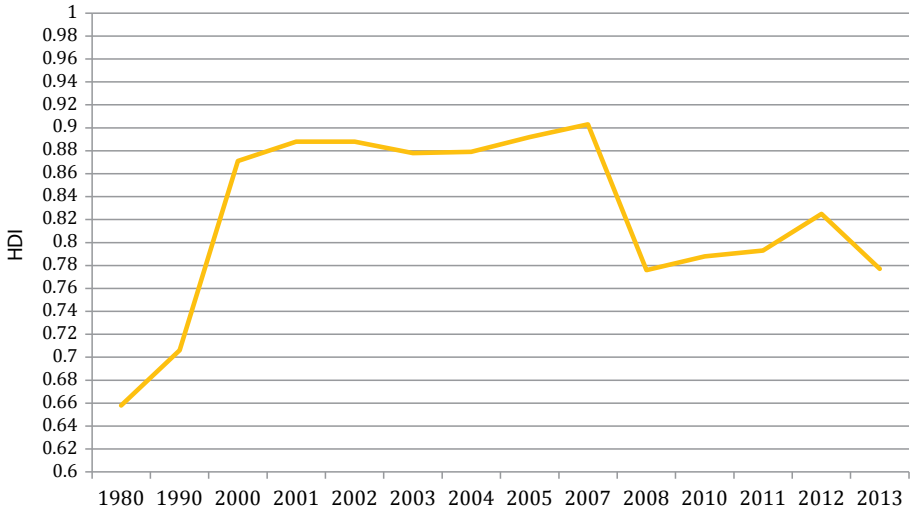


Figure 12: Progression of Barbados' Human Development Index (HDI) since 1980 (Source data: UNDP – Human Development Reports)

The Gender Inequality Index (GII) reflects gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity. Reproductive health is measured by maternal mortality and adolescent fertility rates; empowerment is measured by the share of parliamentary seats held by each gender and attainment at secondary and higher education by each gender; and economic activity is measured by the labour market participation rate for each gender.

Barbados has a GII value of 0.350, ranking it 66 of 187, a decrease from 0.364 in the 2011 index. In Barbados, 21.6% of parliamentary seats are held by women; and 89.5% of women over 25 years have attained a secondary or higher level of education compared to 87.6% of their male counterparts. For every 100,000 live births 51 women die from pregnancy-related causes and the adolescent fertility rate is 48.4 births per 1000 live births. Female participation in the labour market is 65.9% compared to 76.7% for men (UNDP, 2014).

The Inequality-adjusted HDI (IHDI) reflects how the HDI component indicators are distributed amongst the population. The difference between the IHDI and HDI characterise the loss of development due to inequality. For the 2014 report, insufficient data on all components was captured for Barbados to calculate an index, however the global results confirm that Latin America and the Caribbean suffers from the largest income disparities in the world (UNDP, 2014).

Box 2: Millennium Development Goals to be achieved by 2015

In terms of inequality in consumption, as measured by the Gini coefficient, Barbados demonstrates the second highest level of inequality in the Caribbean after Antigua and Barbuda. The Gini coefficient for Barbados stood at 0.47 while average Gini coefficient in the Caribbean is 0.38 (CDB, 2011), where a value of 0 represents perfect equality and 1 perfect inequality.

Barbados has achieved or surpassed many of the MDGs with universal access to education and health services, free access to HIV/AIDS antiretroviral treatment, and almost 100% access to clean drinking water and improved sanitation (Inniss, 2007). Deaths due to HIV/AIDS continue to decline and maternal health and infant survival are improving (PAHO, 2007; PAHO, 2012).

According to HDR data, public expenditure on education and health represented 7.5% (2012) and 7.7% (2011) of GDP (UNDP, 2014). The high level of investment by the government since independence to ensure free access to primary, secondary and tertiary education and to health care has led to the population's high literacy rate and a reputation for a highly-skilled workforce which has witnessed the evolution of the society into a service-driven economy. Figure 13 shows the educational attainment levels of the employed population, illustrating that 91% of males and 93% of females have completed secondary school or higher.

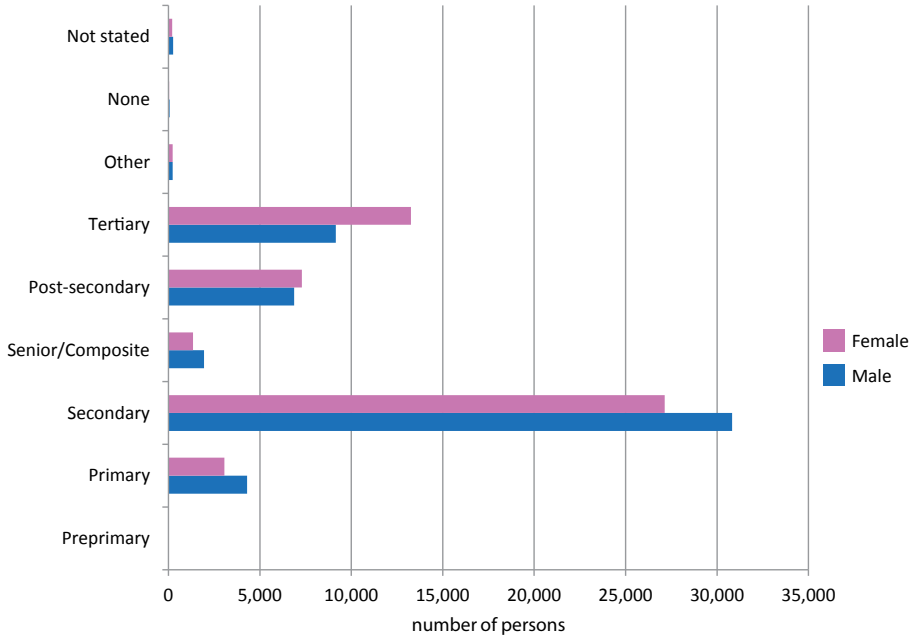


Figure 13: Employed population aged 15 years and over by sex and type of school attended (Source data: Barbados Statistical Service, 2012)

However, inefficient management of financial and staff resources, inadequate maintenance of facilities, lag in keeping the curriculum aligned with global business needs, ineffective or absence of sufficient monitoring mechanisms, and slow adaptation to different learning styles and teaching methods; coupled with the strains on the government purse from external factors have led to an increasingly untenable situation. Budget allocations to these sectors are dropping. For instance:

- Many students are leaving secondary school without qualifications, particularly boys
- Gaps in education, particularly in school-to-work transition and technical and vocational training, have led to unmet needs in the labour market and added to youth unemployment (IDB, 2009)

- The government owes the university in excess of US$100 million (Mascoll, 2014)
- University tuition fees have been introduced for local students and enrolments have subsequently declined for September 2014 by about 35% (Antigua Observer, 2014) leading to restructuring of the course offerings and staff complement
- School leavers unable to afford tertiary education and previously enrolled students unable to continue their programmes will add to the unemployment statistics
- Funding for the QEH was reduced by over US$17 million in 2013, after already operating at a deficit in the region of US$20 million for a number of preceding years
- The QEH has reduced capacity, only able to provide basic services and emergency surgeries due to critical shortages in essential supplies and equipment and indebtedness to pharmaceuticals suppliers (Bradshaw, 2014a)

Although the quality of life is relatively high for in Barbados on the basis of GDP per capita, its middle-income group is shrinking and lower-income groups facing increasing difficulties in a climate of unemployment, underemployment and higher taxation. Reducing accessibility of tertiary education, and even possibly health care, has implications for possible reversal of the trends in development progress if such conditions persist for a long time.

3.4.2 National development objectives

With a fragile resource base and an open economy characterised by a narrow range of exports and a heavy dependence on imported goods, Barbados like many SIDS is extremely vulnerable to external shocks. Volatile global prices, removal of preferential trade regimes and dependence on a tourism industry where competiveness is weakening impede the country's capacity to respond and adjust to those shocks.

Limited land size, a fragile marine ecosystem, and degraded terrestrial ecosystems help to induce susceptibility to invasive species, flooding, storm surge, soil erosion, inter alia. Threats to Barbados' environment have the potential to seriously harm the tourism sector, agriculture and food security.

The Caribbean has the second highest rate of infection of HIV/AIDS after Sub-Saharan Africa. Treatment of HIV/AIDS impacts the cost of health care, provision of social services and the strength of the labour force.

Crime and violence, linked to disparities of income and security, are also of concern and threaten socioeconomic stability. With the Caribbean being a major transhipment route for illicit drugs, there is an associated myriad of related crimes from petty theft to organised crime. Increased crime erodes investor confidence and slows economic growth.

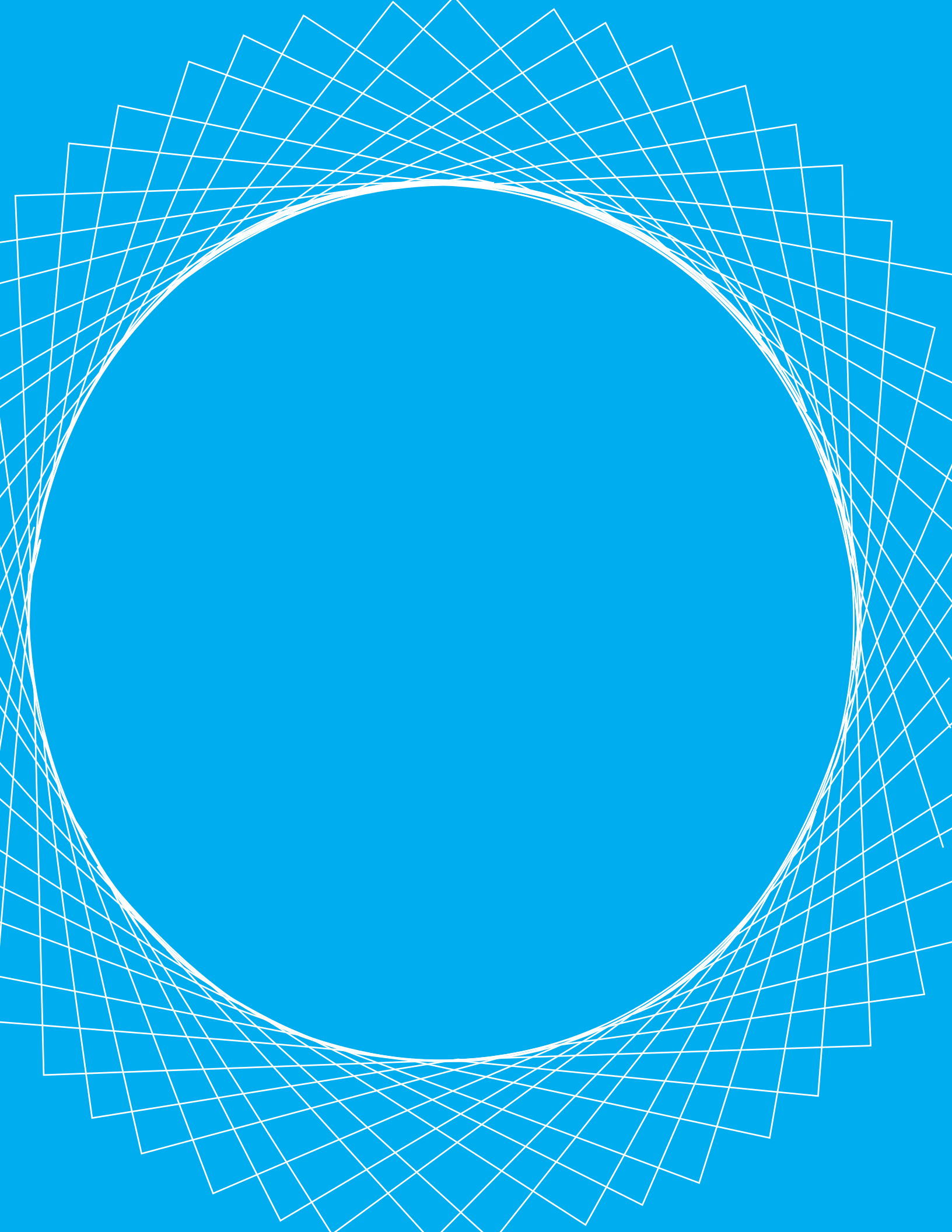
The overarching aim of the Barbados Sustainable Development Policy (NCSD, 2004) is "to ensure optimisation of the quality of life for every person by ensuring that economic growth and development does not occur to the detriment of our ecological environment". Within this framework there is consideration of multiple sectors and aspects in their contribution to the attainment of sustainable development, including health, poverty, consumption patterns, freshwater resources, coastal and marine protection, agriculture, fisheries, waste management, inter alia. With respect to disaster management, the policy advocates the use of post-disaster assessments, risk assessments, and environmental impact assessments (EIAs) and evaluation of potential disaster risk in the development control process. However, there are no defined indicators for measuring sustainable development with the document, although there was work done on developing such.

Similarly, the National Strategic Plan of Barbados 2005-2025 (NSP) defines the country's most serious vulnerabilities as:

- Exposure to hurricanes
- Limited land and natural resource base
- A fragile marine ecosystem
- Limited economic diversification and a high degree of economic openness
- High cost of infrastructural services relative to the population and the tax base

The goals as defined are:

1. Unleashing the spirit of the nation – a cultural transformation that will seek to create greater equity and social justice, while building an inclusive society with opportunities for all.
2. New governance for new times – greatly enhanced political participation and the empowerment of all communities, alongside an overhaul of the administrative machinery of government as a catalyst for change, while also strengthening civil society.
3. Building social capital – involves the development of the human resources necessary to function in a knowledge-based services economy, a revolution in education, a well-developed public health system and the eradication of poverty.
4. Strengthening the physical infrastructure and preserving the environment – requires protection, preservation and enhancement of the environment, infrastructure and scarce resources.
5. Enhancing prosperity and competitiveness – through transformation of economic activity to contribute to sustainable growth, employment and overall prosperity.
6. Branding Barbados globally – consolidation of the Barbadian image through political stability, education, democratic governance and good leadership.



4. Legal, Normative and Institutional Framework of the Country

4.1 Legal framework

4.1.1 The Constitution

In Chapter III of the Constitution of Barbados, section 25 "Time of emergency" speaks to the proclamation of a state of public emergency by the Governor General as a result of imminent war or occurrence of earthquake, hurricane, flood, fire, outbreak of pestilence or infectious disease, or other calamity. This declaration may remain in force for a maximum of six months unless it is extended or revoked at any time by a majority of the members of the House of Assembly.

Sections 13 (Protection of right to personal liberty) and 25 (Protection from discrimination on grounds of race, etc.) refer to reasonable measures for dealing with public emergencies that may supersede these rights. Section 16 (Protection from deprivation of property) assures that property or rights thereto shall not be compulsorily acquired except where the law makes provision for such due to danger posed to the health of humans, plants or animals, or for the conservation of natural resources.

4.1.2 Laws and legally binding provisions

There are a range of legal instruments that contribute to the management of disaster risk in Barbados. While the Emergency Management Act is quite comprehensive, the laws governing the operation of other agencies that engage in disaster risk reduction activities e.g. the Town and Country Planning Act and the Health Services Act, do not speak directly to DRM or the relationship of the field to risk reduction. However, their articles designate authority to address matters of environmental protection, sanitation and land use control, for instance, which are key tools in applying preventive and corrective actions for the reduction of vulnerability and risk. DRM-specific legislation integrates responsibilities for coordination and response.

EMERGENCY MANAGEMENT ACT, CAP. 160A (2006-20) COMMENCEMENT 1 APRIL 2007

This Act provides for the effective organisation and management of disasters and other emergencies, and establishes the Emergency Management Advisory Council and the DEM. Under the Act, the Governor General is empowered to declare a disaster or other emergency by proclamation after he has been advised by the Prime Minister and after consultation with the Director of the DEM (Part VII).

The Act sets out guidelines for the functioning of Emergency Operations Centres (EOCs) and emergency shelters (Part IV); delimitation of vulnerable areas and categories of persons with provision for EIAs and hazard impact assessments and executed in conjunction with the Town and Country Planning Department (Part VI); and provisions for a national alert system (Part VII).

EMERGENCY POWERS ACT, CAP. 161 (2006-20) COMMENCEMENT 19 MARCH 1939

The purpose of this Act is to make exceptional provision for the protection of the community in cases of emergency. The Act empowers the Governor General to declare a state of public emergency by proclamation.

As long as a declaration is in force the Cabinet of Barbados is authorised to make orders relating to the public interest, e.g. to provide for the supply of food, water, light and fuel; maintaining transportation; taking possession or control of property; and paying compensation due to effects of an order. However, the Act still lacks Regulations for its effective enforcement.

PREVENTION OF FLOODS ACT, CAP. 235 (1998-39) COMMENCEMENT 12 NOVEMBER 1951

This Act provides for the execution of works necessary to prevent and control floods and inundations caused by excessive rains, high tides and low-lying lands. The Act also empowers the Minister responsible for Communications to declare flood areas, with maps delineating the boundaries. However in exercising his functions the Chief Technical Officer is required to have regard to the Coastal Zone Management Plan in accordance with the Coastal Zone Management Act, Cap 394. It also prevents the erection of buildings or planting of crops in a designated flood area without permission from the Minister.

TOWN AND COUNTRY PLANNING ACT, CAP 240 (2007-51) COMMENCEMENT 8 JULY 1968

Designed to regulate the orderly and progressive development of rural and urban lands, preserve and improve such, and control the use of land, the Act mandates the completion of a complete survey of the country and preparation of a development plan, which should be reassessed every 5 years. The Act makes provision for the submission of an EIA (rather, "require such information as [the Chief Town Planner] thinks fit) as a component of planning permission request, and further when a development is proposed for the coastal zone management area (Part IV s17(1)). Tree preservation orders may be issued in the interest of amenity or soil conservation (Part V s27).

HEALTH SERVICES ACT, CAP 44 (1999-18) COMMENCEMENT 1 SEPTEMBER 1969

For the promotion and preservation of the health of the country's inhabitants, the Act gives authority for the construction, repair and maintenance of sewers and sewerage disposal works. It gives remit for creation of regulations to ensure water quality, disposal of waste, control of vermin, maintaining sanitary conditions and preventing the incidence of disease, including food borne illness, inter alia. The Minister may compel works to be executed on any premises for the protection or in the interest of public health.

SOIL CONSERVATION (SCOTLAND DISTRICT) ACT, CAP 396 (1998-39) COMMENCEMENT 1 FEBRUARY 1959

Providing for the improvement and conservation of soil and prevention of deterioration or damage by erosion, including stormwater, the Act allows determination of eligible land uses, permissible crops and plants, protection of streams from their source and along their banks, and water control measures. A Soil Conservation Order also may prescribe restriction or ban of cultivation and methods of cultivation, and type, scale and modality of livestock rearing (Part III s7). However, failure to execute the Order by a land owner or occupier is punishable by a fine of $100. Implementation of the Act must have regard to the CZM Plan.

SHIPPING (OIL POLLUTION) ACT, CAP 296A (2001-58) COMMENCEMENT 12 MAY 1994

This Act serves to enable civil liability for maritime oil pollution and give effect to relevant international conventions pertaining to marine pollution. These include the 1978 Protocol of the 1973 amended International Convention for the Prevention of Pollution from Ships, 1976 and 1992 Protocols of the 1969 International

Convention on Civil Liability for Oil Pollution Damage, and the 1992 Protocol of the 1976 amended International Convention on the Establishment of an International Compensation Fund for Oil Pollution Damage. As such, where oil is discharged or escapes from a ship, the owner is liable for any damage, mitigation and remediation costs. Exemptions include if the incident was due to an act of war, insurrection or exceptional natural phenomenon or negligence on the part of the authority maintaining navigational aids. Ships entering or leaving the port or terminal must also have insurance in compliance with Article VII of the Liability Convention. Further, importers of oil and other persons shall make annual contributions to the International Compensation Fund.

MARINE POLLUTION CONTROL ACT, CAP 392A (1998-40) COMMENCEMENT 1 MAY 2000

This legislation aims to prevent, reduce and control pollution of the marine environment, regardless of source, including land-based, sea bed and dumping activities and airborne sources. The polluter pays principle is applied, whereby a polluter may be required to take mitigation measures to reduce concentrations of a pollutant below prohibited levels, or the EPD may execute such actions and charge the offender. Convicted offenders may be liable for up to US$200,000 in fines and 7 years imprisonment, in addition to an amount calculated to be equal to the financial gain that would have been made as a result of the commission of the offence. It applies to all waste disposal and discharges that can impact water quality, including inland disposal and marine outfalls. Thus, in its application, the Act may be used to regulate ambient water quality and non-point sources of pollution, as well as contribute to land use management and move towards a water catchment-based approach to environmental management. Regulations have not yet been enacted.

COASTAL ZONE MANAGEMENT ACT, CAP 394 (1998-39) COMMENCEMENT 1 MAY 2000

The CZM Act intends to facilitate the more effective management of the country's coastal resources, their conservation and enhancement. As it relates to disaster reduction or mitigation, the CZM Plan includes standards for EIAs for developments which may affect the coastal zone, and standards for other activities that may affect coastal resources such as removal of coral and seagrasses, dredging, and use of explosives and chemicals. The CZM Plan must also be taken into account in the exercising of functions under the Marine Pollution Control Act, Cap 392A.

ENVIRONMENTAL MANAGEMENT ACT

In draft for over a decade, the Bill describes strict regulation of use of ecosystems that form buffers against hazards. In providing for the management and sustainable use of natural resources, these include forestry and the coastal zone, as well as protection of water resources and wild animals, and against pollution. There is provision for the DEM to hold a seat on the Hazardous Substances Control Board to be created.

While it is not yet enacted, the Environmental Protection Department (EPD) implements its provisions, but does not have any legal authority to enforce or prosecute offenders. The EPD's authority is bound by the Health Services Act 1969, whose provisions are limited and outdated (Ramsay, 2012). The new Act has much stronger and appropriate penalties to encourage compliance.

OTHER LEGAL INSTRUMENTS

Several other pieces of legislation also work in coordination to give support to various standard operating procedures (SOPs) and national plans e.g. Fire Safety Act, Safety and Health at Work Act.

In terms of protecting public health from diseases transmitted by plants and animals, including zoonoses[30], and subsequent potential outbreaks, the mandates of the various departments of the Ministry of Agriculture are governed by over 30 pieces of legislation (some dating to the 1920s) and ensuing Regulations, including:

- Animals (Diseases and Importation) Act, Cap 253 and the Animals (Diseases and Importation) (Amendment) Act, 2014
    - Animals (Diseases) (Anthrax) Regulations, 1951
    - Animals (Diseases) (Epizootic Abortion) Regulations, 1951
    - Animals (Diseases) (Rabies) Regulations, 1951
    - Animals (Diseases) (Swine Fever) Regulations, 1951
    - Animals (Diseases) (Foot and Mouth) Regulations, 1952
    - Animals (Diseases and Importation Control) Regulations, 1961
    - Animals (Diseases and Importation Control) (Amendment) Regulations, 1991
    - Animals (Diseases) (Amblyomma variegatum, Heartwater and Dermatophilosis) (Prevention and Control), Regulations, 1994
    - Agricultural, Diagnostic and Other Services (Fees) Order, 1996
    - Animals (Diseases and Importation Control) (Amendment) Regulations, 1999
    - Animals (Diseases and Importation Control) (Amendment) (No.2) Regulations, 1999
- Dairy Industry (Regulations and Control) Act, Cap 260
- Cultivation of Trees Act, Cap 390
- Trees Preservation Act, Cap 397, 1981-49
- Livestock (Control of Strays) Act, Cap 139A, 1990-40
    - Livestock (Control of Strays) Regulations, 1992
- Prevention of Cruelty to Animals Act, 2000-16
- Plant Protection Act, 2007-53

These instruments empower Veterinary Officers and Plant Protection Officers to enter and inspect premises, quarantine suspected or infected organisms, conducting testing, and where necessary destroy such. They may declare quarantine zones or a phytosanitary emergency within the country and restrict movement of material. They also control the importation and exportation of organisms.

BUDGET APPROPRIATION AND EXECUTION

The Department of Emergency Management is financially supported by budgetary allocations from the central government. These monies from the Consolidated Fund are voted on by Parliament. Figure 14 shows the budgetary allocations for the past 5 years.

In addition to budgetary allocations to the DEM, the sum of US$5,000 is allocated annually to be divided among 30 District Emergency Organisations and US$5,000 per annum for the Roving Response Team. The

30 A zoonosis is any disease or infection that is naturally transmissible from vertebrate animals to humans and vice-versa

sum of US$25,000 per annum is also allocated for contingencies in case of an emergency, but as of 2013 is administered by the Ministry of Finance instead of the DEM.

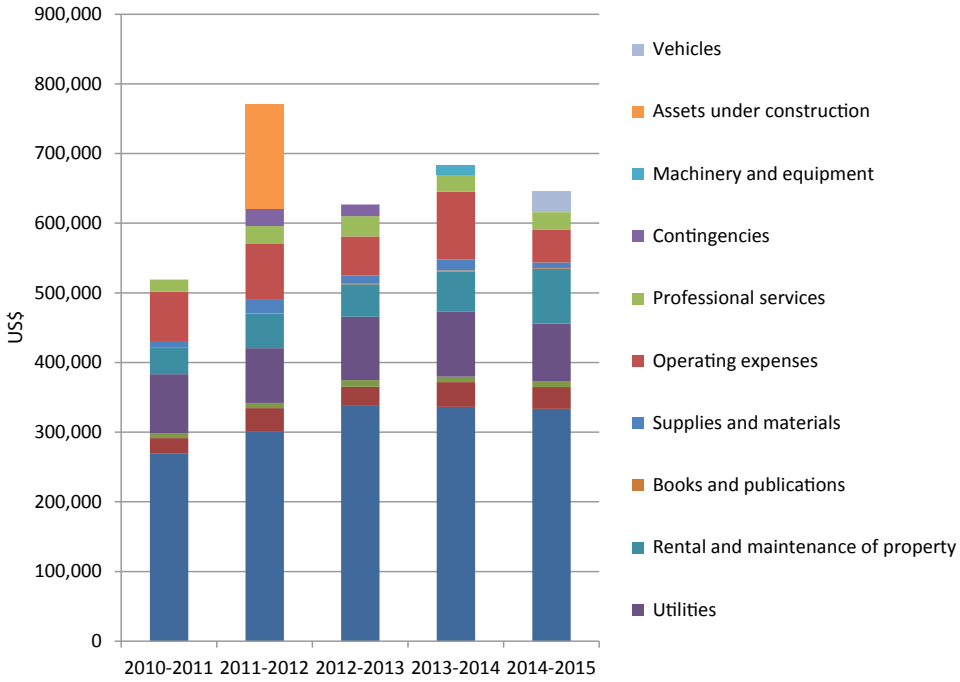


Figure 14: Annual budgets for the Department of Emergency Management as provided by central government to facilitate the execution of its national Comprehensive Disaster Management Strategy and Framework [*Note: not shown – contingency of US$8,525,000 due to Tropical Storm Tomás in 2010] (Source: DEM, Ministry of Home Affairs)

4.2 Regulatory Framework

4.2.1 Regulatory instruments for policy and technical decision-making on DRR

The structure of the national disaster management mechanism has facilitated the stimulation of interdisciplinary and inter-sector partnerships and supported the mainstreaming of risk management into the national planning process. This mechanism is fully described in section 3.3. Similar to the legal provisions, the regulatory system presents tools for decision making principally with the aim of avoiding or rectifying vulnerability and risk through e.g. land use zoning, construction guidelines, natural resource management and climate change adaptation.

PHYSICAL DEVELOPMENT PLAN

Land is a scare and extremely valuable commodity that must be carefully managed. As such, several competing sectors have to rationalise and prioritise its use. A land use policy that allows ad hoc change of use for competing sectors presents difficult and complex development planning challenges. Such policies very often retard sustainable development initiatives. The ideal situation should include balanced development that especially protects people´s aspirations and food security issues.

Since 1970, Barbados has developed a comprehensive land use policy – the Physical Development Plan (PDP). The PDP is a useful planning tool that seeks to create a direct link between national development and land resources by ensuring the allocation of adequate land to support economic development, social development and environment conservation, as depicted in Figure 15.

The Policy was most recently amended in 2003, and the process for revision is being initiated. Its main purposes are to:

- Foster the economic, environmental, physical and social wellbeing of residents
- Establish a vision to guide the future form of development with respect to land use and environmental management
- Guide the future form of development on the island and inform the public, business and government sectors as to the nature, scope and location of development
- Provide a guideline for other private and public works and actions, that impact the social, economic and environmental health of the nation

The land use policy framework captures the preservation and enhancement of Bridgetown as the capital and the regional centres of Speightstown, Holetown, Oistins and Six Roads, each with Community Plans. A consultation exercise is underway for development of a plan for the St David's to Six Roads corridor as it is in increasing demand, especially for change of land use designation from agricultural. Community Plans are also required to be developed for the suburban centres of Wildey and Warrens which have been focal areas of rapid commercial expansion in the last 15 years.

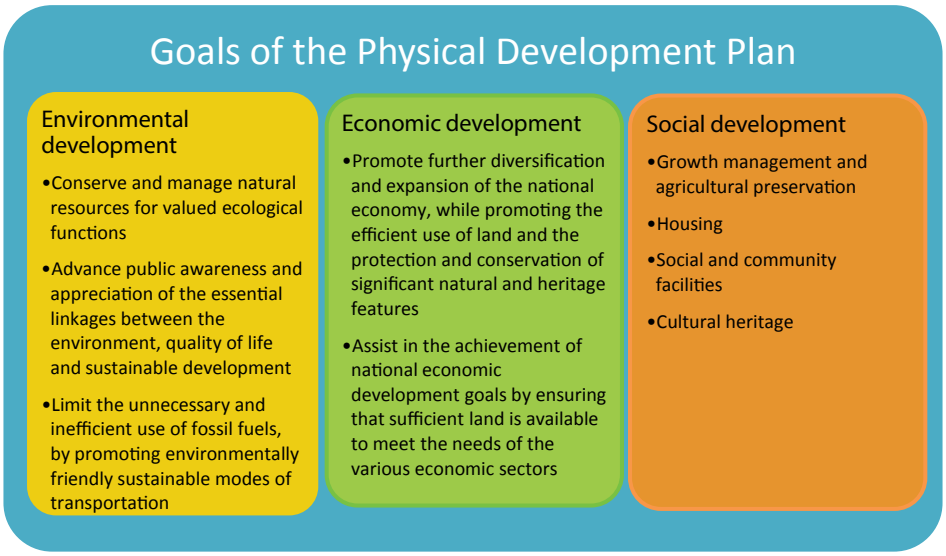


Figure 15: Goals of the Physical Development Plan (Amendment) 2003

Tourism has a special focus, with special reference to policies on Natural Heritage Conservation Areas, Coastal Landscape Protection Zones and National Forest Candidate Sites. All developments must adhere to the Integrated Coastal Zone Management Plan. New beach-oriented tourism will be directed primarily towards established corridors along the south and west coasts. EIAs are generally required for special industry, golf courses, resource extraction (e.g. quarrying, mining), and non-agricultural uses on agricultural land.

The PDP sets the framework for infrastructural development, and in conjunction with the use of setback requirements of the Integrated Coastal Zone Management Plan (30m from the high water mark) and building standards from the Building Code, also incorporates DRR strategies into the development control process. It is intended that the updated PDP (expected completion 2015) will explicitly consider the impacts of natural hazards and climate change.

WATER ZONING POLICY

The country's water zoning policy was established in 1963, revised 1973, for protection of water sources, based on travel time for pollutants, with decreasing stringency from Zone I to Zone V (see Figure 16). Enforcement is the joint responsibility of the Barbados Water Authority (BWA), the Ministry of Health, and the TCDPO. Water quality monitoring is conducted by the BWA and the Environmental Protection Department.

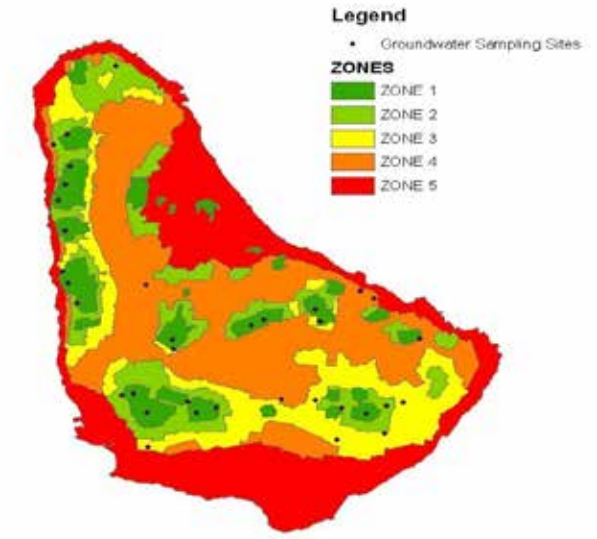


Figure 16: Groundwater zones and freshwater sources in Barbados (Source: Environmental Protection Department)

BARBADOS WATER AUTHORITY (WATER SERVICES) REGULATIONS

Since 1982, the regulations have been in place to complement the zoning protection with clear management capabilities. They facilitate the use of water conservation strategies, including temporary reduction of pressure in the distribution system, temporary shut downs and temporary pricing increases.

NATIONAL BUILDING CODE

The Barbados National Building Code (BNSI, 2013) establishes various technical requirements and standards governing the design and construction of buildings in Barbados, addressing issues relating to structural sufficiency and durability, fire safety, health and amenity. The effects of climate change in the region resulting in increased intensity of natural phenomena e.g. hurricanes, earthquakes and torrential rainfall, and the technological advancement in the industry with respect to building components and construction methods were the impetus for the updating of the document from 1993.

The Building Code incorporates a pre-emptive building control system to ensure compliance to the technical standards. It has not yet been incorporated into law, but it is expected that it will be implemented through the enactment of a proposed Building Control Act, which will empower the Building Standards Authority to execute its primary functions of the administration, interpretation and enforcement of the Building Code and the proposed Act. The Building Code does not affect the operation of any law concerning the use of public land, buildings, structures or roads.

Specifically relating to DRR, Part 5 on Structural Requirements includes the following provisions:

- Section 5.3 Structural stability and serviceability

A building shall be designed and constructed so that, taking into account the nature of the ground, the combined dead loads (i.e. weight of walls, permanent partitions, floors, roofs, ceilings and finishes including services and other permanent construction) and imposed loads. Wind loads (basic wind speed 208km/h in 3s gusts) and earthquake loads (CUBiC Part 2 Section 3: 1985) are sustained and transmitted to the ground. This shall be achieved without impairing the safety of any part of the building or causing such movement of the ground as shall impair the stability (i.e. shall not collapse – failure of one or more parts, subsidence, displacement, overturning or buckling) and serviceability of any part of the building or another building.

- Section 5.5 Roof covering

Where a roof covering is replaced by another of lighter weight the supporting roof structure of the building shall be assessed to determine its resistance to uplift resulting from a minimum basic wind speed of 208km/h; suitability to safely support the additional dead load and transmit it safely to the ground.

INTEGRATED COASTAL ZONE MANAGEMENT PLAN

Barbados, as a coastal state, relies heavily on its coastal zone for economic viability and the ICZMP gives consideration to the mitigation and prevention of disasters related to coastal hazards. It seeks compatibility between economic and environmental interests, through application of measures to avoid degradation of the coastal areas and reduce long term risk. In draft since 1998, it is applied through the Town and Country Planning Act and EIA procedures as a material consideration. It contains:

- Policies, strategies and standards for the development and maintenance of structures in the coastal zone management area
- Standards for water quality in coastal and marine areas
- EIA standards for developments which may affect the conservation and management of coastal resources
- Standards for the management of underwater parks and restricted areas
- Provisions for public access through and to the beach and other natural areas of the coastal zone

4.2.2 Public policy

COMPREHENSIVE DISASTER MANAGEMENT

Disaster management and disaster risk reduction strategies are integrated into the national development planning and approval process through the development and implementation of Comprehensive Disaster Management as the platform for disaster management in Barbados.

This policy makes provision for the integration of disaster risk reduction strategies and options into development planning which will lead to the reduction of disaster vulnerability and the ultimate attainment of Sustainable Development. In order to achieve sustainable development the following areas of activity have been identified:

- An enabling environment for CDM through a legislative framework,
- Promote proactive disaster management through risk reduction strategies and programs,
- Improve Barbados capacity to management emergencies or disasters and their consequences in a coordinated, effective and efficient manner,
- Promote integrated and coordinated disaster management actions through partnership with diverse stakeholders and the government,
- Harness the competencies and resources of the citizens of Barbados by providing a community disaster management program,
- Ensure adequate financial arrangements which will facilitate quick and effective preparedness, response and recovery efforts,
- Ensure that disaster recovery efforts are in accordance with prevention and mitigation strategies and options (DEM, 2010).

Emergency shelter policy

This draft policy is designed to define the context of the establishment, maintenance and provision of Emergency Shelters within the NEMS subject to available resources. This framework is established for the national arrangements to manage emergency shelter needs arising from the impact of hazards and expedite the rehabilitation of citizens that are rendered homeless by these hazard events. Such persons will be provided with temporary shelter, giving priority attention to vulnerable groups, particularly the physically and mentally challenged, the elderly and low-income groups.

NATIONAL SUSTAINABLE DEVELOPMENT POLICY

With respect to disaster management, the policy advocates the use of post-disaster assessments, risk assessments, and environmental impact assessments (EIAs) and evaluation of potential disaster risk in the development control process. The management of freshwater, coastal and marine resources, agriculture, fisheries and waste are also analysed as contributors to sustainable development. However, there are no defined indicators for measuring sustainable development with the document, although there was work done on developing such. Please also see section 2.4.2.

NATIONAL POLICY FRAMEWORK AND SECTORAL DIRECTIVES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION ACTIONS

Establishing a national process for adapting to GCC impacts and minimising GHG emissions, in the context of sustainable development, is the primary goal of this draft policy framework. Within the objective of establishing an appropriate mechanism for responding to climate change challenges, the policy recognises the need to improve overall capacities in the management of disaster risk and response. Its directives include

promoting research into GCC impacts which may affect human settlements e.g. coastal inundation, sea level rise, storm surge; undertaking climate hazard and vulnerability assessments; adjusting land use management, development control and disaster management plans based on risks in low-lying coastal areas; increasing awareness and thereby risk reduction.

This tool strongly summons the integration of various pieces of legislation and actors, including enactment of the Environmental Management Act, enforcing building codes, rolling out efficient water resource management policies, and critically incorporating GCC considerations into the national budgeting process. It further emphasises areas for capacity building and inter-agency coordination, research and centralised information sharing, and a multi-sector approach to DRM.

4.3 Institutional framework

4.3.1 Organisation of the national system and mechanisms at all levels

The National Emergency Management System (NEMS) is a broad-based multi-sector stakeholder mechanism coordinated by the Department of Emergency Management, displayed in Figure 17. It is made up of the Emergency Management Advisory Council (EMAC) and its Standing Committees, national emergency services, local volunteers, non-governmental (NGOs) and community-based organisations (CBOs), regional and international partners and the private sector.

According to the Emergency Management Act Part III s7(3), the functions of the EMAC, shown in Table 7 include recommendation of policies, programmes and activities to enhance the emergency management programme and reviewing the work of the Standing Committees with respect to their specialised areas.

Under the EMAC are 15 Standing Committees, outlined in Figure 18 and their membership in Annex II, which are organised by emergency response functions e.g. shelter, emergency telecommunications, public utilities, etc. They are chaired by selected members of the EMAC, who are technical heads of government agencies with responsibility for the execution of national disaster management policy and programmes in their respective areas of expertise (DEM, n.d.). In operation since 1 April 2007, it replaced the Central Emergency Relief Organisation (CERO) Secretariat which operated since the 1940s.

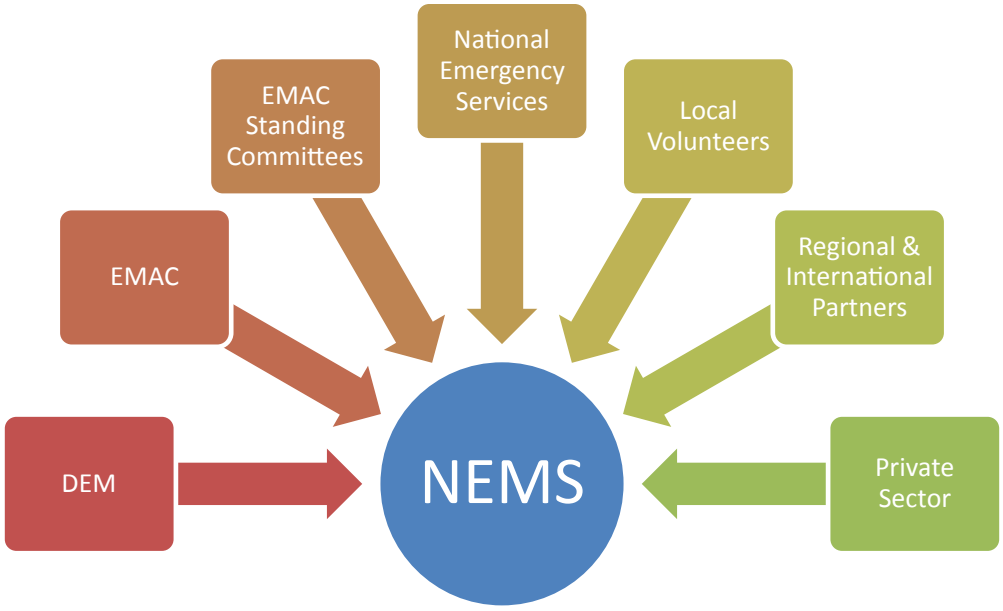


Figure 17: Construct of Barbados' National Emergency Management System (NEMS)

Table 7: Representative organisations of the Emergency Management Advisory Council (EMAC)

Barbados Defence Force
Barbados Fire Service
Royal Barbados Police Force
Prime Minister's Office
Ministry of Agriculture
Ministry of Health
Ministry of Home Affairs
Ministry of Tourism
Ministry of Transport and Works
Ministry of Education and Human Resource Development
Ministry of Environment, Water Resources and Drainage
Ministry of Social Care, Constituency Empowerment and Community Development
Town and Country Planning Development Office
Division of Energy and Telecommunications
Barbados Red Cross Society

District Emergency Organisations (DEOs) are the volunteer arm of the DEM, responsible for organising and coordinating community resources for an effective response in times of crisis. Their membership comes from the communities which they are intended to serve. There are 30 DEOs across the island, strategically within each of the 30 political constituencies. The DEO works with the community to develop and mobilise disaster prevention and preparedness programmes to reduce the impact of identified hazards (e.g. flood, hurricane, fire, earthquake, vehicular accidents). The body engages various groups within the community, including churches, service clubs, neighbourhood watches and NGOs, and individuals. There is close interaction with government agencies serving the communities, such as police and fire services (DEM, n.d.).

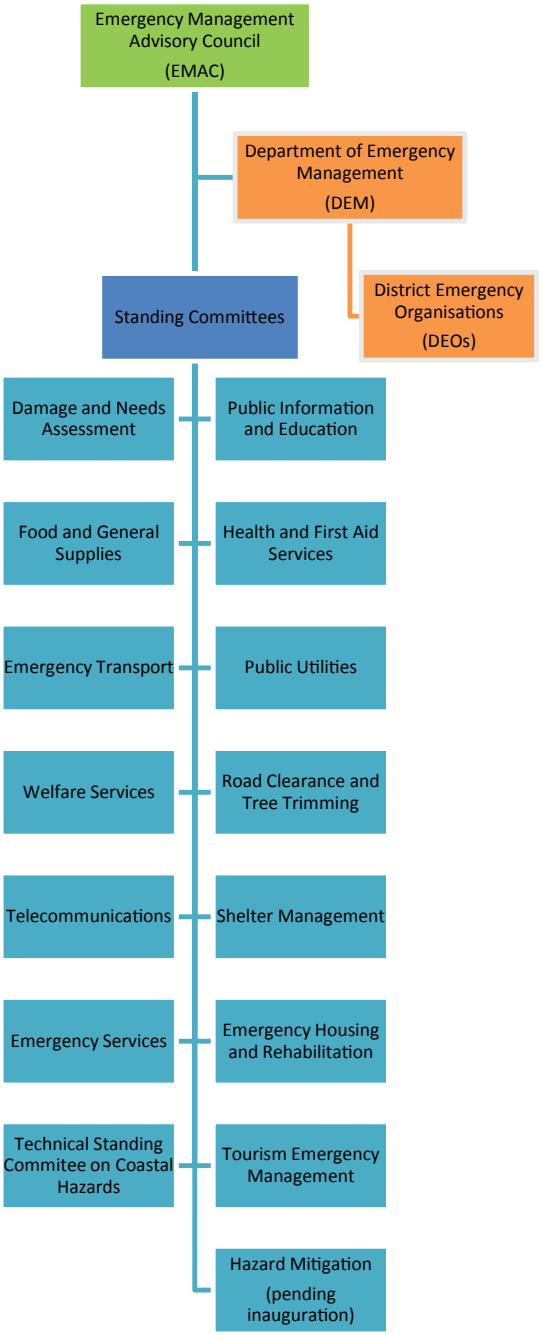


Figure 18: The Emergency Management Advisory Council (EMAC) and its Standing Committees

The Emergency Operation Centre (EOC) mechanism is fully established and functional, as legally required, and greater emphasis is now being placed on secondary satellite EOCs at the community levels for coordination and response. National search and rescue (SAR) teams have been established with appropriate training and exercising at the national and regional levels. Barbados also is part of the regional search and rescue teams and there is a national SAR plan and relevant SOPs.

With the Chief Shelter Warden, the Director of the DEM ensures the maintenance of the list of premises available and suitable for use as emergency shelters during or after an event. Emergency marine shelters for boats and other vessels are also maintained in consultation with the Chief Fisheries Officer.

Each Ministry and its departments and statutory bodies are required to prepare and submit an emergency management plan annually to the DEM and to have Liaison Officers to communicate with the Director of the DEM with respect to procedures and responsibilities in relation to the national Emergency Management Plan (EMP).

The Vulnerable Persons Committee is a multi-stakeholder group, chaired by the National Assistance Board (NAB), with membership including Barbados Council for the Disabled, the Welfare Department, the Child Care Board, DEM, the Royal Barbados Police Force (RBPF), and the hospitals. Its main function surrounds coordinating data on vulnerable persons (children, the elderly, persons with disabilities) to be able to provide assistance in case of emergency. In addition to providing training and public education, the Committee also reviews and updates the Evacuation of Vulnerable Persons Plan, conducts site visits to vulnerable areas and to Category 1 shelters, as well as advocates for accessible shelters.

Scientific and technical agencies

The Caribbean Institute for Meteorology and Hydrology (CIMH) works to support its Member States in improving the capacity of their meteorological and hydrological services, through training, research, specialised services and technical advice. CIMH manages a number of decision-support tools on behalf of the region, including the DEWETRA Platform, Drought Monitor[31] and Precipitation Outlook[32].

Among its most recent initiatives is to address the lack of accurate and consistent climate data and information in the region to understand climate changes, predict impacts, and respond strategically at local, national and regional levels identified in USAID's Rapid Climate Change Vulnerability Assessment (2013). To this end, with the support of USAID, CIMH will establish and house a Regional Climate Centre to provide tailored climate and weather services to support DRR and GCC adaptation; improve data collection for monitoring and forecasting; and build capacities to access, analyse and use climate data to better inform decision-making (USAID, 2014).

Civil society

The Barbados Red Cross Society has been a long-standing partner in public education and humanitarian response, incorporated by the Barbados Red Cross Society Act 1969-35. Dedicated to serving communities, the national society also draws its membership from the community to reach those who are particularly vulnerable. The organisation's Strategy 2020 has 3 aims:

- Save lives, protect livelihoods and strengthen recovery from disasters and crises
- Enable healthy and safe living
- Social inclusion and a culture of non-violence and peace

The St John's Ambulance Association generally provides first aid training and emergency response, typically as a complement to the QEH ambulance service.

31 Caribbean Drought and Precipitation Monitoring Network http://63.175.159.26/~cdpmn/cdpmn.html
32 Precipitation Outlook http://www.cimh.edu.bb/?p=precipoutlook

The Amateur Radio Society of Barbados and Barbados Citizens Band Radio Association are volunteer groups which support emergency telecommunication through transmission via ham radio and UHF radio.

Private sector

Private sector partners are engaged principally through the Standing Committees of their specialisation and form important relationships with the DEM. These include the broadcast agencies for early warning and public awareness, the telecommunications companies for early warning and emergency communications, and the electric utility to ensure rapid restoration of service to maintain critical services such as the hospital.

Regional and international partners

The Caribbean Disaster Management Agency (CDEMA) is CARICOM's regional coordinating body for disaster risk management. Among Its functions are:

- Mobilising and coordinating disaster relief
- Mitigating or eliminating, as far as practicable, the immediate consequences of disasters in Participating States
- Providing immediate and coordinated response by means of emergency disaster relief to any affected Participating State
- Securing, coordinating and providing to interested inter-governmental and nongovernmental organisations reliable and comprehensive information on disasters affecting any Participating State
- Encouraging the adoption of disaster loss reduction and mitigation policies and practices at the national and regional level; cooperative arrangements and mechanisms to facilitate the development of a culture of disaster loss reduction
- Coordinating the establishment, enhancement and maintenance of adequate emergency disaster response capabilities among the Participating States (CDEMA, n.d.a)

CDEMA forms an important of the DRR network as a key instrument for strategic visioning for CDM in the region, capacity building, and partnership formation. A significant portion of CDEMA's assistance comes through externally-funded projects. Often Participating States argue that the projects take an overly singular approach and produce much documentation, but at the same time some of the outputs are quite applicable, such as the model Hazard Mitigation Policy and Emergency Shelter Management Policy.

The Eastern Caribbean Development Partners Group (ECDPG) was established to provide a forum for information sharing among donors and development partners, and to make strategic decisions regarding programme development and coordination. Its objective is to facilitate an effective, timely and coordinated response operation, in the event of a rapid onset emergency and request from an affected Member State and in support of the existing regional mechanism (CDEMA, n.d.b). The partners are able to coordinate their collective humanitarian response as well as supporting the Regional Security System in its response, and post-disaster assessments. The United Nations Resident Coordinator sits as Chair and CDEMA as Co-Chair. Members include the UN System (e.g. UNDP, UNICEF, PAHO), Caribbean Development Bank (CDB), IFRC, USAID/Office of US Foreign Disaster Assistance (OFDA) and the UK Department for International Development (DFID).

Since 1974, the CDB has been responding to requests from its Borrowing Member Countries (BMCs) for assistance with post-disaster rehabilitation. The Disaster Management Strategy and Operational Guidelines (CDB, 2009) outlines the process for assistance to BMCs for disaster risk management and climate change

adaptation, with the overall goal of contributing to sustainable development and poverty reduction by reducing the burdens caused by disasters.

4.3.2 National plans and their implementation

NATIONAL STRATEGIC PLAN 2005-2025

Objective 4.5 of the National Strategic Plan specifically aims "to improve disaster management" and incorporates the goals of CDM as key indicators of national development. Its approach includes development of a national multi-hazard plan, instituting a comprehensive building code, and developing policies for managing mass crowd events. However, unlike all the others, Goals 4 and 6 have no indicators to measure progress towards the targets. Please also see section 3.4.2.

DISASTER MANAGEMENT PLANS

In 2003, the Barbados government embraced the Comprehensive Disaster Management (CDM) Strategy. This strategy represented a deliberate attempt by the CDEMA Participating States to holistically incorporate all phases of the disaster management cycle (prevention, mitigation, preparedness and response, recovery and rehabilitation) while focusing on promoting and accelerating disaster risk reduction initiatives.

The Director of the DEM is mandated to prepare an annual Emergency Management Plan as stipulated by the Emergency Management Act Part III s9, which itemises, inter alia:

- Preparedness and response for persons and organisations legally mandated to perform functions related to emergency management
- Notifying the public in case of a threatened or existing hazard or emergency
- Preparation and maintenance of supplies and services for mitigation, response and recovery
- Protection and restoration of communications
- Provision of shelter for persons during or after a disaster or emergency
- Evacuation protocols
- Protection of life and property from looting and riotous behaviour in the aftermath of an emergency

There are several specific national, departmental and sector plans, including:

- National Mass Casualty Plan
- National Mass Crowd Plan (being updated)
- National Search and Rescue Plan
- National Oil Spill Contingency Plan (revised 2013)
- National Hazardous Material Plan
- National Influenza Pandemic Preparedness Plan
- Dangerous Infectious Diseases Plan

Figure 19 displays a comprehensive list of the DRR plans in Barbados. These all have appropriate sub-plans that include all of the Emergency Response Functions (ERFs) including evacuation, shelter and medical services.

Action has been initiated to develop community-based plans but these have not yet been fully developed. A National Evacuation Plan is in draft awaiting the scientific data to highlight the likely inundation lines to inform the coastal evacuation process. National capacity exists for the assessment of national readiness to face adverse events and this is done prior to the start of the annual Atlantic hurricane season.

The Mass Crowd Policy and Plan are in the process of revision, with changes including: inclusion of events within Barbados' territorial waters; approval being required from the Mass Crowd Planning Subcommittee through the RBPF; triggering of the NEMS by the Incident Commander on site; and an event may be postponed or cancelled due to expected adverse weather. A mass casualty incident is defined by at least 12 persons requiring medical attention and/or which disrupts normal delivery of health care services. A mass crowd event no longer focuses solely on numbers of persons, but the requirements for contingencies, preparedness and mitigation of potential impacts on participants and the community. Mass casualty management training is an additional requirement.

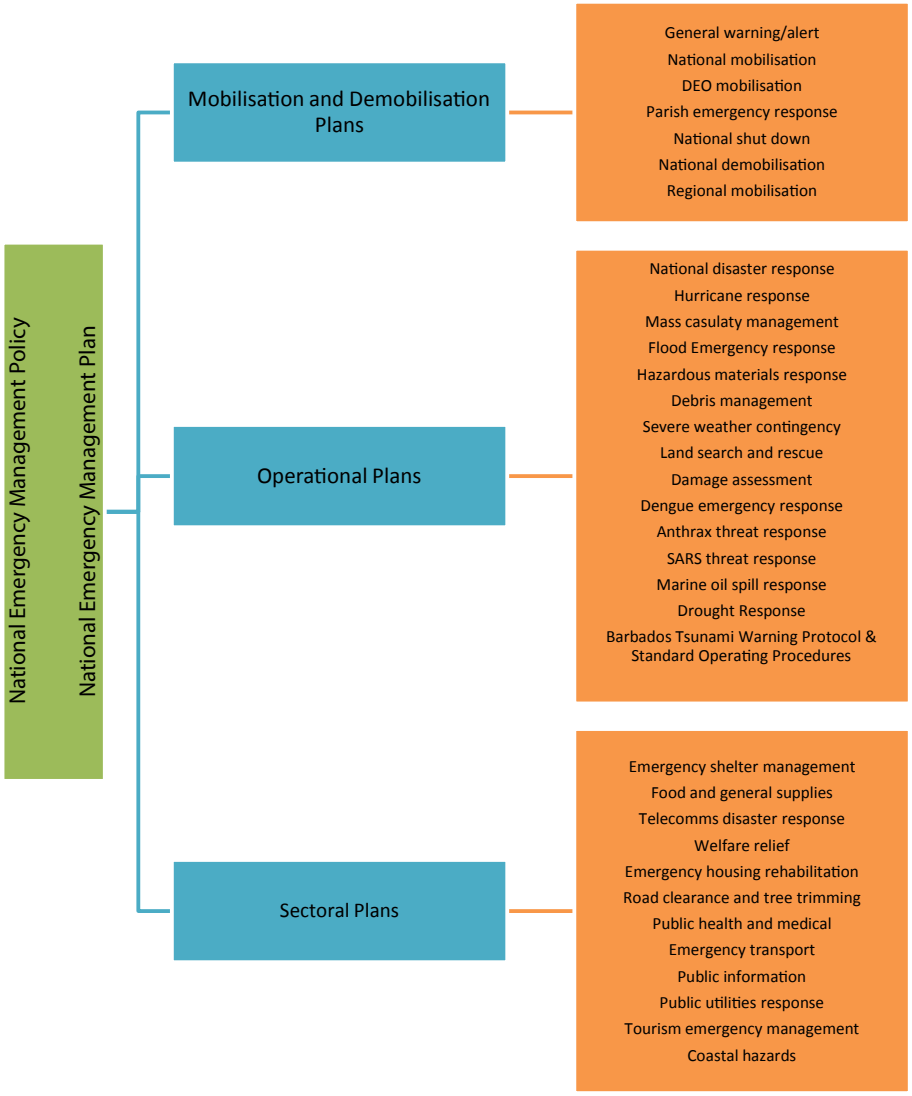


Figure 19: Emergency management planning structure for Barbados

The Management Plan for Historic Bridgetown and its Garrison (2011) holds as one of its strategic objectives the development of appropriate risk responses and availability of efficient emergency services. Within this context the UNESCO World Heritage Site relies on the existing legal framework for disaster management and land development regulation. The risks identified to the management of the site include meteorological, coastal and seismic hazards, fire, climate change, development and social pressures, and environmental and security threats. Section 3 contains a detailed risk assessment for natural and anthropogenic risk factors, and Section 4G articulates the Action Plan for Risk Management.

According to legislation, government agencies are required to submit annual Disaster Plans to the DEM. Below shows the most recent submissions:

Table 8: Government agencies submitting annual disaster plans to the Department of Emergency Management

Year of most recent submission	Submitting agency
2014	Drainage Division Ministry of Transport and Works
2013	Town and Country Development Planning Office Office of Public Sector Reform
2012	Ministry of Home Affairs Barbados Drug Service Starcom network (private broadcasting company)
2011	University of the West Indies Ministry of Education and Human Resources

Liaison Officers are designated within the public and private sectors and the requirement is for plans and SOPs to be developed, updated and shared with the DEM on an annual basis. Training has been developed for these Liaison Officers throughout the sectors. In addition, the DEM conducts Plan Development training workshops on an annual basis for all sectors.

DROUGHT MANAGEMENT PLANS

The National Water Conservation Plan examines long-term and temporary approaches to managing the resource, summarised in Table 9.

Table 9: Measures for management of water resources as defined in the National Water Conservation Plan (Source: http://www.unccd-prais.com/Uploads/GetReportPdf/5f04d645-897c-4557-b71c-a0fa014a4adc)

Long-term strategy	Emergency actions
Distribution system • Reduction of leakage in the distribution system • Reduction of pressure in the distribution system	• Temporary pressure reductions • Temporary shut-down of parts (or all) of the system on a rotational basis • Temporary increases in the second and subsequent tariff blocks • Temporary licence restrictions on private abstractions • Voluntary reduction appeals
Consumer level • Universal metering • Pricing and tariff structure • Low water use fittings 'rebate' • Educational programmes and information dissemination • Rainwater catchments	

An Emergency Drought Management Plan was approved by the Planning and Priorities Committee in 1997. It identifies parameters that would be used to monitor, forecast and predict the impact of drought, such as precipitation, groundwater measurements, and salinity and weather data, and reservoir levels. It seeks to define the conditions under which a drought-induced water supply emergency exists and to specify the response actions. Consequently, the BWA is seeking to establish a rain gauge network to supplement the existing network so that estimation could be made on the impact and variation of rainfall (GOB, 2004).

The Sustainable Water Management Strategy and Action Plan, articulated until 2016, provides for the comprehensive management of water resources through a series of strategies in the areas of demand management, supply management and augmentation, institutional capacity building, and legislation.

REGIONAL RESPONSE

Barbados, as part of the Regional Response Mechanism (RRM), is also the CDEMA Central Sub-regional Focal Point (SRFP) for the Eastern Caribbean with response responsibility for the countries of St Vincent and the Grenadines, Saint Lucia and the Commonwealth of Dominica. A regional model SRFP Protocol has been developed by CDEMA and Barbados is in the process of adapting it. One of the responsibilities of the SRFP is to maintain a regional warehouse which houses emergency relief supplies ready for dispatch to an affected country in the sub-region, although there are national warehouses in each country (DEM, 2010).

Summary

Commendably, the NEMS encompasses a broad array of stakeholders which have important voices in the execution of disaster mitigation, preparedness and response. The needs of vulnerable groups appear to be adequately represented through the membership of the Vulnerable Persons Committee, although a comprehensive database of the constituents served by this group is needed. The National Disabilities Unit started such for PWDs since its establishment but it has since never been updated due to lack of technical personnel. Missing is a role for the youth and women. Overall, the special needs of these groups in relation to vulnerability and disasters e.g. in awareness and preparedness, emergency shelter situations, post-disaster recovery and access to education and employment, seem to be overlooked within the policy and planning framework.

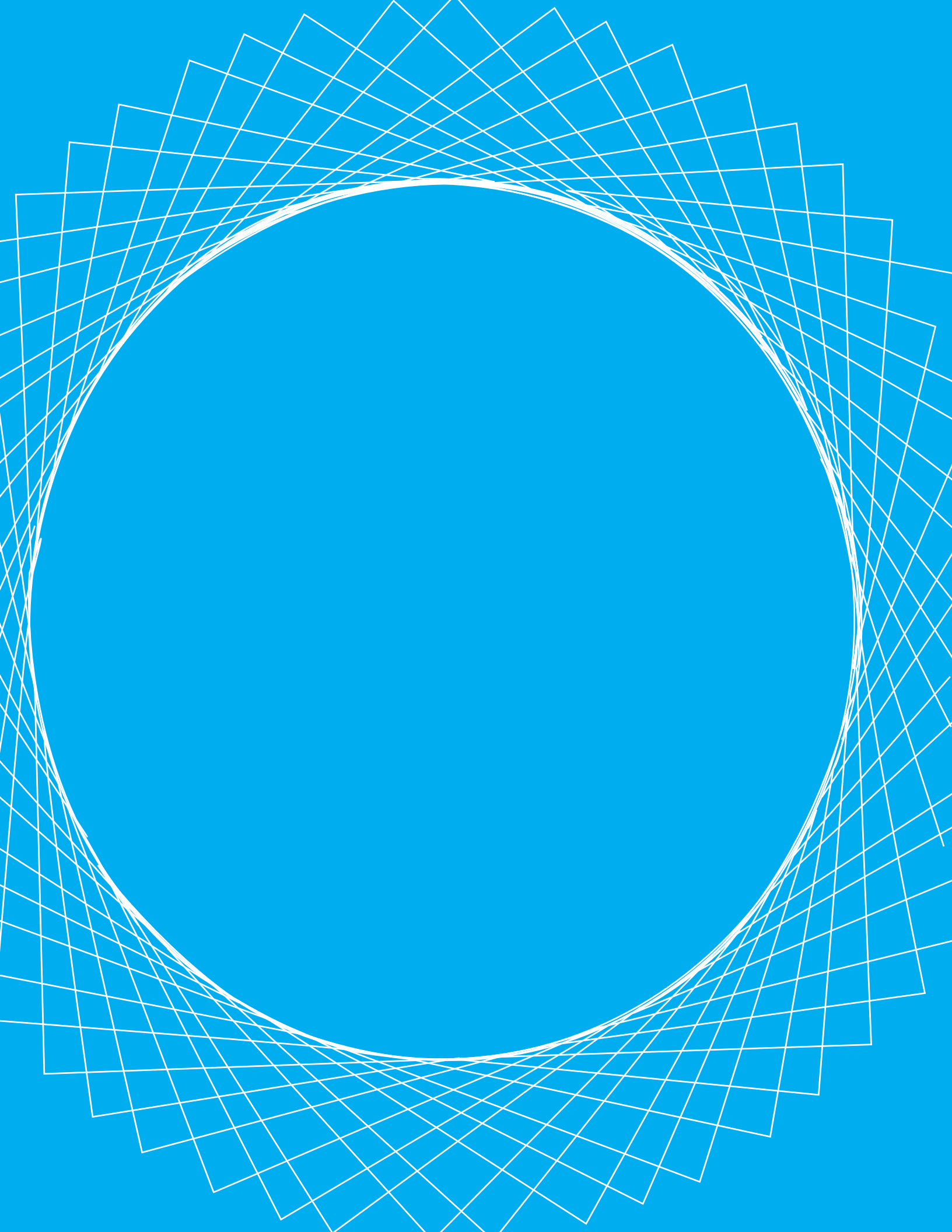
Further, the NEMS does not include key sectors besides tourism. While inclusion of every sector within the Standing Committee structure will make it more cumbersome than at present, a mechanism needs to be found to replicate the excellent level of engagement and integration that the tourism sector has found. While the legal requirement for every Ministry, department, etc to complete annual disaster plans exists, the effectiveness of such is limited, as seen in Table 8.

Likewise, the normative framework captures the work of many agencies in various sectors which contribute to risk reduction. Nevertheless, the most glaring problem facing the legal and regulatory framework of Barbados is the number of instruments that remain not promulgated. This makes any adherence to regulations voluntary and obviates any power of the regulatory authorities to enforce or prosecute. Thus this in itself represents a substantial contribution to the perpetuation and creation of vulnerability.

The Emergency Management Act is sound with respect to its coverage of disaster response, duties and powers of the DEM Director and disaster management personnel, and provisions relating to vulnerable areas and public participation. However, the Act does not yet have Regulations, which would among others clarify and

govern the roles and responsibilities of the actors in the DRR system. A review of the legislation was conducted and recommendations for updating the Act were submitted to the EMAC in March 2014, which are under review.

The budget allocated to the DEM from central government is dedicated to its administration and operations, revealed in Figure 14. Other departments within the NEMS also receive central government resources to execute these functions; however there is no easily discernible data on the specific allocations to DRR or investments that clearly play a role in reducing risk. Inability to quantify this contribution prevents the economic measurement of the value of investment in DRM, which can be important in attracting private investment or attracting donor funds.



5. The State of Disaster Risk

5.1 Historic analysis of disasters

Barbados is exposed to a wide range of natural and anthropogenic hazards[33], with a high level of risk[34] exposure. As a SIDS, with small size, a densely populated low-lying coastal zone and an undiversified tourism-based economy, these hazards typically put a large proportion of produced capital at risk and often affect the entire territory and economy. Barbados has the potential to be impacted by meteorological, geological and biological hazards.

Tables 10 and 11 capture some of the historical impacts of natural hazards in Barbados, and Annex III a more comprehensive list. Noting that hazard monitoring and reporting would be incomplete, especially for drought and localised flood and landslide events, return periods may have higher frequency than shown.

Table 10: Summary of hazard events in Barbados since 1670 by type (Sources: Barbados Meteorological Service; Boruff, 2006)

Hazard Type	Time Period	Events	Return Period
Flooding	1886-2000	34	3.35
Drought	1946-2009	22	2.86
Tropical systems	1786-2010	20	11.20
Earthquake (and felt shocks)	1670-2014	10	34.40
Landslide	1901-2000	8	12.38
Tsunami	1751-2000	7	35.57

The most recent significant impact from a meteorological event at a national scale occurred in 2010 when Tropical Storm Tomás passed just to the south of Barbados. According to data from OFDA/CRED International Disaster Database, the greatest historical disasters that have affected Barbados in the last decades have been principally storms and floods.

Table 11: Historic hazard impacts in Barbados (Sources: EM-DAT http://www.emdat.be/; USAID, 1972; Lashley, 2010)

Date	Hazard	Lives lost	Persons affected	Economic losses US$'000	Main sectors affected
Aug 1949	Flood	41			
Sept 1955	Hurricane Janet (Cat 3)	38	29,000 8,000 homes		Housing
Oct 1970	Floods	3	200	500	Infrastructure (roads, bridges), fishing, agriculture (soil erosion), electricity, communication

Date	Hazard	Lives lost	Persons affected	Economic losses US$'000	Main sectors affected
Jul 1980	Hurricane Allen (Cat 3)		5,007	6,000	Fishing, poultry, housing
Nov 1984	Floods		100	2,000	Infrastructure
Sept 1987	Tropical Storm (Emily)		230	100,000	
Aug 1995	Floods	1		5,000	
Sept 2002	Storm		2,000	200	
Sept 2004	Tropical Storm (Ivan)	1	880 531 homes	5,000	Coastal erosion, housing
Nov 2007	Earthquake 7.4	0	1		
Oct 2010	Tropical Storm (Tomás)		2,500	37,000	Housing, electricity, water

While loss of lives in disasters is decreasing, risk exposure and economic loss are increasing, especially due to small scale highly frequent events (UNISDR, 2011), as seen in Table 12; human development processes play a major role in the configuration of risk constructed by growth in socioeconomic exposure and gaps in development.

Table 12: Summary impacts of hazard events in Barbados during 1980-2010 as captured by EM-DAT[35]

Number of events	9
Number of people killed	1
Number of people affected	10,718
Average affected annually	346
Economic damage (US$'000)	106,700
Economic damage annually (US$'000)	3,442

The last major hurricane to have struck Barbados directly was Hurricane Janet in 1955. It originated 600km to the east of Barbados, passing 24-32km south of the island as a Category 3 hurricane, affecting Grenada and then moving along the Caribbean Sea where it reached its maximum Category, 5. Janet caused 38 deaths, damaged or destroyed over 8,000 homes and left 29,000 persons homeless, but the cost of damages was not quantified (Lashley, 2010).

It should be noted that: the hurricane took a very unusual track, veering from a northern trajectory to dip WSW; the country is much more populated than in 1955; and the value of exposed assets is significantly higher now, particularly along the west and south coasts, which were heavily battered by Janet. Moreover, a phase of above average hurricane activity is currently being experienced, with an average of 14 named storms per season since 1995 instead of 10. To illustrate, 1995 saw 19 named storms (11 hurricanes), 2005 had a record 28 (15 hurricanes), and 2008 experienced 16 (8 hurricanes) (Lashley, 2010; GIS, 2005).

35 For a disaster to be recorded by EM-DAT at least one of the following criteria must be fulfilled: 10 or more reported deaths, 100 or more persons reported affected, declaration of a state of emergency, or call for international assistance issued.

The flood of October 1970 was described as twice as great as that of 1949, and seven times the 1964 event, dumping 584mm of rain in 10 hours, compared to the annual average of 1524-1651mm. The reduced loss of life relative to 1949 was attributed to its occurrence during the day and the absence of high winds (USAID, 1972). The October 2010 floods saw one of the typically flood-prone areas, Chapman Lane in St Michael, affected as in 1970, again attributed to blocked drains (The Barbados Advocate, 2010).

There are less data available on the damage and losses caused by less severe, more frequent extensive hazard events such as flash floods, landslides and drought, the accumulation of which are believed to be more significant than the intensive events. While extensive events are globally responsible for only 13% of mortality, they result in 42% of economic losses. Environmental degradation, poverty and unplanned urban development exacerbate these risks. Low levels of investment in DRR and high average annual losses (AAL) would in the long term render a country less capable of absorbing losses from these extensive events (UNISDR, 2013).

Earthquakes and tsunamis are not as recurrent as hurricanes but could inflict significant damage to the island. On 29 November 2007, a 7.4 magnitude earthquake at a depth of 156km off the coast of Martinique was felt in Barbados. On 18 February, 2014 a 6.5 magnitude earthquake was recorded 172km NNE of Barbados at a depth of 14.8km, felt from Martinique to Grenada, and reported as the largest in the Barbados zone since 1980 (USGS; Caribbean360, 2014). The most recent observations recorded for a tsunami impact are from 25 December 1969 with a recorded wave height of 0.46m. The teletsunami of 1755 produced wave heights in Carlisle Bay of 1.5m (NGDC, 2014).

The impacts of and preparation for drought are also generally ignored and undocumented aside from impacts on the agricultural sector. The 1994-1995 drought was described as a 1:150 year event, where over 3,000 households were regularly without water and supplies to the virtually all of Bridgetown failed (BWA, n.d.a). In 2002-2004 the northern and eastern areas of the country were most severely impacted by low availability of freshwater, with virtually no supply in the north for about 4 weeks (Emmanuel, n.d.). The 2009-2010 event was also significant, with many countries in the region, including Barbados, reporting rainfall totals within the 10% lowest on record from October 2009 to March 2010 (Farrell et al, 2010).

Box 3: Tropical Storm Tomás impacts and lessons learned

In October 2010 this system developed very quickly into a tropical storm. Emergency plans were thus initiated by Department of Emergency Management (DEM) late on the night of 30 October. Shelters were not opened but individuals were advised to consider if it was in their best interest to stay home or relocate to the home of a friend or relative.

Damages and cracks were experienced on roadways across the island and fallen trees blocked roadways.

Impacts from this powerful tropical storm led to damage to many roofs, knocked down power lines, uprooted trees and caused much of the island's residents to lose power for more than 24 hours. The vulnerability of public utilities was exemplified in the fact that the Barbados Light and Power Company struggled for more than 7 days to return service to some central areas after 75-80 of the electricity service was damaged.

The fact that Barbados is not regularly impacted by tropical storms or hurricanes has led to an attitude of complacency in the general population (CDEMA, 2010).

This event demonstrated that most individuals are not actively or regularly taking steps to reduce their own vulnerability through investment in shutters, maintenance of secure roofs or vigilance of storm systems throughout the entire hurricane season.

To a lesser extent, epidemics and wildfires are also potential hazards. In addition, Barbados faces risks from sinkholes and has underground caves because of the karst topography characteristic of limestone bedrock. The tragic Arch Cot cave-in event in 2007 where 5 lives were lost demonstrated that although the risk is relatively small, monitoring of these underground formations is needed.

5.2 Hazard Threats

A relatively wide consensus exists about the most relevant threats that affect Barbados. In order of relevance, recurrence and affectation the most relevant threats are hurricanes and its secondary effects, flooding and landslides, earthquakes and industrial accidents or hazardous materials. Each threat is described below according to its typology.

5.2.1 Of Natural Origin

TROPICAL CYCLONES

Tropical cyclones and their secondary effects (strong winds, heavy rain, storm surges and floods) are among the more well-documented hazards for Barbados and surrounding neighbours, and threaten all exposed structures, including residential, public and commercial buildings, telecommunications, agriculture, tourism facilities, roads, bridges and utilities (gas, water, electricity).

Tropical systems are the most frequent hazard phenomena in the Caribbean. According to the US National Oceanic and Atmospheric Administration (NOAA) historical hurricane tracks, 64 meteorological events (hurricanes, tropical storms and tropical depressions) have passed within a 100km radius from the centre of Barbados since 1855 (98 within a 150km radius). Figure 20 shows the trajectory of these historical events.

Box 3 analyses the impacts, contributing factors and lessons from the most recent impact by Tropical Storm Tomás in 2010; Figure 21 shows some of the damage caused.

Barbados would be expected to lose more than 80% loss of gross fixed capital formation (GFCF)[38] from cyclonic wind damage from a 1:250 year event; AAL are estimated at 1-10% of GFCF (UNISDR, 2013).

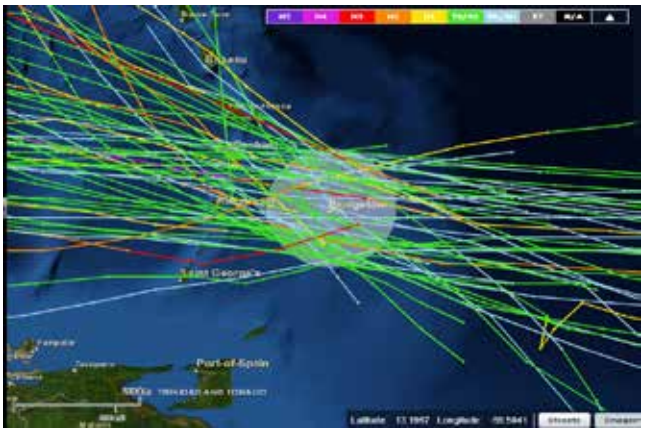


Figure 20: Historical tracks of tropical cyclonic events passing within 100km of Barbados since 1855 (Source: NOAA)

38 The estimated average loss per year over a long time period, considering the range of loss scenarios relating to different return periods (UNISDR, 2013)

Figure 21: Damage due to TS Tomás - a sunken catamaran in The Careenage (left) and St Mary's Church (Source: http://www.rentinbarbados.com/photos-hurrican-tomas)

FLOODS

There can be 4 types of floods experienced in SIDS: flash, river, coastal and ponding. Ponding floods are often associated with the accumulation of rainfall in low-lying areas. Barbados is expected to have AAL from ponding flooding of 0.04% its urban produced capital (UPC)[39] and 0.32% of GFCF from a 1:250 return period, higher than that of wind damage. Such flooding can result in significant indirect losses for households and businesses even more so than direct losses due to stagnation for several days, causing disruption of transport and posing health risks (UNISDR, 2013).

Flooding in Barbados is caused both by the direct effect of a tropical storm or hurricane, or by the rainfall of the rainy season. Flash floods are not uncommon and result from poor drainage, blocked gullies and/or inadequate storm water infrastructure in many areas of the country (see Figure 22).

Figure 22: Effects of flooding events in Christ Church (Source: The Nation Newspaper)

Low pressure systems that bring extended periods of rain or intense rainfall often cause flooding. Some of the areas generally prone to flooding include Speightstown and Gibbes in St Peter; Weston and Holetown in St James; the plains of the Constitution River, Chapman Lane, Bayville and Aquatic Gap in St Michael; and Graeme Hall and Wotton in Christ Church.

39 Originates more than 1000km or 3 hours travel time away

The period of 19-23 November 2014 saw several days of intermittent rainfall due to a passing trough system, including a deluge on 21 November which led to flash flooding in several areas. This was due to a combination of factors, such as pre-existing soil saturation, siltation of shoreline wells by sand, and general inadequate capacity of the drainage systems (The Barbados Advocate, 2014b). These events led to a major collapse of roads in South District, St George and White Hill, St Andrew, which is already prone to land slippage. Residents in White Hill have been burdened by lack of provision of essential services such as water and waste collection, and homes in the slippage area are cracking and precariously positioned on the edge of a gully (Bradshaw, 2014c).

Among the factors increasing exposure to floods are: urbanisation, with paved impermeable surfaces reducing infiltration of precipitation into the soil; the inadequate maintenance of the drainage systems; poorly engineered drainage systems with insufficient capacity to carry the amount of water expected; blockage of gullies and drains with garbage.

Box 4: Flooding in St Peter and St Lucy, April 2011

On April 11, 2011 a low pressure system passed over the southern islands of the Lesser Antilles bringing unseasonal precipitation. Overnight heavy rainfall caused flooding in many communities across St. Peter and St. Lucy parishes. Persons in the communities of Rose Hill, Collerton, and Gills Terrace were inundated with mud and water that moved large appliances and damaged furnishings and vehicles. The DEM and the local District Emergency Organisation (DEO) worked together to assist the affected households and the Barbados Defence Force was requested to provide further support (CDEMA, 2011).

DROUGHT

A drought can be considered to be a lack of precipitation over a protracted period, resulting in a shortage of water for some activity, user group or environmental system (National Drought Mitigation Centre, n.d.). The definition of a drought is highly dependent on environmental factors such as seasonal and climate variability and the context of water as a resource for user groups and ecosystems. Wilhite and Glantz (1985) have therefore categorised drought as follows:

- Meteorological: departure of precipitation from 'normal' levels for a defined duration, based on typical climate conditions
- Hydrological: relates to the effects on surface and subsurface flows e.g. stream flow, groundwater levels
- Agricultural: describes impacts of precipitation levels, evapotranspiration, soil moisture deficit, etc in relation to crop water demand
- Socioeconomic: correlates conditions to the supply and demand of an economic good e.g. hydroelectricity, domestic potable supply

UNISDR (2011) asserts that drought is globally still a hidden risk, with disproportionate social and economic impacts on the rural poor. Drought conditions in Barbados have a frequency of about 3 in 10 years, and are generally correlated with El Niño events. Figure 23 shows total annual rainfall recorded for 1984-2013. With an arithmetic annual average of 1282.8mm, the data reveal that 5 of the last 30 years have been below 1050mm and similarly above 1500mm. Significantly, these very wet years tend to immediately follow very dry years, having implications for resource and watershed management planning, agriculture, groundwater recharge and flooding. 2010 is currently the wettest year on record at 1885.8mm, which was preceded by 1015.1mm in the drought year of 2009.

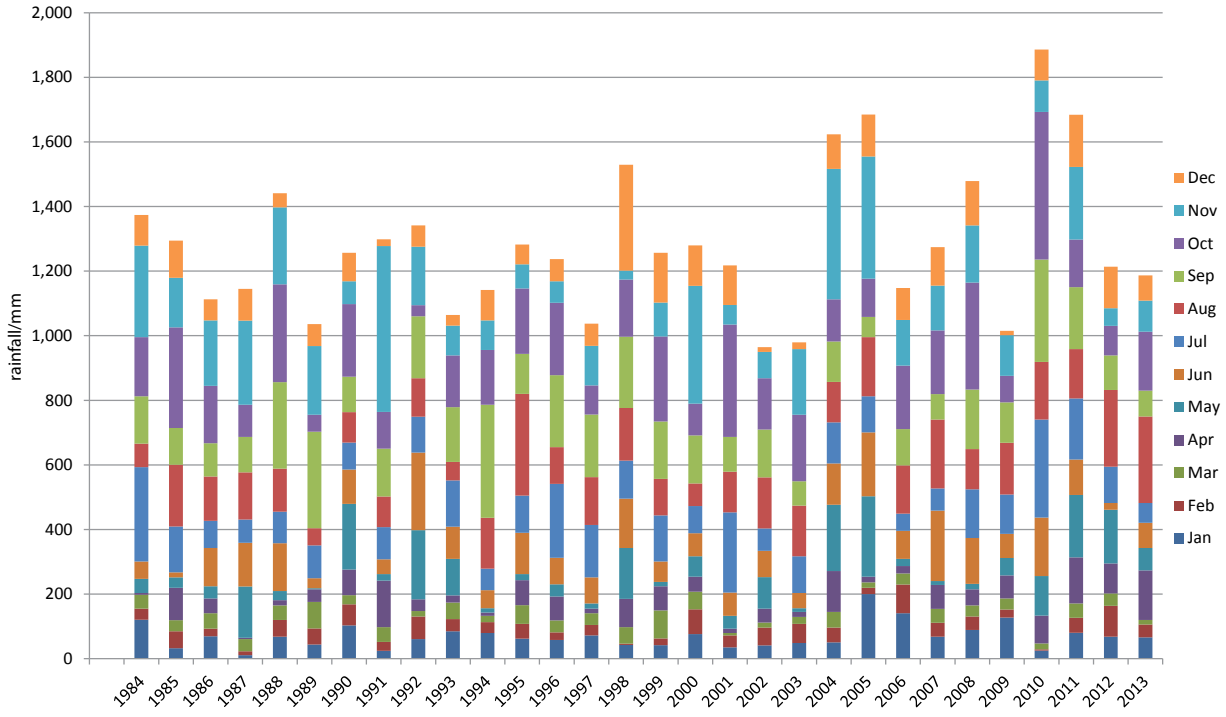


Figure 23: Annual rainfall for Barbados 1984-2013 recorded at Grantley Adams International Airport showing monthly variation. (Source data: Barbados Meteorological Service)

The longer record from 1942 in Figure 24 clearly shows the oscillation in rainfall patterns. 1972 was the driest year with 842.8mm. 2002, 2003 and 2009 are among the 15 driest years in the record; 2004, 2005, 2008, 2010 and 2011 are among the 15 wettest. This high fluctuation between extremes within a single decade may possibly be influences of climate change.

Given Barbados' classification as a water scarce country[40] and the heavy dependence on groundwater, drought conditions have severe implications for water resource users, particularly in the domestic sector, which uses 60% of all water (GOB, 2001; see Table 13) and the tourism industry as the main economic industry and being very water intensive. Estimates 20 years ago indicated per capita usage of 700 litres per day (lpd) by tourists compared to 213lpd by locals (Singh and Clouden, 1999), with more recent analysis suggesting it could be as high as 10 times local consumption (Greenidge and Greenidge, 2011). BWA officials indicate figures of tourist consumption of 674lpd compared to 240lpd per capita by locals (Farrell et al, 2010). The severe drought of 1994-1995 resulted in prolonged water outages for many households and the capital, including QEH. Subsequently measures such as recycling wastewater, desalination, conservation and updating of the water rate structure were implemented to try to mitigate such issues in the future (CDB, n.d.).

40 UN Commission on Water

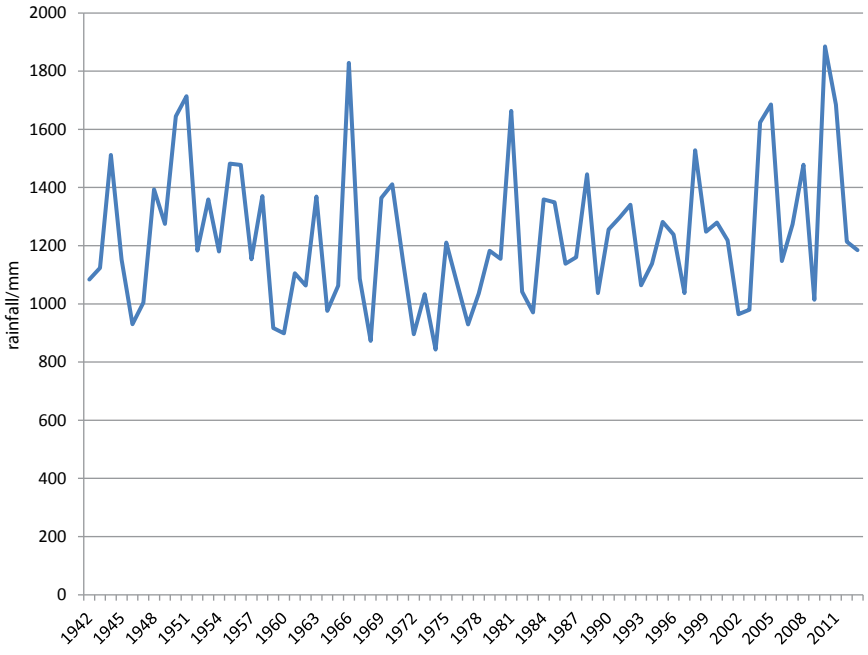


Figure 24: Annual rainfall for Barbados 1942-2013 recorded at Grantley Adams International Airport (Source data: Barbados Meteorological Service)

Table 13: Comparison of water use by category in Barbados 1996 and projections for 2016 (Source: Singh and Clouden, 1999 from BWA's Water Resources Management and Water Loss Studies 1996-1998)

Use by Category	Consumption 1996			Projected demand 2016		
	m³/day	Mgd	%	m³/day	Mgd	%
Domestic (metered and unmetered)	48,681	10.71	22.00	51,337	11.29	27.36
Industrial and commercial	16,955	3.73	7.66	17,460	3.84	9.30
Hotels and ships	5,200	1.14	2.34	10,821	2.38	5.77
Agriculture	52,091	11.46	23.54	63,545	13.98	33.87
Golf course irrigation	2,458	0.54	1.11	14,182	3.12	7.56
Unaccounted-for water	95,973	21.11	43.35	30,000		16.14[41]
Total consumption	221,358	48.69	100.00	187,345		100.00

LANDSLIDES

Small scale landslides are associated with coastal escarpments where undercutting by wave action creates instability. However, the majority of landslide activity is restricted to the Scotland District, where slumps, earth flows, and debris flows are the main landslide types present. Failures occur when the clay soils decrease in strength due to increased pore-water pressure (IDB, 2010a). This may be in direct response to intense rainfall or perched water tables associated with the bedding within the bedrock or older clay-sealed slip surfaces. Leaks and breaks in water pipes, often triggered by land movement, also contribute to trapping of water between the geological strata.

41 Calculated by author

A vulnerability study confirmed that the principal factors which predispose the Scotland District to slippage and erosion in are soil type (e.g. unconsolidated Joe's River muds) and slope, and categorised zones based on erosion and landslide risk to guide development (Scott Wilson, 2000). Ground cracking, scarps, and gully development are some of the consequences of landslides which render land unusable for farming. Roads are often undermined by failing slopes and blocked by displaced slide material. The structural stability of housing is also impacted.

EARTHQUAKES

Historical evidence exists about the occurrence of earthquakes and seismic activity in the Caribbean Sea's basin since the beginning of the last century. Figure 25 shows the seismic activity in the Caribbean of magnitude 6.0 or greater, which is comparable to that registered in Central or South America. Historical events affecting Barbados are listed in Annex III.

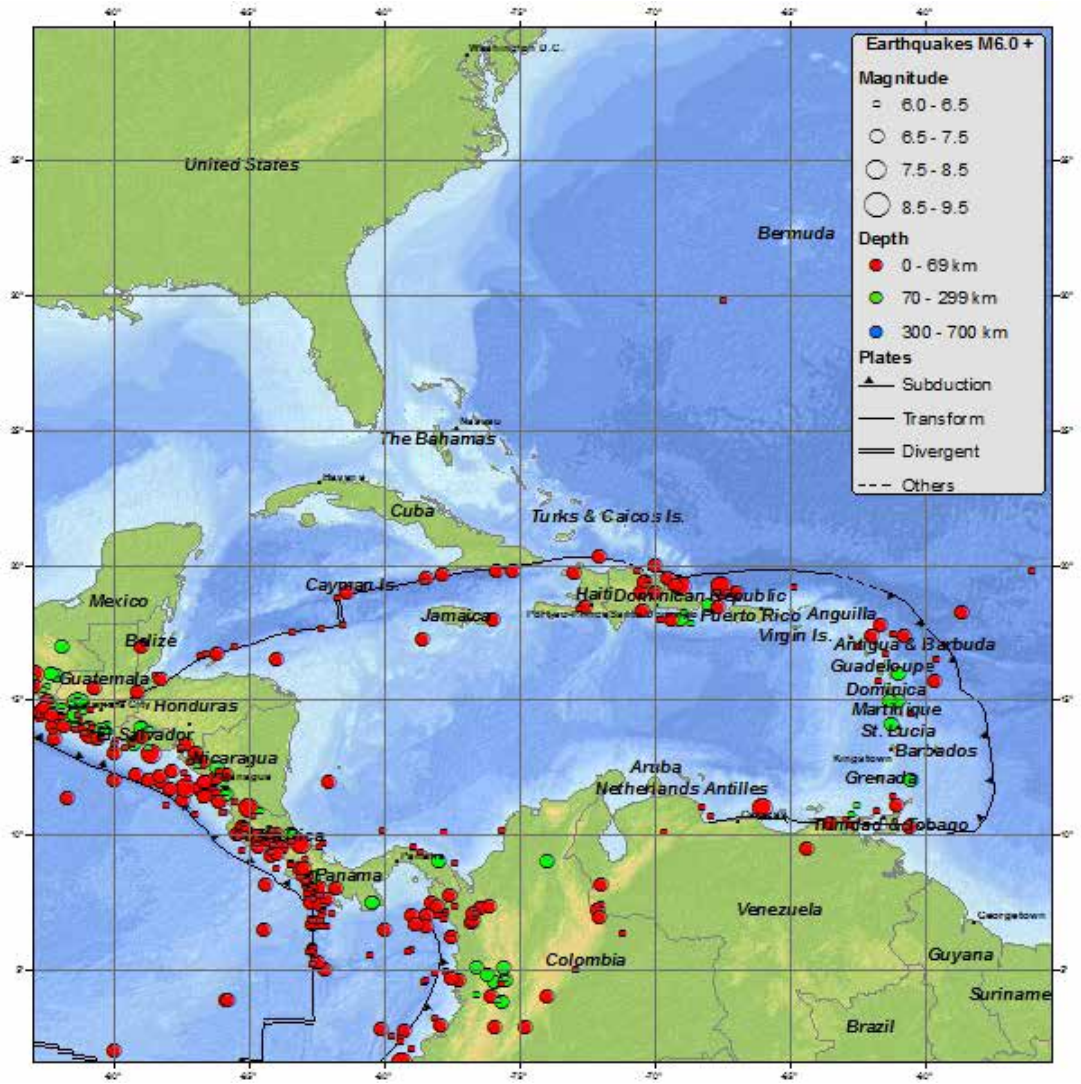


Figure 25: Caribbean seismicity map for 1900 to March 2012 (Source: USGS)

The relevance of this hazard lies primarily in its infrequency and therefore the unpreparedness of the population, as demonstrated during the 2007 event; as well as the building stock which is generally constructed to withstand hurricanes as opposed to seismic activity. Although the Building Code has been recently updated, it does not recommend specifications or materials for reducing vulnerability to seismic hazards. While risk analysis has been undertaken at regional level, it is still useful for informing construction and national regulations. Additionally, there are localised areas of reclaimed land that could present increased vulnerability due to possible movement of sediments and even liquefaction in the event of a major impact.

Barbados is ranked among the top 10 countries in the world in terms of probable maximum loss (PML)[42] of UPC from earthquakes, at approximately 17% for a 1:250 year earthquake, and would be expected to lose more than 80% of GFCF. AAL are estimated at 1-10% of GFCF (UNISDR, 2013).

A probabilistic seismic hazard analysis has been performed by the Seismic Research Centre (SRC) of the University of the West Indies (UWI) in order to compute probabilistic seismic hazard maps for the Eastern Caribbean region (10-19°N, 59-64°W), from Anguilla to Trinidad and Tobago. Bozzoni et al (2011) demonstrate that Barbados is located within seismic zone 3 (SZ3) of the 15 in the region, which includes shallow-focus earthquakes (ffi50km). Barbados lies closest to the subduction zone between the North American and Caribbean plates, which extends to depths of 200km, generating earthquakes of up to 8.0. An area of dormancy is associated with the deepest section of the Barbados accretionary wedge.

Seismic hazard maps at a regional scale are shown in Figure 26 with return periods of 95, 475 and 975 years with a representation of the peak ground acceleration (PGA).

The Leeward Islands are characterised by higher seismicity than the Windwards for both short and long period components of ground motion. Barbados has the lowest hazard for all components of ground motion due to its distance from intraplate seismicity.

According to estimates by Bozzoni et al (2011), for a return period of 95 years, Barbados will experience maximum acceleration in the terrain between 0.05 and 0.15g. The detailed representations of this expected maximum acceleration are shown in Figure 27 maps.

Other authors (CDMP, OAS-OFDA) have estimated that the Barbados zone could experience earthquakes of level VII on the Modified Mercalli intensity scale (see Annex IV) for a return period of 50 years, which would imply damage to some construction and different signs of movement.

42 The maximum loss that could be expected for a given return period (UNISDR, 2013)

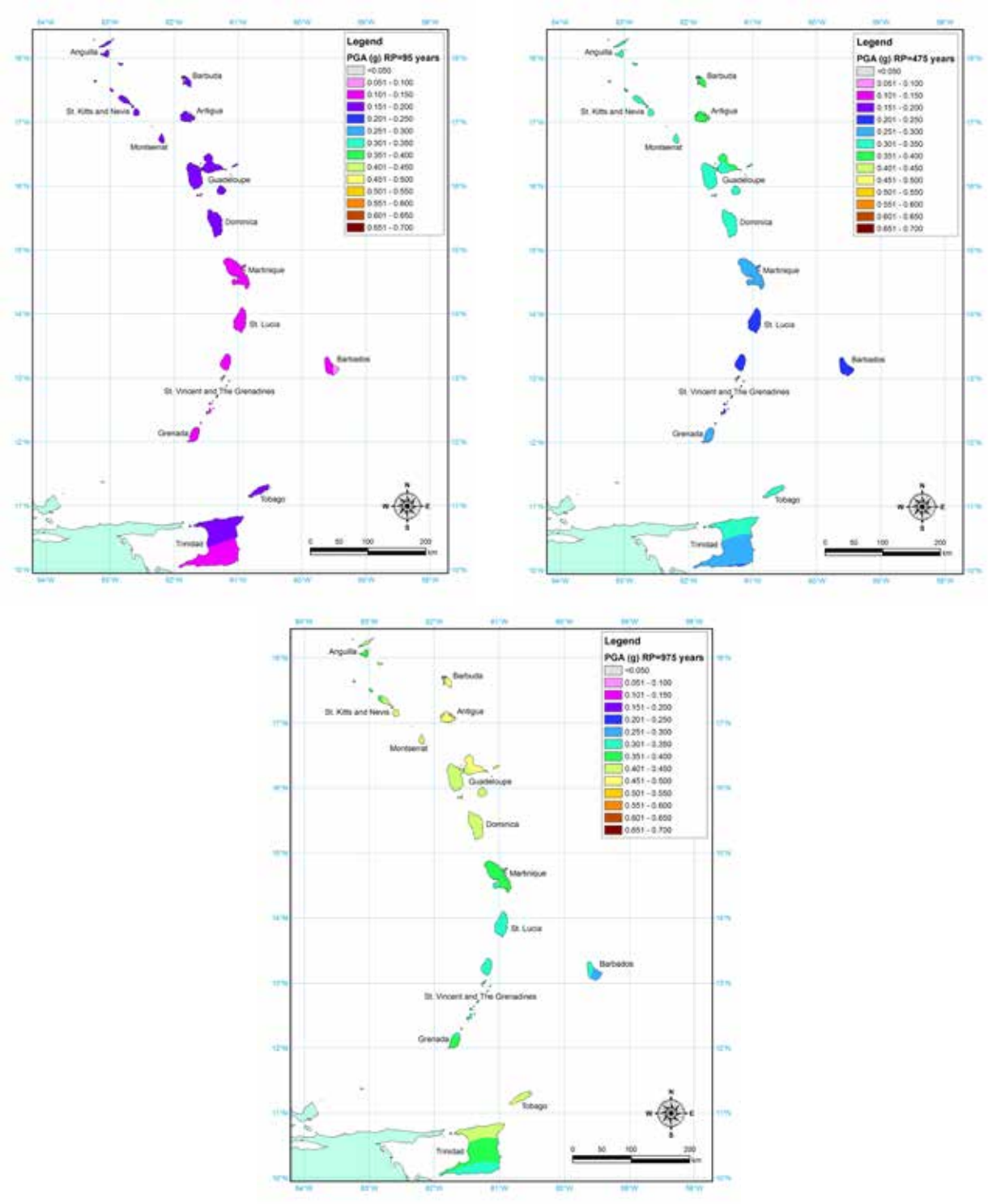


Figure 26: Seismic regional hazard maps for the Eastern Caribbean showing peak ground acceleration (PGA) for return periods (RP) of 95 (top left), 475 (top right) and 975 (bottom) years (Source: Bozzoni et al, 2011)

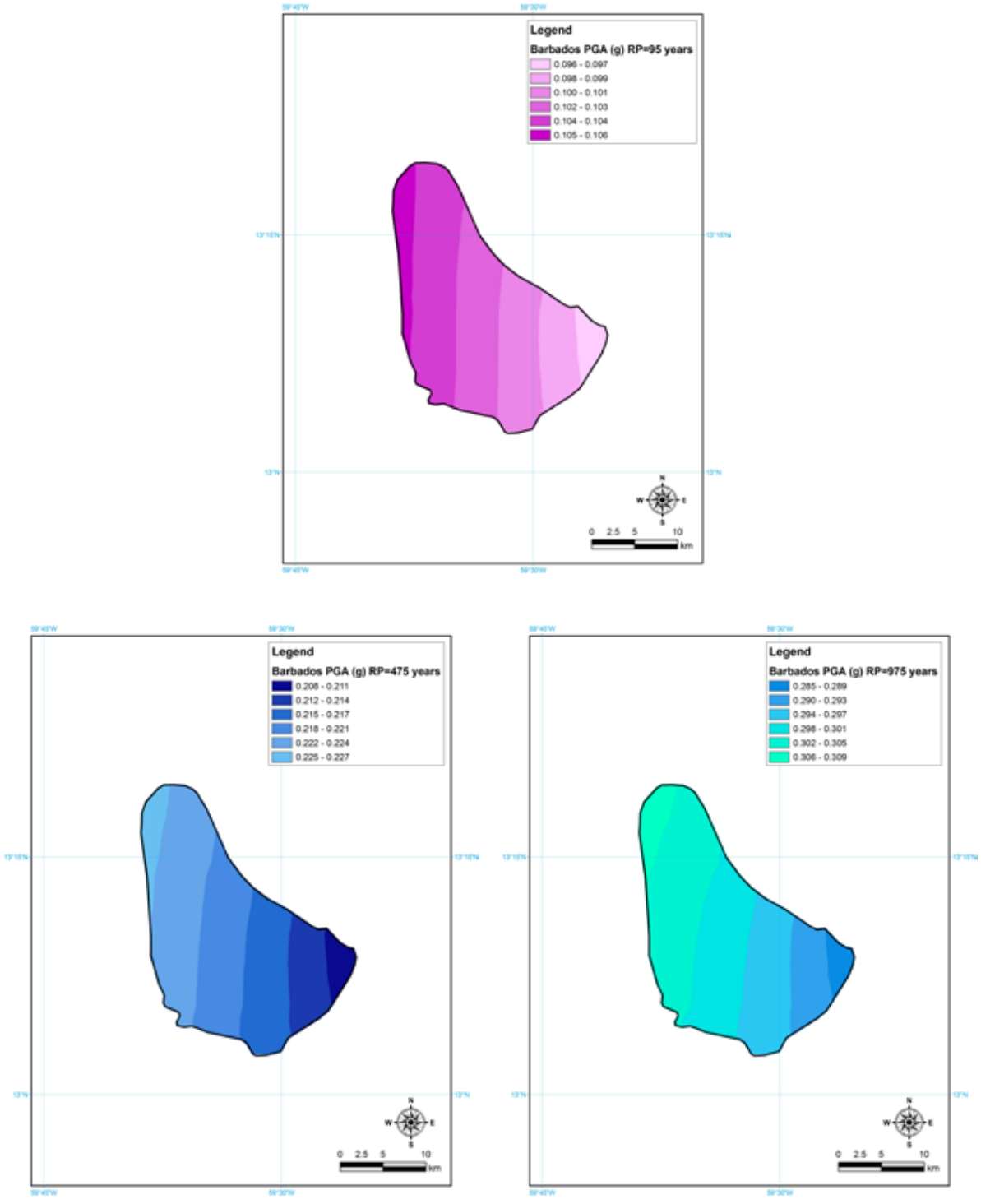


Figure 27: Expected peak ground acceleration (PGA) for Barbados for return periods (RP) of 95 (top), 475 (bottom left) and 975 (bottom right) years. (Source: Bozzoni et al, 2011)

TSUNAMIS

The Eastern Caribbean is in a zone of significant tectonic changes, with all tsunamigenic sources (earthquakes, volcanoes, landslides) in close proximity. Since 1498, there have been over 350 tsunamis in the region of the Caribbean Sea and Bermuda, with events as recent as June 2013 (NGDC, 2014). According to the UWI SRC (n.d.), the most likely tsunamis to affect the area are from shallow (<50km depth) earthquakes greater than magnitude 6.5. Local tsunamis and teletsunamis (such as from the 1755 Lisbon earthquake which traversed the Atlantic and affected the region) generated by earthquakes pose potential threats. Figure 28 shows tsunami sources and run-up events in the region since (year). Of the 5 events in the NGDC database for Barbados, the observed wave heights range from 0.46-1.5m (see Annex III).

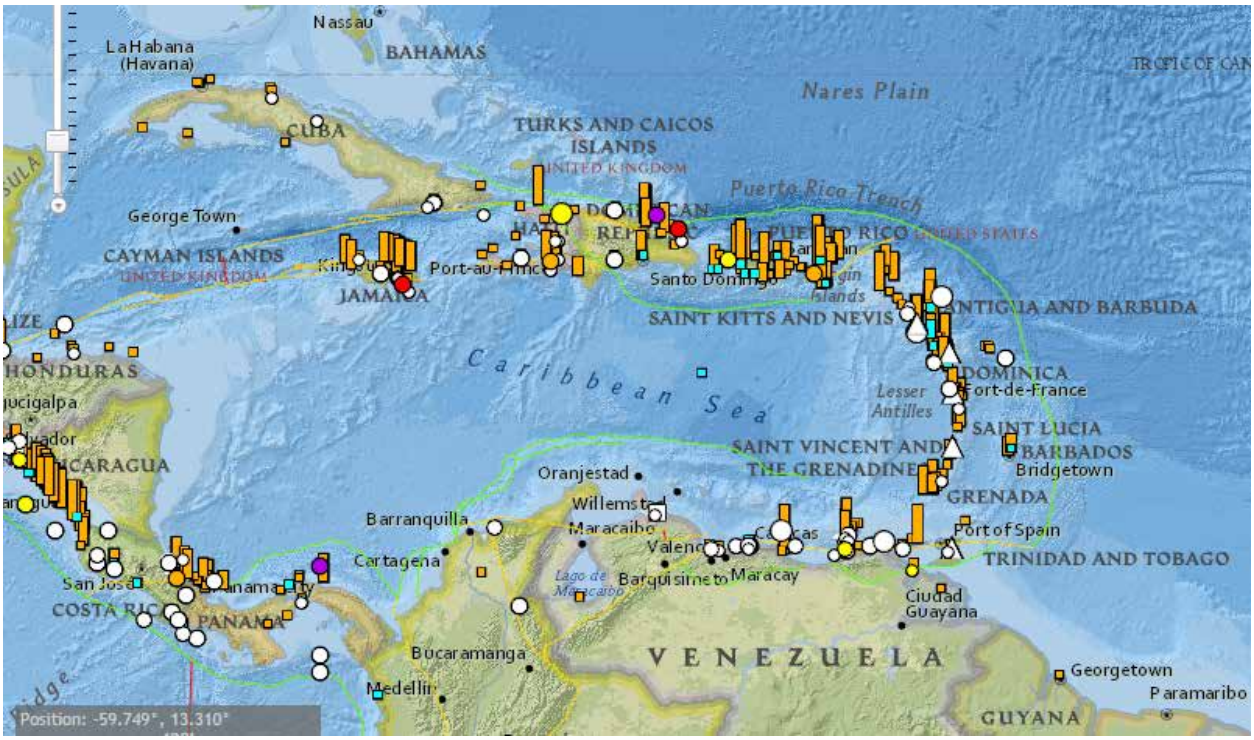
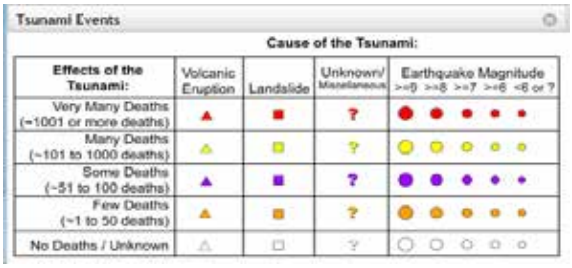
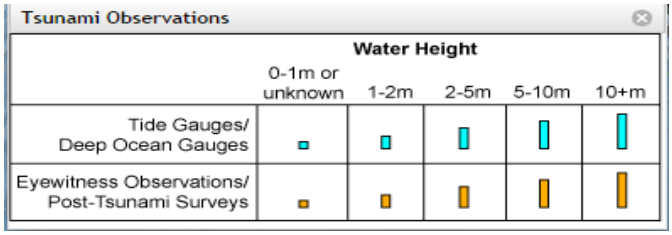


Figure 28: Tsunami sources and impacts in the Caribbean Basin
(Source: National Geophysical Data Center http://maps.ngdc.noaa.gov/viewers/hazards/?layers=0)





5.2.2 Of anthropogenic origin

CLIMATE CHANGE

Climate change is a serious and substantial threat to the economies of Caribbean nations, the livelihoods of communities and the environments and infrastructure across the region. In this landscape of multi-hazard risk, changing climate represents an additional stressor and this shifting risk profile will affect the outcome of a wide range of decisions affecting individual, societal and economic well-being. Barbados is already experiencing some of the effects of climate variability and change through damage from severe weather systems and other extreme events, as well as more subtle changes in temperatures and rainfall patterns. Modelling projections for Barbados reported by Simpson et al (2012) predict an increase in average atmospheric temperature; reduced average annual rainfall; increased sea surface temperatures; and the potential for an increase in the intensity of tropical storms. Further details of the analysis follow below.

Drought and food production

These projections permit the assumption that decreased rainfall combined with an increase in the average temperature creates potential drought scenarios that could affect food production. The increase in frequency and intensity of storms and hurricanes could cause more recurrent and destructive floods, as well as possible landslides, and their attendant impacts.

Housing and tourism

Approximately 25% of Barbados' population lives within 2km of the coast. High density tourism development, particularly on the west coast, is highly vulnerable to sea level rise (SLR) and storm surge. A 1m SLR places 8% of the major tourism properties at risk, with an additional 32% at risk with a 2m SLR. Critical beach assets would be affected much earlier than the SLR-induced erosion damage to tourism infrastructure.

Water resources

SLR is expected to increase saline intrusion of coastal aquifers, whereas decreases in precipitation and changes in rainfall patterns should give rise to more frequent and severe drought conditions. Coupled with increases in temperature, this could have deleterious effects on aquifer recharge rates. Water levels in west coast aquifers are a mere 0.3m above sea level and salinity has already been detected in the western catchment, indicative of high levels of abstraction plus reduced recharge rates, lessened rainfall and higher evapotranspiration rates. The load on sanitation requirements will also become a concern associated with decreased availability of water resources.

Desalination has been used to adapt to this vulnerability by the BWA and the private sector. BWA no longer pumps water from coastal wells. New, possibly deeper, wells may have to be drilled in zones farther from the coast, increasing the costs of production, treatment and distribution to high consumption areas. Furthermore, change in climatic patterns could generate more and longer periods of drought.

Coastal resources and infrastructure

All of the ports in Barbados are projected to be inundated by storm surge associated with a 1m SLR; however turtle nesting sites (on beaches) are destroyed by erosion in minor storm surge events. Even under the 0.5m SLR scenario, 37-72% of the highly valued beach resources in Sandy Lane and in Holetown would be lost. With a 2m SLR, 65% of Sandy Lane and 97% of Holetown's beach would become inundated. With a 3m SLR impacts

would be further exacerbated and Holetown beach would be lost. However, as such changes would happen gradually, it would be reasonable to assume that adaptation measures would be taken over time; even so far as abandoning some properties as protection measures became economically impractical. It should be noted that likely median projections for global sea level rise by the Inter-governmental Panel on Climate Change (IPCC) are in the range of 0.44-0.74m by 2100 across all scenarios. This can be 10-20% higher in equatorial regions (Church et al, 2013).

LAND DEGRADATION

Erosion in the Scotland District during the period 1985-1990 was recorded at its lowest of 2.43t/ha/year (sands) to as much as 760.07t/ha/year (clays). While the geology and climate contribute to land degradation, large scale clearance of vegetation, unsustainable farming practices, extraction of mineral resources and settlements exacerbate the problem (GOB, 2002).

The main factor in accelerating land degradation in Barbados is the change in land use. Removal of productive land from agriculture (for residential and commercial use, hotels, and golf courses) has increased the coverage of impervious surfaces, triggering greater surface runoff and flash flooding (Simpson et al, 2012). The expanding urban and suburban populations have been partially derived through clearance of vegetation, some unauthorised construction on former wetland areas, and authorised development in naturally flood-prone areas (either prior to development control or approved with conditions). This situation is exacerbated by inappropriate agricultural practices such as the use of herbicides that destroy total ground cover and promote runoff, and planting systems that encourage runoff instead of water retention in the topsoil and aquifer recharge.

OIL SPILLS AND OTHER HAZARDOUS CHEMICALS

Oil spills are typically not in the realm of public knowledge of their occurrence, and over the years have been small and managed by local responders. Table 14 lists reported incidents since 2009.

Table 14: Incidence of petrochemical spills from 2009 to 2014
(Source data: Environmental Protection Department)

Date	Product	Quantity/bbl	Location	Parish
1 Jan 2009	oil	3	Bridgetown Port Inc	St. Michael
6 May 2009	hydrocarbons (possible diesel, gasoline and kerosene)	unknown	Warrens	St. Michael
28 Apr 2009	oil	19	Holborn	St. Michael
21 Oct 2010	diesel	5	Oistins Bay	At sea
27 Jan 2011	used oil	unknown	Jackson Terrace	St. Michael
9 Feb 2011	diesel	unknown	Porters	St. James
22 Feb 2011	used oil	unknown	Wildey	St. Michael
28 Feb 2011	used oil	unknown	Spring Garden	St. Michael
14 Oct 2011	diesel	42	Spring Garden	St. Michael
29 May 2013	oil	<1	Little Bentley	St. George

Date	Product	Quantity/bbl	Location	Parish
23 Jul 2013	oil emulsion	unknown	Checker Hall	St. Lucy
17 Jul 2013	used oil	unknown	St. Matthias	St. Michael
17 Jul 2013	oil	1.15	The Pine	St. Michael
23 May 2014	tar	unknown	Gemswick	St. Philip
26 Aug 2014	oil	2.15	Jemmott's Lane	St. Michael

GROUNDWATER CONTAMINATION

A number of factors contribute to the threat of groundwater contamination in Barbados. Given the importance of the groundwater resources to the country (refer to section 4.2.1), this is of critical importance to the health of the population. Coupled with issues of over abstraction and reducing recharge, threats to the resource are high.

Illegal squatting or other unpermitted use of Zone I areas are a direct threat to the potable water resource. A lack of piped water and sewage facilities means that all human and kitchen wastes seep into the ground via soak away pits immediately above the key aquifers, therefore there is very little travel time for contaminants to degrade before reaching the water table. Studies indicated that sewage from soak away pits and overland flow into the gully systems in the Belle contribute greatly to the high nitrate and bacteria levels seen in the wells (EPD, 2009). Of the 3 main locations of squatter settlements – Rock Hall in St Philip, Howell's Crossroad and Bellevue in St Michael – the latter sits atop the largest Zone I aquifer in the Belle. If there is agricultural use, then contaminants can come from animal waste, pesticides and herbicides. Commercial and industrial uses can bring oils, heavy metals and any number of other toxic substances, however very little data is available on the quantities and composition of effluent discharged from many operations (EPD, 2009).

Gullies are the main watercourses throughout the country and a main conduit for rainwater into aquifers for recharge. They are also a known location for open illegal dumping, particularly of large items e.g. appliances, cars. This presents potential for seepage of metals, oils and chemicals into the groundwater. Zoning, chlorination and monitoring appear to provide effective protection from bacterial groundwater contamination; chemical contamination is still a concern (Headley, 2012).

INFORMAL SETTLEMENTS

The aforementioned issue of "occupiers without title" has further implications beyond groundwater contamination. The areas occupied can be prone to flood, landslide or other hazards, making it unsuitable for habitation, thus creating new vulnerability. The situation of poverty and unsecure land tenure generates a tendency to use unsafe construction materials and/or methods which cannot withstand significant hazard events.

Further, the current land acquisition regime actually creates incentives for squatting since occupiers of the land are able to claim rights of title after uncontested occupancy of 10 years. This "adverse possession" is referred to in the Limitation of Actions Act, Cap 231 as that in opposition to the true owner and ousts the true owner. Actual physical, exclusive and unequivocal possession must exist. Intention to possess must also be demonstrated by the adverse possessor i.e. actions in keeping with ownership, such as erecting fencing.

However, comparatively, the squatter population is quite small at less than 100 houses.

WILDFIRES

Wildfires are typically prevalent during the dry season. They create a number of risks, specifically to human health in terms of respiratory disease e.g. asthma, bronchitis, respiratory irritation and respiratory tract infections; destruction of property and crops; and severe burden on water resources. The Barbados Fire Service reports trends in wildfires as shown in Figure 29. Drought does not seem to have a strong correlation with frequency of wildfires if the data are compared to rainfall as in Figure 30, contrary to the inverse relationship that might be expected with rainfall. Extended dry conditions increase the propensity for the occurrence of wildfires, however many are also triggered by open burning of trash in residential areas and by malicious intent. Already stressed water resources would then need to be utilised to extinguish these fires.

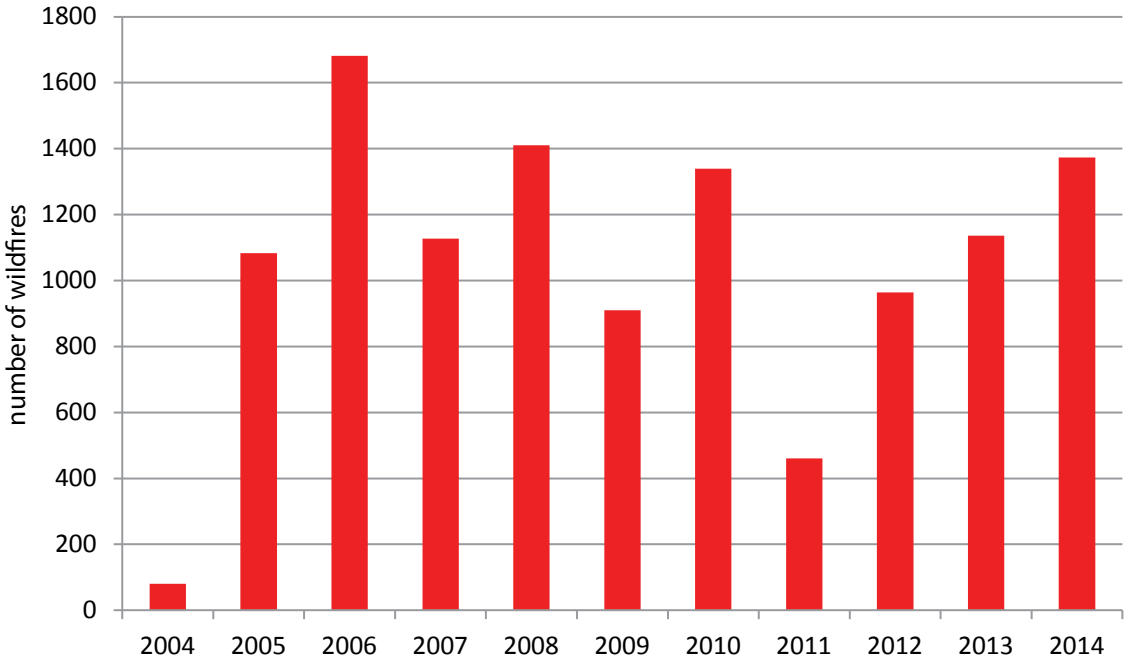


Figure 29: Number of wildfires in Barbados 2004 to September 2014 (Source data: Barbados Fire Service)

Figure 30: Patterns of annual rainfall and occurrence of wildfires 2004-2013 (Source data: Barbados Meteorological Service and Barbados Fire Service)

Though seasonal and typically not very expansive, like many other small events, the cumulative effects of these incidents are not captured. For instance, the aggravation of respiratory ailments and associated health care, the activation of fire responders, the strain on water resources, and loss of productivity are not quantified to give a true reflection of the impacts.

5.2.3 Emergencies affecting health and livelihoods

Disaster situations present a number of variables which can severely disrupt access to social services, transportation and livelihoods, thereby slowing the recovery and reconstruction process. Simpson et al (2012) note that the occurrence of medium or large magnitude disasters, such as hurricanes or floods, has an effect in the emergence of plagues, diseases and sickness of considerable importance. Flood waters contaminated with faecal matter and urine from infected rats is often associated with and is one of the main causes of post-disaster leptospirosis outbreaks.

Large masses of stagnant water can also lead to the spread of water and vector-borne ailments such as cholera and dengue fever; the latter is already endemic in Barbados (see Figure 31). The lack of centralised sewage treatment throughout the country creates additional risk of septic tanks overflowing during floods, which can return into the home or flow into the streets and eventually flow into the marine environment. There is also continued use of pit latrines in some locations. While overall it has dropped considerably from 32.1% of households in 1990 to 3.8% in 2010, 50% of these are located within the Greater Bridgetown (26.1%) and Southeast (23.9%) areas (CDB and GOB, 2012).

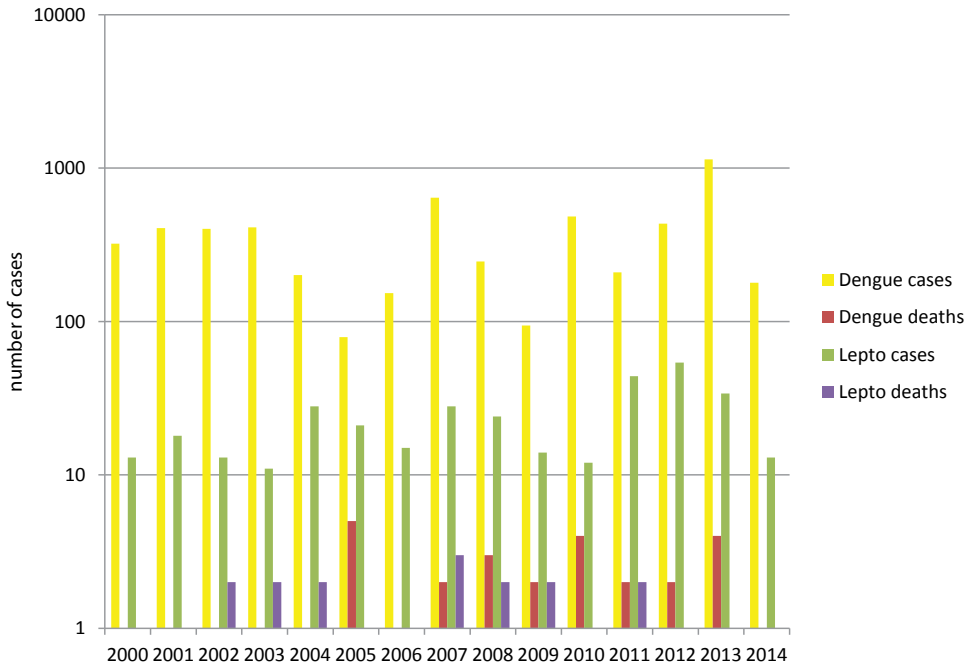


Figure 31: Incidence of dengue fever and leptospirosis in Barbados for 2000 up to September 2014 (Source: Ministry of Health)

Where an emergency causes power outages for several days, or during drought conditions, the provision of potable water to homes becomes challenging, with BWA being the electric utility's largest consumer. This increases the likelihood of incidences of sanitation and food-borne illnesses. Simpson et al (2012) report that diarrhoeal illnesses in Barbados show seasonal variability which may be correlated with reduced water supply.

Besides interruption of transportation services generally reducing commercial activity in the immediate post-disaster period, the livelihoods often most directly affected by disaster are in agriculture and tourism, generally from hydro meteorological hazards. Crop losses due to drought and flooding are often severe, negatively impacting nutrition and food security. Among the effects due to drought are high evapotranspiration rates reducing the effective application of water, low water levels affecting the germination of crops as well as increasing the prevalence of pests and disease. A period of extended drought beginning during the 2009 dry season was followed by the passing of Tropical Storm Tomás in October 2010, causing significant financial losses for 230 farmers due to flooding (Simpson et al, 2012).

ZOONOSES

With a high level of food imports (approximately US$300 million annually) and influx of tourists as well as other travel, zoonoses represent a significant public health risk, which must be managed through surveillance, multi-sector collaboration and ever-improving capacities for risk assessment, testing and enforcement. Many such diseases have high mortality rates and can spread rapidly through a population. Examples of zoonoses include avian and bovine tuberculosis[43], leptospirosis, rabies, foot and mouth disease and salmonella. Many of

43 A census of all cattle in Barbados conducted during 2010-2012 concluded that there was no bovine TB present in the country

these are included in the global list of notifiable diseases, incidences of which must be reported to the World Organisation for Animal Health (OIE)[44].

Ebola virus disease is a severe, often fatal (50-90%), disease with severe vomiting and diarrhoea as well as being haemorrhagic. Transmission is via contact with body fluids of infected or dead persons, or exposure to contaminated objects. The viral load after a fatality remains very high and therefore transmission post-mortem is also high. The lack of disclosure of potentially infected persons who decide to travel presents significant risk for international transmission. During the incubation period (2-21 days) i.e. not symptomatic after exposure, is not contagious (WHO, 2014).

The threat level for Barbados is described as possible, particularly given the tourism-based economy. If a single case occurs in Barbados it will trigger a public health emergency. Training of the health care workers is paramount in containing any potential infections, including the use of rigorous personal protective equipment, as they provide treatment and are at highest risk of exposure. There is enhanced surveillance at the ports of entry, including medical assessment and decontamination facilities. Hotels and private doctors are also reporting on cases of diarrhoea and vomiting. An isolation/quarantine facility is being completed. Protocols for containment measures and a Procedural Manual for Ebola have been developed. Work is underway to coordinate a decontamination team to work in communities and schools, for instance. Legislative frameworks need to be reviewed and updated as necessary e.g. the Quarantine Act, and for the handling and disposal (by cremation) of bodies (St John, 2014b).

EPIDEMICS

There are a number of diseases which can spread rapidly throughout the population and have debilitating effects, and/or can be exacerbated by weather conditions and more so as a result of climate change. Increased temperatures due to climate change would also be expected to increase the geographic range and breeding seasons of some vectors, thus widening the spread of diseases such as malaria, which is currently not found in the country. Increased precipitation and/or flooding would also expand the available breeding grounds for vectors. Such which have arisen within the last decade include SARS, anthrax, H1N1 influenza and most recently, the chikungunya virus.

Forty-nine cases of the chikungunya virus, transmitted by the Aedes aegypti mosquito (as is dengue fever) and the Aedes albopictus mosquito, have been confirmed in Barbados, with another 200 suspected. The actual number of cases is projected to be much higher than reported because many persons do not seek medical attention, but instead self-medicate. This is from the first imported case on 3 June. As Barbados is a virgin population to the disease, therefore lacking 'herd immunity'. Further, it has an existing population of vectors which is not well controlled due to sheer volume and despite vector control measures by the Ministry of Health. Consequently, the potential for epidemic is high, which is characterised as 38-63% infection in a virgin population. Persons with co-morbidities e.g. hypertension, diabetes mellitus, asthma seem to be suffering more severe symptoms. The Ministry of Health's testing protocol now focuses primarily on high risk groups – children under 15 years, adults over 60 and pregnant women. There is also a higher rate of co-infection with dengue and chikungunya being observed than suggested in literature. There are currently no more supplies of acetaminophen on the island, with persons self-diagnosing and stocking up to treat both diseases (St John, 2014a; Springer, 2014). The effects of the disease, which include severe arthritic pain, significantly limit the

44 http://www.oie.int/en/animal-health-in-the-world/oie-listed-diseases-2014/

ability of a person to cope and respond in the event of a disaster. The Ministry of Health's efforts are focused on public education to remove breeding sites and protection from being bitten.

5.3 Vulnerability

Vulnerability refers to the "characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (UNISDR, 2009). Vulnerability cuts across social, environmental and economic boundaries, and is inextricably related to social processes in disaster prone areas. It typically speaks to the fragility, susceptibility or lack of resilience of a population faced with different hazards (IDB, 2010a). SIDS economies face exceptional disadvantages due to their size, insularity and remoteness, making them susceptible to economic shocks, including natural hazards, to which they are among the most vulnerable globally (Benson and Clay, 2004).

5.3.1 Analytical criteria and methodology

Vulnerability and Capacity Assessment (VCA)

The Red Cross Vulnerability and Capacity Assessment (VCA) tool is a participatory process designed to assess and address major risks affecting communities, determine the vulnerability to those risks, and assess the community's capacity to cope with and recover from a disaster (Barbados Red Cross, 2010). The steps in the process are to:

- Identify and map vulnerabilities and hazards
- Determine and map resources and skills in the community, including civil society groups and other social networks and their importance and influence
- Ascertain the main issues and associated actions which can be implemented by the community to mitigate risks
- Develop proposals to support selection of a micro-project which addresses one of the main issues

The process includes an analysis of the historical development of the community, its demographics and characteristics. There is also an evaluation of the seasonality of key aspects such as income security, agriculture, tourism, illnesses and hazard occurrence. Livelihoods, their distribution and possible coping strategies are also explored.

There is a paucity of Vulnerability and Capacity Assessments, with only 6 communities having them conducted using the Red Cross Community VCA methodology since 2010. Some of these results are summarised in Table 18.

Hospital Safety Index

PAHO's Hospital Safety Index helps health facilities to assess their safety by providing a snapshot of the probability that a hospital or health facility will continue to function in emergency situations, based on structural, non-structural and functional factors, including the environment and its health services network. This gives decision-makers a general idea of its ability to respond to major emergencies. However, it is not intended to replace more detailed vulnerability studies.

The final HSI score places a health facility into one of three categories of safety, helping determine where interventions are most urgently needed:

- Category A: deemed able to protect the life of their occupants and likely to continue functioning in disaster situations
- Category B: can resist a disaster but in which equipment and critical services are at risk
- Category C: the lives and safety of occupants are deemed at risk during disasters

The Queen Elizabeth Hospital is the main health care facility in the country, for which an assessment was conducted in 2008. The QEH was rated at Category B and the Ministry of Health has since conducted retraining and is applying the process to the satellite polyclinics.

A safe hospital remains structurally intact after a hazard event, has staff well-trained in emergency response, and articulated and tested contingency plans for continued operations after the event. Achieving this state requires the commitment of a range of stakeholders outside of hospital staff, including government, engineers and the private sector, as safe health facilities are a critical component of the response and recovery process. PAHO is a willing partner in helping facilities to improve their resilience.

5.3.2 Components

Wilches-Chaux (1993) suggested a number of approaches to identifying vulnerability. These are:

- Natural/environmental vulnerability: determined by the intrinsic environmental limits of living organisms e.g. extreme temperatures; refers to humans coexisting with the environment without domination and destruction. It also takes into account the vulnerability of ecosystems to direct and indirect human action, and the high risk associated with communities that exploit or inhabit them.
- Physical vulnerability: refers specifically to the location of settlements in zones of risk and deficiencies in physical structures to withstand such risk
- Economic vulnerability: demonstrates an inverse relationship between per capita income and disaster losses; it occurs at multiple levels:
    - Local/individual – factors of unemployment, insufficient income levels, exploitation, work instability, difficulty in accessing educational services, health and leisure activities
    - National – excessive dependence on external uncontrollable factors e.g. prices of fuel, inputs and manufactured products, servicing external debt
- Social vulnerability: the level of internal cohesion and organisation of the affected community; the more complex the formal and informal network, the more easily a society can absorb impacts of a disaster
- Political vulnerability: constitutes the level of autonomy of a community to make decisions; refers to the concentration of decision-making power, centralisation in governmental organisations and weaknesses in political autonomy at the regional, local and community levels.
- Ideological and cultural vulnerability: dictated by a community's perception of the world's and man's role in it e.g. passivity, fatalism, belief in myths, etc.
- Educational vulnerability: refers to the lack of educational programmes, inadequate instruction or instructors, capacity and materials, unavailability of education programmes that include DRR at local and regional levels, the community's level of understanding of the issues involved in DRR.
- Institutional vulnerability: refers to the obsolete and or rigid institutions in which bureaucracy and political power reside.

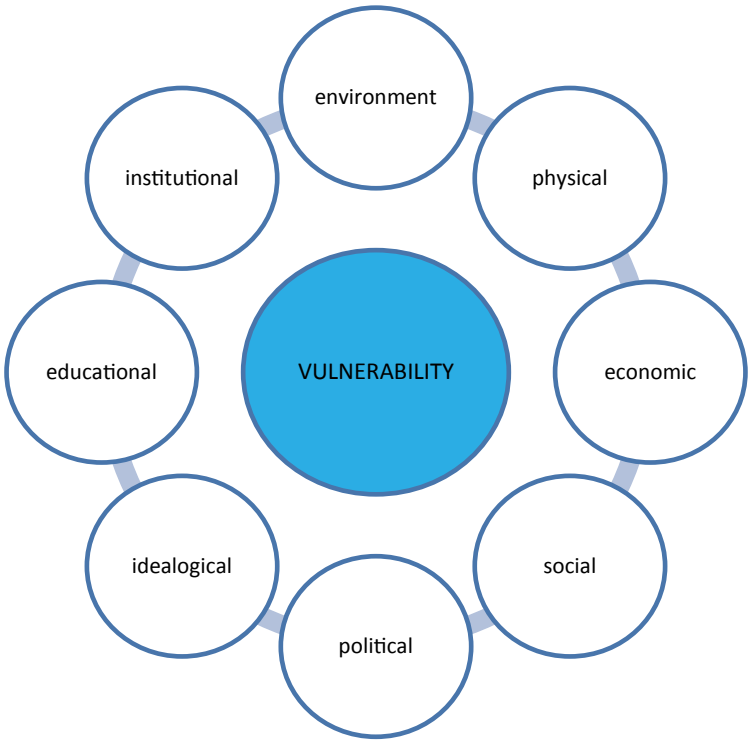


Figure 32: Components of vulnerability as proposed by Wilches-Chaux (1993)

5.3.3 Vulnerability analysis based on selected criteria

ENVIRONMENTAL VULNERABILITY

Rapidly expanding development, historical deforestation, and land and coastal degradation are increasing exposure to floods, storm surge and landslides. Land cover and use changes have altered and intensified the patterns of runoff, and introduced various forms of pollution with consequent impacts on human health, aquatic ecosystems and biodiversity.

Climate change studies indicate patterns of increasing temperature and more frequent and intense tropical cyclone activity with higher sea surface temperatures. Models also indicate decreased precipitation by 15-20% by the end of the century, yet with more intense rainfall events; however, is significant uncertainty in the rainfall projections from the regional climate models and more so for the Lesser Antilles (Farrell et al, 2010; Cashman, 2011). Less overall rain and greater runoff leads to a corresponding decline in the recharge of groundwater aquifers.

Ecosystem management

The colonisation of the island since 1625 led to massive deforestation, primarily for sugar cultivation, with removal of most forest cover by 1665. Subsequent development also saw the draining and/or infilling of wetlands along the west and south coasts, e.g. Heywoods, Holetown, Paynes Bay, Batts Rock, Bridgetown, Accra, Oistins and Silver Sands, such that there is only one mangrove remaining at Graeme Hall, the maintenance of which is currently questionable, and marshy grassland at Chancery Lane (Horrocks, 1997). Construction,

land reclamation, dredging and eutrophication have been the main causes of mangrove loss in Barbados. Designated as a Ramsar Wetland of International Importance, Graeme Hall Mangrove has been degraded as a result of extensive reduction in salinity due to an inoperative sluice gate, dumping of raw sewage into the wetland; contaminated storm water runoff from 1,150 acres of government-managed drainage systems upstream; and, commercial and residential pollutants from adjoining properties (Simpson et al, 2012).

There was also widespread uprooting of sea grass beds, leaving coral reefs as the only remaining element of the coastal ecosystems. This has created a now inherent vulnerability to coastal flooding and submergence of inland areas which were formerly swamps and springs e.g. in Holetown and Spring Garden which become inundated in light rains. Sand dunes, beaches and reefs are also being degraded.

Turners Hall Woods, gullies and sections of the Scotland District represent the remaining forested areas in the country, constituting about 25% of the land area (Downes and Downes, 2003). Among the major challenges with respect to land resources over the years have been conversion of agricultural land to residential and other developments, changes in fiscal policies which increases property value and applicable land tax, insufficient conservation, and socio-cultural preferences for wide houses (ECLAC, 2003).

Vegetated areas are key for the infiltration of precipitation into the soil for the recharge or aquifers and the mitigation of flood risk. Expanding areas of impermeable surfaces due to large commercial developments and high housing demand are increasing surface runoff, and coupled with dumping creating blockages in gullies, increase the propensity for flash flooding, especially on the coast. However, the blockage of primary waterways such as gullies by illegally dumped solid waste acts as a dam, which then triggers flash floods downstream when they give way. The behaviours of littering and dumping seem to be increasing as they are perpetuated by adults and children, with no apparent acknowledgement of the repercussions of such irresponsible actions.

Effective, long-term management and protection of forests, watersheds and nearshore marine ecosystems are also important for the maintenance of ecosystem services (such as maintaining soil structure, moisture and fertility, buffering wave action, beach accretion and protecting coastal infrastructure) and for the competitiveness of the tourism and agriculture sectors. In Barbados, the Inter-American Development Bank has lent more than US$60 million over the last 20 years for construction of infrastructure to rehabilitate beaches on the tourist-laden west and south coasts. Yet fishing and tourist boats off these same beaches continue to drag their anchors through the coral reefs that provide natural protection (USAID, 2013).

Agriculture

Land preparation and tillage practices affect surface water runoff, groundwater recharge, ponding or flooding and soil erosion. While the last two decades have seen the enactment of important pieces of legislation such as the Soil Conservation (Scotland District) Act, Cap 396 (Moore et al, 2012), others such as the proposed Sustainable Agricultural Development Bill and the Agricultural Protection Bill have been pending development for as much as a decade (The Barbados Advocate, 2013; CARICOM, 2005). Droughts not only have direct impact on crops in terms of water availability, but also from disease and higher propensity for wildfires. Sudden and extreme losses are often reflected in price increases, which in turn also impacts competitiveness with imports. The loss in vegetative cover also increases the risk of soil erosion, flooding and land slippage on vulnerable slopes.

While drip irrigation is increasingly being adopted, water use by the sector is still inefficient, leading to rationing of the resource. More education and innovation are needed amongst farmers to help mitigate effects of dry spells, such as separating and sanitising water from organic waste (GOB, 2010).

Climate change

Climate change is likely to increase the frequency and severity of natural hazards and disasters in Barbados, with the potential to affect shoreline stability, the health of coastal and marine ecosystems, the tourism industry and private property. According to data from the CZMU, the 100-year flood model projects that 6,000 residences along the south and west coasts and 70% of west coast hotels would be affected by the event (GOB, 2010).

The extreme mass bleaching events of 2005 and 2010 had severe impacts on the local reef ecosystems; the heat stress caused by high sea surface temperatures is generally attributed to warming due to climate change. In 2005 an average of 70.6% of all colonies were bleached, and 80.6% of those in the near shore (<10m depth). The bleached condition persisted for several months after, indicating loss of live coral for some time after the event. Recovery from bleached condition was slow and overall mortality impact was high (25.9%) on both deep and shallow reefs (Oxenford, et al, 2008a; 2008b). There was also a minor bleaching event in 2012 (Rawlins-Bentham, 2013a).

Urbanisation, poor agricultural practices, and discharge of untreated sewage have caused eutrophication and the fatal white band disease. Overfishing disrupts the reef community and creates an imbalance that increases susceptibility to overgrowth by algae (Simpson et al, 2012). Land-based sources of pollution and physical damage also increase stress and impact the integrity of the reefs, reducing their viability to act as a buffer to wave action. 80% of Barbados' fringing reefs are reported as seriously degraded. Bank reefs coral cover has decreased from 37% to 23% over a decade. Shoreline erosion rates are estimated at 15m every 100 years (GOB, 2010). Barbados is among the highest ranked in the world in terms of exposure to reef threats and reef dependence (Burke et al, 2011).

Coral bleaching, the intensification of beach erosion and encroachment of mangroves and lagoons associated with sea level rise could have serious implications for future development, recreational activities and land use in the coastal zone.

Water resources

Increasing population pressures are also impinging on the adequacy of the current water zoning and treatment regimes. Expanding impervious surfaces with greater urbanisation and more housing are reducing the capacity for groundwater recharge. Low precipitation levels coupled with overabstraction (i.e. current groundwater abstraction rates exceed sustainable yield) foster saltwater intrusion. Intensifying agricultural practices and inadequate sewage treatment also contribute to this risk. These present several challenges for the agencies charged with meeting water demand, monitoring quality and safeguarding public health.

Table 15: Annual internal renewable water resources (IRWR) in Barbados (Source data: 1997 Barbados Water Resources Study via FAO Aquastat, 2000)

Source of water	million m^3
Groundwater derived from infiltrated rainfall	73.9
Surface water	5.8
Springs	2.0
Direct runoff to the sea	0.5

Table 16: Comparison of water stress indices for Barbados (Source data: Aquastat Country Fact Sheet for Barbados; Aquastat Computation of long-term annual renewable water resources for Barbados)

Index	Value	Limit of high water stress or scarcity	Year of data
Water stress index	287.95m³/capita	< 500m³/capita	2010
Water scarcity index R_{ws}	0.8975	> 0.4	2005
Water dependency index[45]	0%		NA

Annual renewable freshwater resources are estimated at 225,410m³ per day (EPD, 2009). Agriculture and domestic sectors are the largest consumers of water, with tourism increasing. Estimated water use in 1996 (FAO, 2000) was:

- Agriculture: 19.01 million m3
- Golf course irrigation: 0.9 million m3
- Domestic, municipal and industrial: 25.85 million m³
- Unaccounted-for water: 35 million m³

Outdated infrastructure compounds the problem of water scarcity with losses due to leakage or through unmetered consumption. Non-revenue water (NRW) is defined as the "difference between water supplied and water sold (i.e. volume of water lost) expressed as a percentage of net water supplied". Currently the level of NRW in the BWA is estimated at 44-49%, relative to the international benchmark of 23%, and representing a large financial loss (BWA, n.d.b). Nevertheless, this is down from 60% unaccounted-for water in 1997 (FAO, 2000). This NRW is not all 'wasted'; some is used in firefighting and street cleaning; other sources are system leaks, liberal use of public standpipes, inefficient meters and a few instances of illegal connections (Skeete, 2012). There are about 120 private wells, and as of the 1996-1998 study only 30 were metered (BWA, n.d.a; Cashman, 2011). It was recently discovered that a community of 38 residences had never been metered since its development 10 years ago, but is receiving water supply (Bradshaw, 2014b). With annual energy costs in the region of US$13 million, this wastage has further impacts for resource use, operational efficiency and financial viability. Environmental issues related to land management have also contributed to the current water resource situation. In particular, there has been a lack of maintenance in the formerly extensive system of check dams in gullies, used to direct surface water into the underground aquifers.

Although the karst geology forms a highly productive aquifer, the overlying soils provide very little protective cover (EPD, 2009). Potential contamination sources are increasingly affecting Zone I and II areas, particularly critical catchments such as Hampton which accounts for about 25% of resources. These include application of pesticides, fertilisers and other chemicals in agriculture; oil drilling, which is not as strictly regulated as bulk storage; encroachment of industry, including small operations, many of which have unregulated waste disposal e.g. vehicle repair and maintenance shops; importation of hazardous substances e.g. naptha, calcium carbide, sodium sulphate, benzene sulphonic acid, liquid butane and polychlorinated biphenyl (PCB)-1254; and unofficial and official solid waste disposal sites e.g. Mangrove Landfill's unlined cell 1 upstream of the Molyneux pumping station threatens leachate contamination (GOB, 2001).

45 Refers to the quantity of renewable water resources originating outside of the country

For instance, nitrates have been observed to approach and occasionally surpass the recommended WHO guidelines of 10mg/l at certain abstraction sites. Such elevated levels of nitrates have been correlated with chronic human health effects, and adverse impacts on marine ecosystems. Most recent studies show the highest susceptibility for contamination exists in areas of high population density and residential land use. Approximately 46% of the public supply sources sampled show risk of exceeding the WHO guidelines, and are all within less than 1km of the high susceptibility areas. Further, water quality data collected by the Barbados Agricultural Development and Marketing Corporation (BADMC) from agricultural wells showed highest mean nitrate concentrations of 29mg/l and peaks of 85.3mg/l. Animal excreta from poultry and livestock rearing also represents a source of contamination, for which there are no explicit regulations for disposal, storage or handling (EPD, 2009).

Sewage treatment plants service sections of Bridgetown (1,400 connections) and the south coast (2,222 connections) with secondary and primary level treatment respectively. A proposed plant for the west coast has not come to fruition after over a decade of discussion. Otherwise, domestic sewage is disposed of via septic tanks, suck wells and soakaway pits. A number of hotels, industrial, commercial and institutional facilities manage on site package plants, which then discharge into suckwells. This has negative implications for nearshore water quality for the operations in close proximity to the coast (EPD, 2009). The majority of industrial operators use suck wells as their main method of effluent disposal, however the vast majority by volume is by sea (EPD, 2007). The BWA, EPD and Sanitation Service Authority are collaborating to address the threat of illegal dumping, especially in Zone I areas such as the Belle and Hampton catchments (Joseph, 2013). At present there are no legally enforceable national water or wastewater quality standards in operation; therefore those of the World Health Organisation (WHO) and US Environmental Protection Agency (EPA) are used.

Considering future trends, saline intrusion and contamination are on a trajectory toward declining water quality, demanding higher levels of treatment, which the current infrastructure may be unable to manage, and which would incur more capital and operational costs. Climate change could compromise the integrity of pipeline networks and their satisfactory performance given the known effects of cyclic saturation and prolonged drying out of soil imposing stress and movement on buried pipelines. The cumulative effect of such movements would be observed increase in leakages and bursts, thus demanding greater attention to leak detection and repair (Cashman, 2011).

PHYSICAL VULNERABILITY

The quality of housing construction (e.g. building materials, foundation, secure roofing); compromised drainage infrastructure; and occupation of hazard-prone areas are increasing vulnerability to floods, storm surge and high winds.

The housing stock within the country has progressively moved from being dominated by chattel and wooden structures to an increasing proportion of concrete constructions, with recent surveys revealing wood/timber structures as 23% of the housing stock and concrete at almost 50% (CDB and GOB, 2012; BSS, 2012). However, there is still a predominance of wooden homes within low income communities, which tend to be densely built. These areas tend to be prone to extensive damage from high winds and fire. Over the last few decades there has been concerted effort to incentivise the use of materials such as hurricane straps in new home construction and retrofitting homes and built structures.

There are instances where settlements have been sited in flood prone areas prior to the institution of development controls. The cities (Bridgetown, Speightstown, Holetown and Oistins) and many population centres are located in low-lying coastal areas, along with much of the critical infrastructure (e.g. electricity generating plants, fire stations, hospital, ports) and hotels. In other cases, development plans are approved contrary to the advice of the Chief Town Planner, as the Minister can exercise discretionary powers as provided in the Town and Country Planning Act, based on other considerations.

Adherence to the revised Building Code is not a requirement for development approval as it is not yet legislated. Further, with limited capacities within regulatory agencies, there is often disparity between constructed developments and approved plans (ECLAC, 2010). The development control process, guided by the Physical Development Plan (2003) includes stipulations for setbacks from the coast, cliffs, gullies and watercourses. However there are numerous instances of impacts, for example, where wave action and erosion have undercut homes either due to non-compliance, erecting structures in breach of the high water mark and recommended cliff edge, or construction prior to regulation. There is also illegal squatting in the Scotland District on lands vulnerable to slippage, among other areas. There are efforts being made by the Ministry of Housing to regularise these "occupiers without title", either through giving title since most are on crown lands or removal from vulnerable areas.

Flooding is often a result of inadequate drainage infrastructure, with poorly designed suck wells, infilling of gullies and waterways, and insufficient maintenance. Events in 2008 were attributable to such causes (ECLAC, 2010) and projected stormwater runoff is expected to even further exceed the design capacity of the existing drainage infrastructure (GOB, 2014). Indiscriminate dumping of waste causing blockage of drains and gullies also play a role in triggering flash floods.

Many of the buildings designated as storm shelters are in zones of inundation, particularly on the south and west coasts, where the majority of the population and much of the tourism infrastructure are located (Brewster, 2007). The tsunami risk assessment demonstration methodology applied to Bridgetown showed that emergency services, banking and finance, commerce and tourism would be considerably affected by the "Lesser Antilles" scenario tsunami, and there could be 132 fatalities out of 30,000 (NGI, 2009). This not only increases exposure of people during flood and storm events, but will also affect the trust in the disaster response system, which is vital to its proper function.

ECONOMIC VULNERABILITY

High external debt, heavy dependence on imports, rising unemployment and inequality are eroding the ability of the country and communities to cope with hazard impacts, which can gradually make even small events devastating.

The economic crisis vulnerability of Barbados is calculated at approximately 0.56 of a maximum score of 1.0, indicating high vulnerability to shocks and crisis (UNISDR, 2013). At the sector levels, key sectors such as agriculture and fisheries remain weak in terms of understanding the effects of climate change on the sector and pre-planning to ensure food security and employment nationally (DEM, 2013).

Debt levels for the country and accompanying fiscal imbalances and high government expenditure have contributed to the current economic position of high unemployment, high taxation and minimal economic growth. Gross general government debt at the end of March 2014 stood at approximately US$4.208 million, about double that of US$2.13 million in 2006; while gross public sector debt was US$4.639 million, up from US$2.564 million in 2006 (CBB, 2014a).

The government is the largest employer in the country, with a wage bill of over US$700 million, representing 10.3% of GDP, the highest in the region (IMF, 2014). Unemployment rates have been increasing, being over 10% since 2009, and as high as 13% at the end of 2013 (see Figure 9). During 2014 the government has embarked on a retrenchment exercise following the IMF 2013 Article IV consultation, which is expected to see losses of over 3,000 jobs. Layoffs in the public sector cumulatively reached a total of about 2,800 as of March 2014, estimated to have reduced expenditure by US$10million. There have been contentions over the retrenchment process, including some resulting industrial action. Of particular concern is where affected persons are the sole bread winner in a household, or more than one bread winner per household is affected. These occurrences, though few, have the potential to result in rapid decline of households into poverty. This process will see additional demands on the NIS and Welfare Department as increasing numbers ware seeking to access their services. The private sector has also been affected over the last 5 years, with various downsizing and restructuring actions. In many cases attempts have been made to avoid layoffs by reducing number of days or hours worked.

The government has provided access to a US$5million Unemployment Retraining Fund, designed to provide retraining opportunities for unemployed persons through tertiary and vocational institutions such as the Barbados Vocational Training Board, the Samuel Jackman Prescod Polytechnic and the Barbados Community College. The Minister of Labour lamented that the targeted groups are not adequately taking advantage of the provided opportunity. Conversely, these institutions are limited in their available space and equipment to cater to the demand being received (Joseph, 2014a).

A notable phenomenon is the tendency for lower-income earners living in homes of wooden construction to not have home insurance. The structures themselves often may not have secure foundations or roofing, and may have some level of disrepair. The lack of insurance, and sometimes lack of land title, means that even a small event can produce irrecoverable consequences. For instance, the flooding caused by a small trough system in September 2014 shifted a house off its un-cemented block foundation, displacing a family of 5.

With high reliance on the tourism sector (accounting directly and indirectly for 39% of GDP and 50% of total export earnings in 2008 (GOB, 2010)), natural hazards typically hold threat of high costs to replace infrastructure and facilities, both from the public and private purse. Accompanying disruption of travel and communication services present added economic losses as business is disrupted for extended periods (Philips, 2011). In Barbados, figures indicate that in 2007 over 90% of the hotel room stock of the country was located in coastal areas (ECLAC, 2010a), creating high exposure to coastal and hydro meteorological-related hazards, as well as climate change (e.g. storm surge, coastal floods, tsunamis, sea level rise). Beach tourism investment therefore presents a high level of disaster risk, costs of which are shared by the economy and society as a whole, for instance through coastal erosion, pollution, and unemployment during post-disaster reconstruction.

With limited hydrocarbon resources and low overall uptake of renewable energy, Barbados is extremely vulnerable to volatility of global oil prices. This is a significant threat, although much untapped potential exists in Barbados and across the region. As of 2007, only 3% of electricity in the region was generated from renewable sources (USAID, 2013).

High risks of disruption of international transport and logistics services compound the already high costs, where maritime transport for SIDS is greater than any other country group due to remoteness, challenging connectivity, trade imbalances (high imports) and small shipping volumes. For Barbados, the expenditure on international transport represented approximately 11% of the value of imports during 2004-2013, as compared to 8.1% as the global average (UNCTAD, 2014). These concerns of high cost and connectivity also extend to regional inter-island travel.

With a high rate of importation of goods (food, clothing, petroleum products, medicines, etc.) a disaster which causes loss of access to the air or sea ports for any prolonged period presents a significant threat to the country. As Figure 33 shows, at their lowest level during the time period, the value of imports constituted 31% of GDP in 1992, reaching 52% in 2008, and averaging 40% for 2011-2013. Over 70% of the country's food requirements are met by imports (Skeete, 2010; Emmanuel, n.d.). Barbados has a 3-month food reserve in case of disaster (GOB, 2010).

Agricultural losses lead to utilisation of more national resources for the importation of food as food insecurity becomes particularly acute. Despite its declining contribution to GDP and employment, the sector still plays a critical role in food and livelihood provision and the servicing of other economic sectors such as tourism and manufacturing. For the most part, croplands are rain-fed, with only 29% irrigated, thus suggesting limited capacity to cope with meteorological drought (Farrell et al, 2010).

Closure of ports also reduces revenue from tourism, the country's principal generator of foreign exchange. These vulnerabilities will substantially impede any reconstruction and recovery processes.

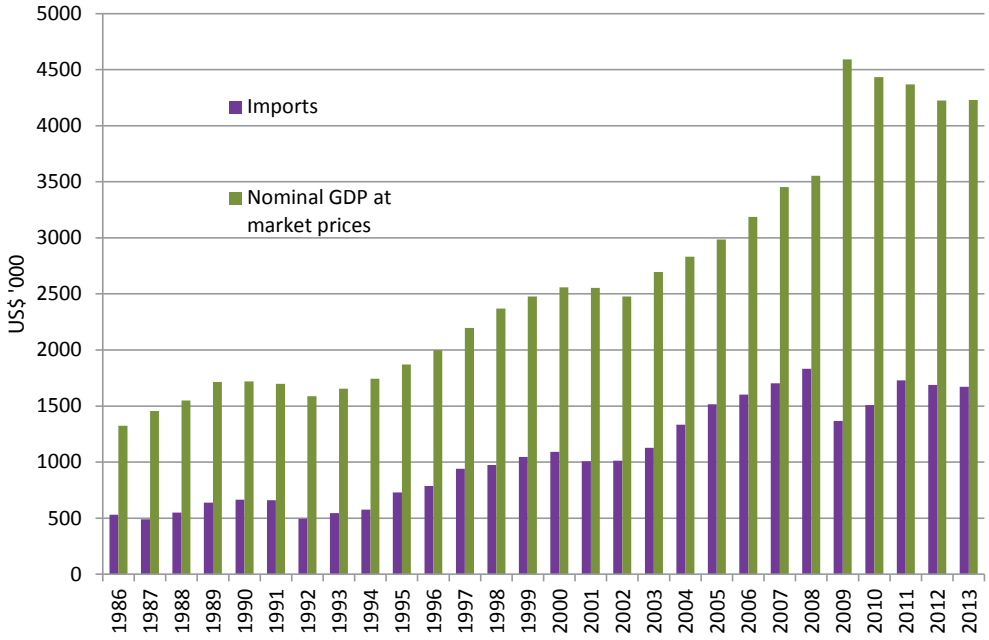


Figure 33: Value of imports compared to nominal GDP for Barbados 1986-2013 (Source: Central Bank of Barbados)

Being a small island developing state designated as a country in transition, Barbados has restricted access to grant and concessionary financing to support its entire sustainable development programmes. In addition, the current global economic environment has further eroded the ability of the government to adequately support all facets of the disaster management cycle (DEM, 2013). The government has not yet seized the opportunity to integrate risk reduction into its national accounting and budgetary systems. Quantification of investments within the context of resilience building helps to strengthen the perception of and advocacy for disaster risk management and allows visualisation of the contribution of risk resilience to the stability of the economy and to poverty reduction and sustainable development. It would also strengthen the linkages to climate change adaptation and environmental management, thus reinforcing the position for investment in these areas.

Box 5: Unfolding vulnerability - a compiled case study of Speightstown, St Peter (Sources: CERMES, 2010; Hinds and Spence, 2008)

Characteristics:

Speightstown in the second largest town in Barbados and is a hub for commercial activity for the north of Barbados. it dates back to the 17th century as a port vital for trade and connecting Barbados to other countries.

Historically, the area was covered in mangrove forests that served as a primary catchment area and drainage outlet for watercourses and gullies inland.

Increased precipitation along with the clearing of the mangrove swamp has led to increased frequency of flooding in Speightstown, which has been further exacerbated by poor drainage facilities and maintenance e.g. the Salt Pond Canal, a direct outlet to the sea, had not been designed to accommodate the volume of water being discharged through it or to prevent the accumulation of beach sand at its seaward end; hence it is usually blocked and flooded. Severe floods were experienced during 1984-1987, and again in 1993 and 2004.

Hazards:

Sea level rise, coastal erosion, storm surge, flooding, predicted to become more severe and destructive in the future

Vulnerability:

- Approximately 370 structures are at risk with the potential for about 11-18 (3-5%) being completely destroyed
- Population at risk about 1,036 (2.8 persons per household)
- 139 persons or 13.4% of the affected population is over age 65
- At-risk tourism infrastructure from climate change valued at around US$750 million (2005); tourism accounts for 27% of the total land use
- Approximately 65% of critical facilities are within the storm surge zone
- The inundation zone covers a substantial portion of the major newer residential (tourism-based) construction
- Coral reefs (natural structural buffer to storm surge) are likely to be damaged by wave action, debris and siltation

Expected impacts from natural hazards and climate change:

- In the event of a 1:100 year flood most of the properties along the bypass road will be inundated
- Areas of beach will be exposed to direct wave action and some will be lost to erosion
- The water table levels along the shoreline are expected to get much higher causing sewage wells not to function properly hence increasing the risk of flooding
- Several residents and business operations in such areas would be affected
- Expected coastal land lost due to 0.2m SLR is 1.13m. This would threaten the loss of the recreational beaches in the area and pose a direct threat to municipal and tourism infrastructure

- Impact on the coastal resources, mainly beaches and coral reefs, will lead to habitat modification particularly compromising turtle breeding and other marine life feeding resources
- The impact of a 1:150 year flood event is estimated to be between US$7 million and US$20 million

Steps taken toward risk reduction:

- Collection of hydrological data, completion of a series of flood analyses and GIS database, flood hazard mapping
- Installation of hydrological and meteorological equipment
- Development of a hazard mapping manual
- Strong community participation/leadership in:
  - Identification of safe evacuation routes and critical facilities, especially shelters
  - Collection, assessment and evaluation of hazard information, local population data, and information on socioeconomic conditions
  - Development of the Community Disaster Management Plan
  - Community drills and exercises
- Training received in:
  - Hazard mapping
  - Community disaster management planning
  - River and dam engineering
  - Geographic information systems
- Flood mitigation works

In pressing further into risk reduction at the community level, the perception of risk is critical in persons being motivated to take action. A deeper understanding of the nature is also needed such that individuals are able to correlate an event to triggering a hazard (e.g. excessive rainfall causing flooding and landslides) but also to the social and economic repercussions thereafter.

Utilising stakeholders` perceptions of the issues to tailor future adaptation policies would increase the effectiveness of the policies. Policies designed with a participatory approach, involving the persons it would actually affect, their concerns, culture and values, tend to be more transparent and easily implemented and upheld. Hence to achieve effective implementation and maintenance of a good adaptation policy is to achieve increased resilience and the ability to cope with climate hazards. Consensus and consultation are crucial in effective policy formulation and implementation.

SOCIAL VULNERABILITY

The degree of community cohesion varies greatly from place to place. Generally it may be said that communities tend to be more closely knit in rural areas and low-income areas, and also neighbourhoods where there is an active community centre and/or recreational facilities. Observations suggest that in these areas residents are more likely to use public transportation and engage outside of their homes; hence there are more opportunities to bond and form relationships, forming support networks which are useful in an emergency. Some communities, generally suburban, have neighbourhood watch systems, which build rapport between households, and with the police and other emergency services.

DEOs provide an opportunity for community members to voluntarily engage in the disaster management process. However, participation is sporadic. One factor of this appears to be the definition of DEO boundaries according to political constituency boundaries, fostering the perception of political alignment. There is also a need for stronger integration with the Constituency Councils (DEM, 2013). DEOs also collaborate with other community-based organisations such as the Barbados Red Cross Society and Parish Independence Committees on activities such as surveys, clean-ups, hazard education, first aid training and disaster response (Taikaram, 2010).

Persons with disabilities (PWD) and the elderly are two of the vulnerable groups within the society, representing approximately 5% and 16% of the population respectively (BSS, 2012). There are a number of government agencies and NGOs advocating for and providing services and support to these two groups, several of which participate in the national Vulnerable Persons Committee.

A number of legislative provisions govern the care and protection of children as having some relevance to hazard situations. These include the Family Law Act (1981) and Regulations (1982), the Protection of Children Act (1991), the Prevention of Cruelty to Children Act (1981), the Child Care Board Act (1991) and the Education Act (2001). Yet, they need updating to fully comply with the articles of the United Nations Convention on the Rights of the Child, and are weak in addressing the needs of children in disasters (O'Garro, 2009).

Civil society, sector organisations and the private sector are actively represented within the NEMS through the Standing Committees. However, there is no participation by gender or youth groups.

There is a perception among national authorities that there are no gender-specific issues relevant to DRR in the country, and therefore no attempt has been made to address them. Contingency plans, response measures, post-disaster needs assessments and other procedures do not account for any gender sensitivities (DEM, 2013). During the recovery and reconstruction process, female-headed households are particularly vulnerable, where they are the primary caregiver and income earner. When shelters are being occupied for an extended period and children cannot return to school, it means the mother cannot return to work. Research shows that 19.4% of female-headed households are poor as compared to 11.5% of male-headed homes. The burden of care and access to educational opportunities and the labour market are among the driving forces of this disparity. The burden of care is further amplified in indigent poor households, where there are on average 2.3 children and 11.2% overcrowding as compared to 1.5 children and 2.9% overcrowding in non-poor households.

At the time of the CALC survey (2010) employment among men and women was 62.9% and 54.7% respectively. Further, the types of skills possessed by the two groups indicate a likelihood of males being more readily employed in the immediate post-disaster situation i.e. 72.3% of men are trained in agriculture or a skilled trade as compared to 8.6% of women (CDB and GOB, 2012). Conversely, loss of ability to provide for their household may be more demotivating for men than women and may lead to increase in inappropriate coping mechanisms such as drinking, as has been observed in other islands (USAID, 2013). Because there has not been a major impact in Barbados for several decades, there may not have been opportunity for such situations to be revealed. Fortunately this provides opportunity for systems to be put in place to mitigate their occurrence.

Literature suggests that as a consequence of climate change vulnerable groups will be subjected to multiple, simultaneous problems, including widespread loss of employment and production due to abandonment of low-lying areas, food insecurity, health risks and large-scale eco-migration. Resource-dependent, low-income communities are constrained in their capacity to adapt and climate change will increasingly be a key contributor to morbidity, mortality, and continued poverty (USAID, 2013).

POLITICAL VULNERABILITY

There is little vested autonomy within communities or parishes to make decisions or independently respond to local-level crises, with disbandment of local government in 1969.

The centralised governance system has begun a process of decentralisation with a system of Constituency Councils as a mechanism to address issues of social isolation, political apathy, economic deprivation, and alleviating delays in procedures. Among their core functions are identifying priority needs of the constituency, supporting and building the capacity of local organisations, and executing priority programmes and projects (Department of Constituency Empowerment, n.d.). The role of the Constituency Councils in DRM is not clearly defined, potentially leading to conflicts with the DEOs.

The DEOs are also mandated to operate EOCs, for which they dedicate much time and resources to locate and equip. However, they do not currently possess autonomy to assess and respond to local emergencies independently of the NEOC, nor is there effective communication and coordination between the DEOs and NEOC during an emergency situation (Taikaram, 2010).

This singular decision-making structure can create bottlenecks and extensive delays, particularly in the dissemination of funds in very time-sensitive emergency situations. It also affects agencies' attempts to strengthen their capacities, whereby the lengthy approval process for a nominee to a training programme often means the window of opportunity is closed by the time it is complete.

EDUCATIONAL VULNERABILITY

One of the key roles adopted by the DEOs is to educate their communities about general threats to the community and improving knowledge to address them, including natural hazards and chikungunya, fire safety and first aid. Their activities include presenting diverse topics to their communities on natural hazards and other community-specific issues.

Many other partners are engaged in increasing stakeholder knowledge and understanding about natural hazards and how they can personally reduce their risk, appropriately prepare and respond during an event. They generally work directly through the DEM, or another technical agency depending on the specialisation e.g. CZMU, EPD.

CDEMA has been working assiduously with its Participating States on the "We Ready"[47] campaign which looks at all the major hazards facing the region. Special emphasis has been placed on tsunami awareness as a hazard which previously was unfamiliar to most of the region's population. Lack of awareness about earthquakes and tsunamis represents a vulnerability in itself which is slowly being addressed.

DRM is not a specific subject within the primary or secondary curricula, however elements are integrated in subjects such as geography, social studies and environmental science; and research papers and projects on DRR are increasing at all levels (DEM, 2011). Public service announcements and information segments are included in all media (television, newsprint, radio, websites, some social media), with the greatest concentration immediately prior to and during the hurricane season.

The level of understanding and preparedness of households to various hazards has not been formally assessed.

47 http://weready.org/

INSTITUTIONAL VULNERABILITY

Insufficient inter-agency coordination is a typical complaint in the arenas of environmental management and disaster risk reduction. Because of the truly multi-disciplinary nature of these fields, the input of a plethora of actors is required, which is often difficult due to insufficient human resource capacities, high staff turnover, or conflicts between personalities impinging on decision-making processes. A comprehensive planning approach is not being implemented by the environmental sector.

Lack of clear definition of agency roles and responsibilities often results in duplication or inaction where mandates overlap. In some cases technical staff come to mutual working agreements; in others resolution is eventually provided through legislation. For instance the Safety and Health at Work (SHAW) Act 2005 Cap 356 (entry into force on 1 January, 2013) has clarified division of duties between EPD, the Labour Department and the Environmental Health Department.

Inaccessibility of data from institutions adversely impacts on ability to achieve holistic informed decision-making. Fragmentation of data, location in multiple agencies, and lack of integration and centralisation of data present issues for comprehensive analysis to inform planning. Moreover, the absence of a culture of data collection and management means that often databases may be initiated without sufficient impetus (personnel, equipment and/or technical skill) to maintain and update them.

Oftentimes, much of the investment in DRR-related initiatives occurs in the form of externally-funded projects. Communication on the planning and implementation of projects often does not occur in the inception stages such that key stakeholders that are expected to be involved are unaware of the initiative until after agreements have been signed. Limited technical capacity in most government agencies makes implementation challenging and sustainability dubious. Greater collaboration is needed between agencies during project design to ensure that synergies between projects are capitalised and that expansion or replication occurs instead of duplication of activities. However, as with interagency coordination in general, there is no formal mechanism or virtual forum for sharing such information.

5.4 Capacities

Capacity refers to the "combination of all the strengths, attributes and resources available within a community, society or organisation that can be used to achieve agreed goals" (UNISDR, 2009). Within this context, the goal can be described simply as the reduction in risk or exposure of the population, economy, natural and built environment. Skills are built, strengthened and maintained via multiple mechanisms and at multiple levels – individual, institutional, societal, sectoral – with the objective of realising articulated development goals.

For DRR to be successful, capacities must be developed throughout the entire population, not any select group, agencies or profession. Further, technical capacity development must be coupled with determined functions in the DRR field (UNDP, 2010).

5.4.1 Analytical criteria and methodology

There is a plethora of indicators which can be used to describe capacities, for example, by level (local, national, regional), by stakeholder type (government, private sector, NGO, community, individual), or by resource (technical, human, financial etc.).

In this discourse, capacities are characterised according to the phase of disaster risk reduction to which they apply (Figure 34). Following is a series of matrices that attempt to summarise information by level, sector, and other criteria.

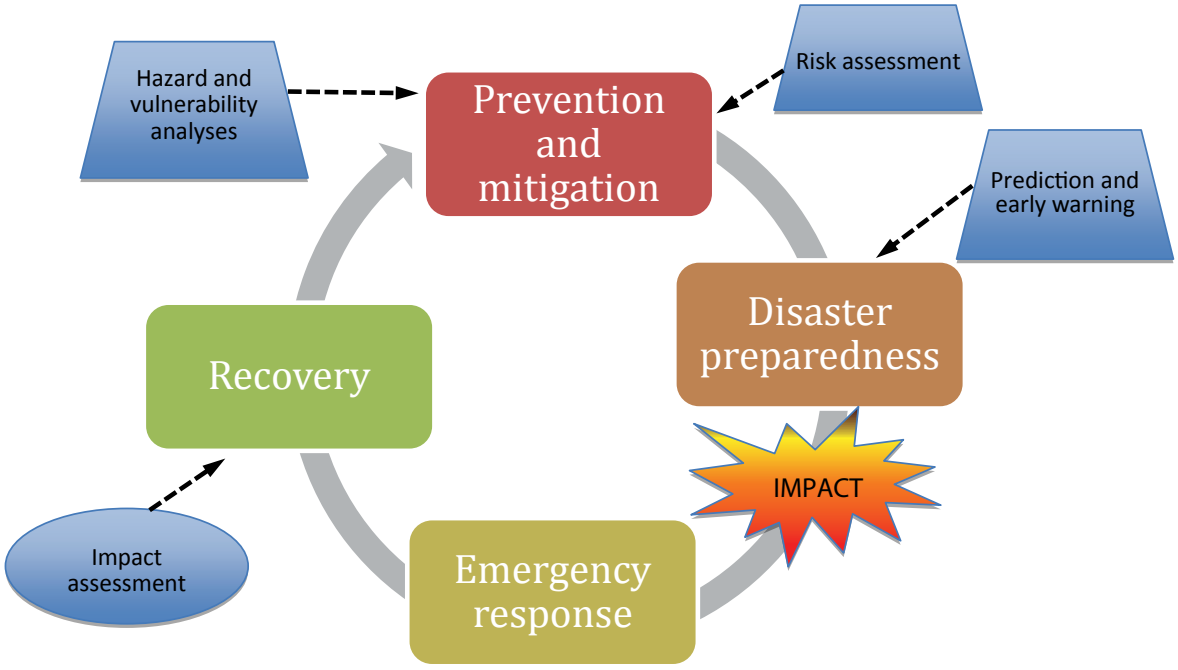


Figure 34: The disaster management cycle

PREVENTION AND MITIGATION

Risk identification and assessment

Vulnerability assessments, hazard maps and risk assessments for critical infrastructure are not generally applied to be able to holistically inform development planning. The exception to this is in the Scotland District, for which such exist. The PDP 2003 contains a map of significant natural features and natural hazard lands. Hazard and vulnerability assessments (HVA) and hazard mapping are informing emergency planning and this capacity is being strengthened by the use of current information and communications technology. The status of hazard maps and vulnerability assessments is summarised below as surveyed in 2003.

Table 17: Hazard maps (HM) and vulnerability assessments (VA) available for Barbados (Source: CDERA, 2003)

Type	Purpose	Coverage	Scale	Date produced	Primary sources
Landslide HM	Guide for agricultural, re-sidential and recreational land management	Scotland District	1:5000	2000	Ministry of Agriculture
Flood HM	Development planning and control	Speightstown, Weston, Holetown, Constitution River, Wotton	1:2500	unknown	Ministry of Public Works
		West and south coasts	1:1000	1994	CZMU

Type	Purpose	Coverage	Scale	Date produced	Primary sources
Seismic HM	To map horizontal ground acceleration, expected maximum Mercalli intensity and horizontal ground velocity	Barbados	0.25° grid	1999	OAS/ CDMP
	To map general level of earthquake hazard in the Caribbean in terms of the Modified Mercalli Scale, PGA and SGA values		0.25° grid	1999	Seismic Research Centre
Human and economic VA	To delineate the 5, 20 and 100-year floodplains	Barbados	NA	1996	Ministry of Public Works
Biogeophysical and socioeconomic VA	To assess the effects of sea level rise and potential for adaptation	Coastal regions	NA	2002	CZMU/CPACC
Tsunami VA	To evaluate possible impacts of tsunamis	Northwest coast	NA	1999	Port St Charles Development Ltd

Maintaining updated high quality risk information on coastal and nearshore processes has been a significant constraint for the CZMU, particularly for special issues such as cliff and slope stability in the Scotland District. Existing information on coastal vulnerability is not linked to a national risk information database with GIS and modelling capabilities. Improved capabilities for comprehensive vulnerability and risk assessments of the coastal zone, which incorporate climate modelling, as well as appropriate long term continuous monitoring and evaluation (M&E) tools to support decision-making in CZM are among the needs targeted under the Coastal Risk Assessment and Management Programme (CRMP) (see Table 21). Baseline data, modelling and regulatory tools are required to enhance the resilience of future development to current variability, disaster risk and projected climate change (GOB, 2010).

The BWA's WSSU Project will be developing GIS capabilities which include datasets such as location of water courses, sewage network, land usage, population density and the different types of soil. This type of information will be used to assist in determining proper sanitation disposal as it relates to areas near water sources in addition to other resource management and protection functions. The GIS can be used in conjunction with the hydraulic network model of the distribution system, which has already helped identify the most critical mains for the mains replacement initiative. This will be coupled with the implementation of a Supervisory Control and Data Acquisition (SCADA) system will allow the BWA to monitor and control its production systems e.g. pump status, reservoir levels, power and water quality. It also facilitates a more proactive in its operations due to a real-time awareness of potential equipment failure and to respond quickly to issues facing the public. The SCADA system will thus contribute to reducing NRW and energy costs.

Structural and non-structural mitigation activities are conducted in the Scotland District, including bench terracing, slope reduction, excavation of silt dams, reforestation, and relocation of communities from areas of high landslide and flood risk. In general, development regulation on the coast is currently based on hazard maps of the 100-year storm surge inundation line, and coastal setbacks are measured based on distance from this benchmark (DEM, 2010; ECLAC, 2003).

Over the years a number of agencies have invested data and information into GIS platforms to support decision making, including DEM, TCDPO, CZMU, the Ministry of Health, the Lands and Surveys Department and the Ministry of Agriculture, Food, Fisheries and Water Resource Management, which have been used to some extent to inform decision making. However, the funding to initiate such is often external, with insufficient capacities to maintain the databases over time. Further, with the lack of integration of these data in a centralised national system, they are unable to be comprehensively utilised e.g. in early warning systems (DEM, 2010). Perennially acknowledged as a significant constraint throughout the region, attitudes and protocols regarding collection, storage, management, sharing and ownership of data and information will need to change. Building resilience and using risk management to aid decision-making where there is uncertainty requires access to the best available data and information. CCCCC (2012) advocates an 'open source' and 'open access' attitude to facilitate sharing and optimising use of the best available information by decision-makers. Where data access is restricted in order to generate revenue, alternative and more viable funding mechanisms are required.

A coastal vulnerability assessment of the St. Peter coastline has been conducted under an IDB/CDEMA initiative Adaptation for Climate Change and Disaster Mitigation: Township Planning Strategies for Storm Surge in the Caribbean. Under this project there has also been the development of a draft toolkit which provides guidance on the replication of the project in other coastal areas (GOB, 2010).

Priority is being given at present to the actualisation of the CRMP to build resilience to coastal hazards (including those associated with climate change) through enhanced conservation and effective management. The overall objective is to build capacity in integrated coastal risk management in Barbados incorporating disaster risk reduction and climate change adaptation in development planning, control and monitoring of the coastal zone. Components relate to coastal risk assessment, monitoring and management; coastal infrastructure; and institutional sustainability for Integrated Coastal Risk Management. Outputs include hazard, vulnerability and risk assessments and mapping using a multi-hazard approach (IDB, 2010b).

An integrated coastal risk data and information platform (CRIP) will be established, accessible by NEMS members and key economic sectors, enabling a robust regulatory system. Management options will be tested, and the best selected for island-wide implementation. Unfortunately, present understanding of the CRIP is imperfect, and requires augmentation for its effective incorporation into decision making (DEM, 2013). CIMH has established a similar web-based platform, DEWETRA, for inland flooding and tropical cyclones, which will be linked to the CRIP. Constraints in integration relate to incorporating non-coastal hazard data and information into the platform for use by key stakeholders. Other concerns relate to applicability, as there has been limited uptake and active utilisation of the DEWETRA platform, despite several training sessions and available technical assistance from CIMH.

The Veterinary Services Department and Plant Protection Department perform a number of functions to prevent the entry of pests and diseases which can pose a threat to public, environmental or agricultural health. The Pesticide Unit also evaluates products for their potential impact on human and environmental health, including groundwater. Among the measures used are:

- Prerequisite for import/export permit for plant or animal material
- Quarantine of suspected or infected material, with quarantine and inspection services at the main ports of entry – Bridgetown Port, Grantley Adams International Airport and Port St Charles. Notably, there is weakness at the approximately 30 fish landing sites (e.g. Consett Bay, Oistins, Paynes Bay, Tent Bay) where inspectors are not stationed.

- Pest risk assessment, which includes requesting the list of endemic pests from the originating country, possibly travelling to said source for inspections, assessment of the potential for introduction and spread, and potential economic consequences
- Creation or revision of policies and priorities e.g. a protocol was instituted with Guyana, Trinidad and Tobago, Saint Lucia and St Vincent and the Grenadines following the outbreak of the hibiscus pink mealy bug in Barbados, with quarantine officers helping to build capacities (e.g. to conduct inspections) in those countries and strengthen their systems, since a significant portion of fresh agricultural produce into Barbados comes from CARICOM.

To ensure the high level of technical skills needed to ensure food and health safety, training is provided for regional quarantine officers annually by UWI, in a joint effort by FAO, the Inter-American Institute for Cooperation on Agriculture (IICA), the US Department of Agriculture (USDA) and the Commonwealth Agricultural Bureaux International (CABI). Further, CARICOM's Council for Trade and Economic Development (COTED) has meetings of Chairs of Pesticide Control Boards, Chief Veterinary Officers and Plant Health Directors annually, maintaining the regional collaboration that is needed to effectively protect all borders.

The Pesticide Control Board (comprised of representation from the Ministries of Health and Agriculture, EPD, and independent expertise) works with the Pesticide Unit to control the entry of pesticides into the country. Applications for permits include submission of the toxicology, MSDS sheet, and formulation of the product; the pests it is used to treat; environmental conditions where it is usually used, inter alia. Some substances are persistent organic pollutants (POPs). Sometimes the inert ingredients can be more dangerous than the active ingredient. Some are simply listed as 'other'. The Technical Subcommittee reviews the application and researches the use of the product; the approaches used by the US Environmental Protection Agency (USEPA), USDA, EU, WHO and Pesticide Action Network; whether there are bans in effect and related conditions; and makes recommendations to the Board, sometimes with for more environmentally-friendly alternatives.

Notably, political interference presents an additional risk and may impede effective execution of duties by the officers. This may come, for instance, in the form of a Minister instructing inspectors to approve an infected batch of crops for export (although technical cooperation between officers in the countries has helped to circumvent this); pressure to clear a shipment through customs which may contain prohibited substances; or objections to restrictions on imports from other CARICOM countries due to pests or infection on grounds of regional free trade..

The scope of CDM includes development of a Hazard Mitigation Policy and Plan, within the context of the national Hazard Mitigation Committee, the last of the Standing Committees awaiting establishment under the NEMS. In October 2014, Cabinet approved the chairing of the Hazard Mitigation Committee by the Chief Town Planner. With a framework for involvement of a wide cross-section of stakeholders, its purpose is to facilitate the implementation of the most cost effective, technically feasible, appropriate and equitable mitigation projects, and within this remit as drafted (GOB, 2013) includes:

- Assessing risks from natural and anthropogenic hazards including climate change impacts, and using risk assessments in the development of Hazard Mitigation Plans and in the development and evaluation of proposals for mitigation projects/ measures
- Facilitating coordination and cooperation amongst local and national government and private sector risk reduction planning
- Assisting the integration of risk communication and risk reduction measures into other plans, policies, tools or processes that lead to safer and more resilient communities

- Encouraging governmental agencies and the private sector to prepare hazard mitigation plans
- Undertaking systematic M&E of progress towards achievement of (risk reduction) results.

At present, the Standing Committee on Coastal Hazards is the only scientific Standing Committee, with its membership drawn from the public and private sectors. This team is focused on minimising hazards along the coast, such as winter swells, erosion, storm surge, tsunamis, sea level rise and oil spills.

Land use and development control

The 2003 PDP addressed some of the pressing land management issues at the time by emphasising protection of natural environmental and cultural heritage resources; defining an Urban Corridor, agricultural areas and National Park areas to maintain the viability of the capital Bridgetown and protect agricultural land forms; and establish environmental impact assessment (EIA) procedures.

Applications to the Town and Country Development Planning Office (TCDPO) are overlaid with hazard maps and water zones, as well as special areas of protection such as the Scotland District, Harrison's Cave and the airport restriction zone to determine the acceptability of the location. The review process is supported by various agencies – the Building Standards Authority (fire safety), EPD (ventilation, sewage, design of sensitive operations such as hospitals and restaurants to prevent spread of disease, etc), Drainage Division (stormwater), BWA (proximity to Zone I) and CZMU (coastal and cliff top developments). The supporting framework includes the Town and Country Planning Act and the Health Services (Building) Regulations 1969. Since 2007, cliff top developments require geotechnical assessments. This follows the tragic collapse of an apartment building erected above a known cave in August of that year, killing 5 members of a family (Goddard, 2012). The UNESCO World Heritage Site designation of Historic Bridgetown and Its Garrison is now an additional consideration. A ridge to reef approach to development is adopted given the size of the country and the linkages between human settlements and the health of water and marine resources.

EIA is designed to identify and evaluate the potential effects a proposed development will have on the environment, weigh alternatives and construct appropriate mitigation and monitoring measures to minimise deleterious impacts. Within the context of the Town and Country Planning Act, an EIA Panel (including the Building Standards Authority, EPD, and more recently DEM) reviews applications that exceed criteria to require an EIA.

The integration of hazard impact assessments into the existing EIA framework of the development control process is being sought, which would allow explicit consideration of the impacts of hazards on the project, its resilience and the exacerbation of hazards caused by the project. Using the approach defined by CDB and CARICOM (2004), this would begin with a qualitative preliminary HVA, along with records of incidence, hazard maps, assessment of expected damage and losses and cumulative effects, etc. While the process has been operating with increasing effectiveness for approximately 10 years, some recommendations have been suggested to strengthen the system, including formalisation of the EIA process through explicit legislation, provision of clear EIA Guidelines which incorporate natural hazards, and establishment of criteria governing expertise of persons who conduct EIAs as well as the government experts who review the submissions (CDB and CARICOM, 2004). Social and economic impact assessments are also recommended for inclusion in the process.

In the Scotland District, the Soil Conservation Unit works with the TCDPO to provide technical advice on development depending on location, soil type and loading, supported by risk maps. The Unit also collaborates with the Ministry of Housing, Lands and Rural Development as well as the Ministry of Transport and Works

in rehabilitation roads and bridges and stabilisation works. The Unit may interrupt any activities deemed detrimental to the area and conduct remedial works, and charge such works to the offender as necessary. Subsurface drainage works are also conducted, which help to alleviate water pore pressure and aid cohesion of the soil. Slippage in areas such as Spring Vale and Bath has reduced due to this work. The BWA has been replacing its iron pipes in the area with flexible alternatives to reduce the risk of compromise.

The national Building Code has established guidelines for disaster risk reduction in the built environment, thereby ensuring that in the recovery phases, inclusive of rehabilitation and reconstruction there is a standard for effective recovery of communities post disasters. However, even with the existing Building Code there exist issues relating to lack of adherence and enforcement. Nevertheless, on the coast in particular, increasing understanding of the risk and the high value of investments, prospective developers are willing to consider risk reduction and environmental protection in property layout and engineering design e.g. hotels are advised not to put critical infrastructure on the ground floor of the property and to adhere to safe setbacks for building. Enforcement of safety standards should also be emphasised in the reconstruction phase to 'build back better' and not recreate vulnerability.

February to July 2014 witnessed the first delivery of the adapted Regional Code of Practice for Safer Building of Houses Course at the Samuel Jackman Prescod Polytechnic, supported by DEM, for contractors, foremen and other experienced personnel in the informal construction sector. This first offering had an enrolment of 14. CDEMA encouraged wider stakeholders in the sector such as insurance agencies and the government to ensure that the course offering is sustained; as well as incorporating it into the regulation of the sector such that higher quality and safer infrastructure results. For instance, in the British Virgin Islands, completion of the course is a pre-requisite for obtaining a contractor's licence (The Barbados Advocate, 2014a). The original course was developed by CDEMA and the CARICOM Regional Organisation for Standards and Quality (CROSQ)[48]. The course examined techniques for making houses more resistant to hurricanes, earthquakes, land slippage and floods, with the aim of enhancing community resilience to disasters by promoting safer building standards. Incentives introduced by government for householders and businesses include retrofitting against wind (hurricane straps and shutters) and water collection systems.

Natural resource management

At the sector levels, key sectors such as agriculture and fisheries remain weak in terms of understanding the effects of climate change on the sector and pre-planning to ensure food security and employment nationally.

Lack of anticipatory planning relating to the management and maintenance of drains, culverts, gullies and other water courses, and private wells has been cited as a key issue in the prevention of flooding (ECLAC, 2010). For inland and coastal flooding, the Drainage Division has been mandated to systematically conduct vulnerability assessments, flood hazard maps and risk assessments; as well as mitigation works, to alleviate severe flooding through clearing major water courses, cleaning and sinking wells, inter alia.

More than 90% of the potable water supply is sourced from aquifers. Water abstraction rates are in the region of 49.5 million m^3, quite close to the resource limit. A desalinisation plant was opened in 2000 in Spring Garden, pumping 30,000m^3/day from brackish water. Notably, all economically viable groundwater resources are being accessed. Allocation policies have not been clearly-defined for specific users, nor are there set priorities for long term and emergency shortages (BWA, n.d.a; Emmanuel, n.d.). Concern has been expressed about saline

30 CDERA. 2005."Code of Practice for the Construction of House: An Instruction Manual for Foremen and Experienced Artisans". CIDA, OAS http://www.weready.org/earthquake/images/stories/cdera_code_of_practice_for_the_construction_of_houses.pdf

intrusion since the desalination plant and the Belle pumping station are extracting from the same aquifer. Certain large-scale developments such as golf courses are required to provide their own water resources.

Relevant water resources management legislation includes:

- Three Houses Act (1713) allows St Philip residents to retain stream water for use, provided it does not have negative effects downstream; 2014 is the first time the spring has run dry
- Porey Spring Act (1864) allows St Thomas to construct and maintain works for the collection and delivery of water to persons other than the inhabitants of the parish
- Underground Water Control Act (1953) licences the abstraction of water
- Barbados Water Authority Act (1980) manages, allocates and monitors all other water resources to ensure their best development, utilisation, conservation and protection in the public interest

Additional instruments for the governance and sustainable management of water resources include:

- Groundwater Protection Zoning Policy (1963)
- Revised Policy of Private Sewerage and Wastewater Disposal Systems
- National Water Conservation Plan
- Draft Policy Framework for Water Resources Development and Management in Barbados (1997)
- Emergency Drought Management Plan (1998)
- Sustainable Development Policy (2004)
- National Strategic Plan (2006-2025)

Vulnerable groups

Admittedly, capacities in understanding and addressing socioeconomic vulnerabilities are weak. Among the planned actions to reinforce this area include developing an inventory of vulnerable persons/groups and the underlying causes of their vulnerability, and alignment of DRR strategies with poverty alleviation strategies. The Ministry of Social Care is spearheading national efforts to implement a poverty alleviation agenda which targets the most vulnerable and incorporates DRR (DEM, 2011).

Regulation and governance

The extreme procrastination in the enactment of the Environmental Management Act and the Marine Pollution Control Regulations imposes remarkable restrictions on the regulatory and enforcement powers of the EPD. Absence of this umbrella legislation and supporting comprehensive regulations (environmental standards, guidelines) continue to cause natural resource management to be fraught with difficulty (ECLAC, 2010). There is no basis for prosecution of offenders in a manner that would serve as a deterrent to the exploitation and pollution of ecosystems.

Nevertheless, EPD continues to execute its functions using best management practices and international standards, even if not legislated. The agency has recently started a process of developing a national chemicals profile in order to design a comprehensive approach to control importation, use and disposal of hazardous chemicals. They have begun with a series of regulatory inspections at some of the industries with potential to release pollutants – paints, rum, electric, meat/food processing – to examine their waste streams and treatment, control measures, and recommend best management practices for improvement. This has been well received by the sectors to date, with the most positive response from those pursuing ISO14000 certification.

Pesticide inspectors scrutinise entities that store and sell pesticides, including how they are labelled, displayed and stored, with authority to remove a product from sale immediately. Notably, for the application process, the associated fee is $25 as opposed to being volume-based, such as is the practice in Jamaica. This has led to a situation where there now exist stockpiles of obsolete pesticides and POPs that must be managed and disposed due to the absence of a restriction of imported volumes. Additionally, in some cases the containment of pesticides in a shipment is not declared until it lands at the port, and the language may not by in English; both of which contravene regulations and procedures. Again, political pressure may encourage the release of the shipment without proper controls.

The Physical Development Plan and Integrated Coastal Zone Management Plan are currently being updated and will reflect an integration of DRR. The same would also occur for the planned revision of the CZM Act, which will include decision support tools for DRR legislation and policy guidance.

Other pieces of legislation are also in need of updating to strengthen their efficacy. For instance, the Prevention of Floods Act needs stronger preventive measures and the express requirement for the preparation of flood management plans and provision for flood plain mapping. Enforcement measures in others are inadequate as deterrents e.g. a $1,000 fine under the Trees (Preservation) Act. Further, the legislation governing flooding and coastal erosion concerns lack provisions to facilitate the selective relocation of critical services (Moore, 2003).

Government is pursuing a Green Economy transformative framework for achieving sustainable development, defined as "an integrated production, distribution, consumption and waste assimilation system... as the basis for natural resource protection, policy intervention, business and investment choice, human development programming" (Moore et al, 2012). There is an expectation of very strong links being forged between environmental management and disaster management, in order to achieve national goals for social and economic wellbeing. Thus all financial institutions will be required to incorporate DRR in their economic models (DEM, 2013). The associated scoping study highlighted building, fisheries, agriculture, tourism and transport as key sectors with high potential for greening and outlined needed precursors to enable this transition, including fiscal reform, education and capacity building, and standards and regulation (Moore et al, 2012). The approach to greening the economy will be characterised by:

1. Upholding the principles of sustainable development in the Sustainable Development Plan
2. Public sector leadership in areas such as sustainable procurement, energy efficiency and water conservation and the enhancement of a market for green goods and services
3. Creating green economic opportunities for small businesses and entrepreneurs
4. Building on existing capacities and systems in public and private sectors
5. Developing the baseline to track progress (GOB, 2010)

DISASTER PREPAREDNESS

National readiness

Prior to the start of the hurricane season, the Minister of Home Affairs hosts the Minister's forum, where major stakeholders from the NEMS gather to report on their readiness in terms equipment tested, exercises conducted, plans or SOPs recently updated, etc.

Every 3 years there is a full scale engineering and safety assessment of Category 1 shelters, most recently conducted in 2013. The subsequent year sees assessment of Category 2 shelters (completed in 2014). These

assessments determine whether the facilities will remain listed as emergency shelters or be removed or can be upgraded. For instance, the Alleyne School in St Andrew is currently being upgraded, such that it can be used as there is only 1 shelter in that parish which is part of the very vulnerable Scotland District. During 2011-2012, facilities at Lawrence T. Gay Primary and Charles F. Broome Primary were upgraded with water tanks and wheelchair ramps. In 2014, a school safety assessment of St James Primary was completed, with subsequent scope of works developed to upgrade the facility. Generally, there is also concern about potable water storage only being available at a limited number of shelters. A complete list of 2014 shelters is included in Annex V.

At least one national full scale exercise is conducted annually in addition to the participation in regional and hemispheric simulation exercises. An increase in emergency drills at the primary schools is being experienced, as well as development of disaster preparedness plans, with strong support from staff and students (DEM, 2011). The post-reviews of these exercises usually identify gaps in procedures, resources and training. An exercise design course has been developed for use at national and regional levels and there is a cadre of trainer of trainers who can conduct courses.

An institutional audit is being conducted of the DEM by the Ministry of the Civil Service, for which results are not yet available.

Public participation

Within the context of CDM, Barbados has specific goals relating to public participation in DRR processes (HFA). These include:

- Harnessing the competencies and resources of the citizens by providing a mechanism and enabling environment for active engagement in the national community disaster management programme
- Enhancing the DEOs to enable communities to be informed, self-reliant and capable of cooperating with the DEM in CDM, through on going public education and awareness programmes.

Within this context, the HFA Report 2011-2013 (DEM, 2013) recommended development of a national training programme for utilisation of the VCA methodology in communities. As of 2012, VCAs have been completed in 6 communities across the country, some of which are shown in Table 18. Several of these communities have also developed Community Disaster Plans.

Table 18: Summary of select Vulnerability and Capacity Assessments (VCA) undertaken in Barbados (Sources: Barbados Red Cross Society VCA reports)

Community	Vulnerable groups	Main hazards and vulnerabilities
Sherman's St Lucy DEO 2012		Storm surge Coastal erosion Flooding Poor drainage (corrosion under bridge) Caves Overgrown vegetation Inadequate number of first aid posts Improper disposal of garbage Hazardous road network Main road to the parish runs along the coast Lack of sidewalks Abandoned/derelict buildings Fire

Community	Vulnerable groups	Main hazards and vulnerabilities
Rock Hall St Andrew 2012	The elderly Residents inaccessible by vehicles	High density of housing Abandoned/derelict buildings (community centre and housing) Weak housing structures Land slippage Improper disposal of garbage Stagnant water/pond Blocked waterways Elevated wells Leaning utility poles Damaged roads Lack of crash barriers
South District St George South DEO 2012	Low income earners Children The elderly Persons with disabilities Single women Victims of disasters	Unexplored cave network, and houses situated atop Fire Hurricanes Stagnant water/pond, mosquito breeding Poor drainage, flooding Soil erosion Blocked waterway Overgrown vegetation Road accidents Lack of pedestrian crossings and sidewalks Poor street lighting Crime Abandoned/derelict buildings
Church Village St Philip North DEO 2012	The elderly Persons with disabilities	Poor drainage, flooding (including of bridge) Lack of awareness of disaster issues Overgrown vegetation Dilapidated housing House fires Poor street lighting Poor road network Lack of sidewalks and road signage Improper disposal of garbage Stagnant water/pond, mosquito breeding Exposed utility pipes e.g. natural gas Storm surge Aged trees
Martin's Bay St John DEO 2010		Poor drainage, flooding (including of bridge) Lack of awareness of disaster issues Overgrown vegetation Dilapidated housing House fires Poor street lighting Coastal and soil erosion Land slippage Poor road network Improper disposal of garbage Aged trees

Community	Vulnerable groups	Main hazards and vulnerabilities
Charles Rowe Bridge St George North DEO 2010		Poor drainage, flooding Lack of awareness of disaster issues Safety of the bridge Dilapidated housing House fires Poor street lighting Aged and rotting trees

The tourism sector is fully mainstreamed in the national disaster risk management programme, and is being utilised as a best practice for all other sectors (see also section on Disaster Response). A Disaster Plan and SOPs have been completed and are being implemented, with human and financial resources provided by sector stakeholders, in collaboration with government.

Training has been developed for Liaison Officers throughout the sectors. In addition, the DEM conducts Plan Development Training Workshops on an annual basis for all sectors.

PAHO supports the country on request with training in Mass Casualty Management (MCM) and Incidence Command Systems (ICS).

Early warning

The current national early warning system (EWS) principally monitors hydrometeorological hazards and their secondary effects (cyclones, floods, storm surge), with Barbados Meteorological Service providing forecasting and acting as the alerting authority. The CZMU monitors and forecasts recurring and seasonal winter swell conditions.

The Meteorological Service determines the appropriate type of notification (e.g. advisory, watch, warning), and in collaboration with the DEM, notifies the public through the emergency broadcast agencies (television, radio, newsprint, telecommunication companies). Early warning messages are targeted to specific segments of the population.

Dissemination mechanisms include mobile and fixed lines, fax, SMS, UHF/VHF radio, television, email, etc. (see Figure 35). The UHF network, managed by the RBPF, extends to all government agencies. These systems are tested weekly, started over the last 2 years; response has increased from minimal to over 50% during that time. The ring down system is currently not in operation due to outdated technology; however negotiations are ongoing with LIME (Cable & Wireless) on the upgrade and extension to the many radio stations across the island, as well as the recurrent costs and maintenance agreement, expected to be borne by the DEM. Efforts are underway to incorporate comprehensive audio notification architecture into the EWS. However, the financial resources to maintain and upgrade the EWS are limited and maintaining trained personnel is challenging.

The Government of Barbados and the United States Geological Survey (USGS) signed a memorandum of understanding concerning scientific and technical cooperation in the earth sciences which provided seismology training for members of staff of CZMU, the establishment of an earthquake and tsunami EWS at Gun Hill, St. George and the placement of sea level dart buoys in the Caribbean Sea to provide real time data on seismic activity in Barbados and adjacent regions. The real time sea level stations and real time seismic station form part of the regional tsunami EWS – the Tsunami and Other Coastal Hazards Early Warning System for the Caribbean and Adjacent Regions (CARIBE EWS).

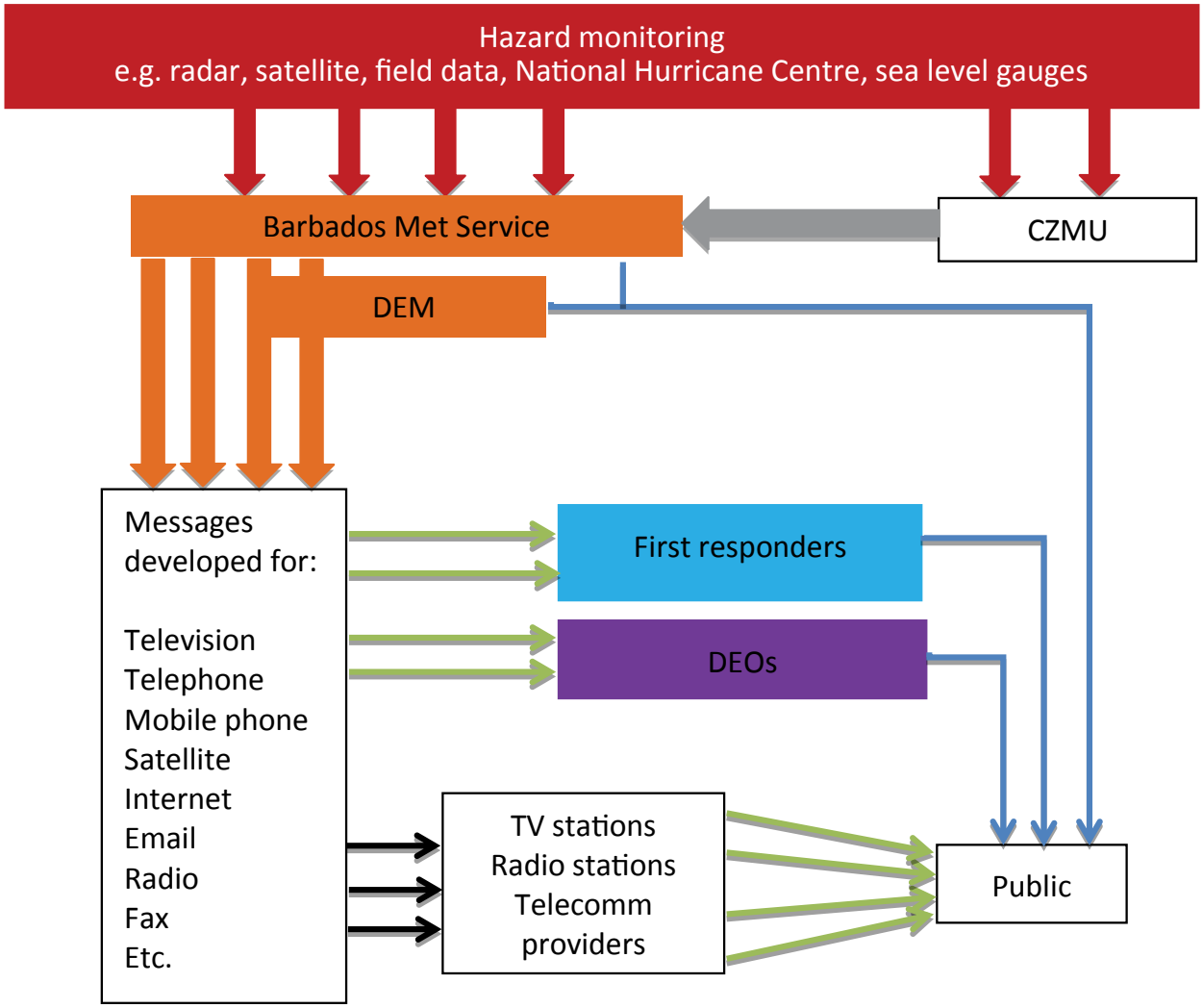


Figure 35: Schematic of Barbados' national early warning system (EWS)

The Technical Standing Committee on Coastal Hazards is currently working on a national warning system for tsunami with a redundant suite of public warning mechanisms, which can then be applied to all hazards. The progress has been advanced from a warning message from the Pacific Tsunami Warning Centre reaching national focal points taking 5 minutes in 2005 to now taking less than 30 seconds due to the investment in equipment and training (Inniss, 2014). A draft warning protocol for tsunamis has been developed for submission to Cabinet, although the mass alerting process is being further enhanced by the provision of sirens in key vulnerable locations and the incorporation of cellular technology. While this CAP-based EWS has been designed for phased implementation, funding is still proving difficult. The associated evacuation plan will be developed following the results of the risk assessment through the CRMP.

Box 6: Summary of the Tsunami Protocol and Standard Operating Procedures (Source: Inniss, 2014)

Objective: to provide the authority and operational framework within which preparedness, response and recovery actions for tsunami hazard are implemented

Scope: to facilitate the planning process from the point of initiation to issuance of the "All Clear"

Critical assumptions in developing and executing the Protocol include:

- A triggering event may occur at any time
- The primary trigger is an earthquake
- Alerts will be provided by the Pacific Tsunami Warning Centre
- Not everyone will hear the warning issued
- Special needs groups require special attention
- Emergency response agencies may need to assist with the warning
- The Met Service will have the capacity to analyse a Tsunami Bulletin

The Protocol details the concept of operations:

- Notification
- Activation
- Warning dissemination
- Responsibility agreement
- Action Plan for Tsunami Bulletins

The Standard Operating Procedures dictate actions under different circumstances.

- SOP A: Caribbean earthquake (rapid onset)
- SOP B: Teletsunami (Atlantic Ocean scale)
- SOP C: No potential for a tsunami
- SOP D: Cancellation
- SOP E: Testing

For each SOP, an Immediate Actions Checklist is used to inform operations. The SOPs outline the role of agencies within the NEMS in the event of a tsunami

A community EWS was established in Speightstown, having been acknowledged as a particularly flood prone area, suffering significant events in 1984, 1994, 1987 and 2004 with considerable economic impacts (see Box 5). Through the Caribbean Disaster Management Project, hydrological and meteorological observation equipment was provided for hazard monitoring. It also realised completion of a series of flood analyses and completion of flood hazard maps. Importantly, some of the tools developed included a Flood Hazard Mapping Manual, Community Disaster Management Planning Manual and a Community Disaster Management Plan for Speightstown which provide a concrete base for replication.

Notably, the community was trained and able to take the lead in the collection, assessment and evaluation of hazard information, critical facilities, and socioeconomic and local population data, with support from regional

and national technical teams. Community drills and exercises were executed based on the Community Disaster Management Plan (Hinds and Spence, 2008). This is a set of outputs that is easily accessible for replication in other communities across the country. The Telephonic Community Flood Warning System Project (CDEMA/JICA), which has identified Speightstown in St. Peter as the project pilot site. The objective of the project is the integration of rainfall early warning systems into the flood hazard mapping systems. This project was impacted however by equipment loss after a significant rainfall event and has not been re-established yet (GOB, 2010). The Community-Based Early Warning Systems Project (DEM/CTIC/UNDP/USAID) will be addressing issues of local preparedness in the environs of Holetown, another area prone to flash flooding, with implementation of the all-hazard all-media Common Alerting Protocol (CAP)[49]. This project has strong linkages to the Water Resource Management and Flood Resilience Climate Change Adaptation Programme which will be conducting public education and flood mitigation works in the same vicinity (see Table 21).

CIMH has been actively engaged in efforts to formalise a more structured, proactive and coordinated approach to drought monitoring, with the support of several meteorological and hydrological services in the region (Farrell et al, 2010). The Caribbean Drought and Precipitation Monitoring Network (CDPMN) aims to provide early warning information by indicating the current and projected future drought severity in the Caribbean. The Precipitation Outlook[50], in operation since 2004, combines climate model outputs with experience. Forecasts from the Climate Prediction Tool (a statistical model) in the form of probabilities of above, near, or below normal rainfall, are balanced with similar output from dynamical climate models, i.e. general circulation models. Both model types predict seasonal rainfall based on the latest observed climate state (e.g. tropical sea surface temperatures).

Meteorological drought indices, such as used in the CDPMN, can be applied to warn, inform and advise regional governments toward reduced societal impacts. This tool can be used to guide management of water resources across sectors (e.g. domestic, agriculture) based on the expectation of high or low rainfall. The seasonal projection is especially important in a groundwater context because impacts of drought tend in most cases to be delayed relative to surface water systems due to the slow nature of the infiltration/recharge process. As a result, it is possible that resource managers may misinterpret this initial lack of a decline in water levels as a lack impact and not response appropriately (Farrell et al, 2010).

CIMH provides monitoring and advisory services, issuing drought alerts for Barbados and Grenada in January 2010. The BWA was spurred in March to implement Stage 1 of its Emergency Drought Management Plan when aquifer levels became critically low – users were encouraged to practice good water use habits and to employ voluntary conservation measures. Given that CIMH models accurately predicted drought conditions during the 2009-2010 period 4- 6 months in advance, concerns exists relating to whether there is adequate capacity to convert drought forecasts to information and to effectively communicate that information to stakeholders, whether all stakeholders are aware of the availability of the forecasting products and support provided by CIMH and the capacity of the downstream users to effectively integrate drought information into decision making (Farrell et al, 2010).

Given the expected reduction in water availability in the future, the Caribbean on a whole needs to strengthen its ability to forecast drought the onset, duration and severity of drought and to better manage its water resources. Drought forecasting and alerting at national and regional scales require coordination between multiple stakeholders. Effective systems must embrace:

49 http://www.wmo.int/pages/prog/amp/pwsp/CommonAlertingProtocol_en.html; http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html; https://www.youtube.com/watch?v=n0iKp60jjtY

50 http://www.cimh.edu.bb/?p=precipoutlook

- An understanding of stakeholder needs and capacities
- Timely data collection and dissemination by multiple stakeholders across multiple sectors
- Human capacity to efficiently process and interpret data
- A collaborative non-competitive environment between stakeholders
- Regular and effective communication between technical personnel and decision makers
- An effective system of protocols for issuing and communicating alerts to various stakeholders across multiple sectors (Farrell et al 2010).

Annex VI includes a summary of actions proposed to CARICOM for the management of water resources, particularly with respect to the 2009-2010 drought.

District Emergency Organisations (DEOs)

The DEM considers its Community Preparedness Programme as a critical component of the NEMS. Moreover, community emergency preparedness is a core feature of both the CDM Strategy and the HFA.

In 2010 an assessment was conducted of the capacity of the DEOs to "augment the emergency services planned by the government" as the mechanism is having difficulty adjusting to the realities of managing a large cadre of volunteers, a shift in mandate from disaster relief and response to comprehensive disaster management (CDM), and a general sense of complacency around disaster preparedness in Barbados (Taikaram, 2010). Most of the DEOs face challenges in fulfilling the mandate as described in the Central Emergency Relief Organisation Guidelines for District Emergency Organisations (The Green Book), focused mainly on response and relief, which includes establishing an EOC, developing a preparedness plan, and enlisting and training emergency services personnel. Some of the findings are captured in Table 19.

Table 19: Some of the findings of the DEO capacity assessment (Source data: Taikaram, 2010)

Organisational capacity	Response capacity	Management and administration
No consistency in level of capacity across the DEOs General lack of consensus on the DEOs' role and responsibilities are in responding to vulnerabilities and disasters Green Book is seen as outdated and inadequate Legality of the DEO mechanism is a concern as DEOs are not named in Emergency Management Act 2006-20 No standard footprint for formation of a DEO exists	Uncertainty about how DEOs would coordinate in a national emergency, including how DEO resources would be allocated Few DEOs have disaster preparedness plans Lack of recognition from government agencies when conducting DEO activities, such as the Royal Barbados Police Force and Barbados Fire Service Trainings previously provided (e.g. first aid, disaster management, light search and rescue, shelter management, and stress management) have been inconsistent from DEM, and as a result, DEOs have different levels of training in different areas as they seek to train themselves Desire to be trained in: • Bereavement counselling • Damage assessment • EOC staffing and management • First aid • Fundraising • Light search and rescue • Presentation skills • Radio communications • Stress management • Training based on geographic need • Vulnerability and risk assessment	Perceived lack of guidance and support by DEM Need to: • clarify the rationale for the relationship between DEM and DEOs • clarify DEO's purpose, roles, and responsibilities • distribute guidelines for organization, administration, and protocol • support DEOs with trainings, equipment, and supplies Need for more staff at DEM who are qualified in disaster management dedicated to assisting the DEOs and improve lines of communication There are too many DEOs

The DEOs were designed to establish, train, and operate an island-wide community preparedness programme under a designated set of functions and responsibilities, but there has not be the subsequent complementary volunteer management structure to guide, assist, and support such an immense mechanism (Taikaran, 2010).

Management and oversight of the work of the 30 DEOs has been allocated to a single Programme Officer. This has proven to be grossly ineffective, inadequate and has been a contributing factor to the floundering Community Preparedness Programme. The Programme Officer, while providing technical guidance, cannot adequately service these organisations on a sustained basis in the prevailing environment (Hinds, 2011). A number of recommendations for the Community Preparedness Programme were advanced as plausible strategies to improving the existing system, summarised in Figures 36 and 37.

National Council for the DEOs

- A volunteer governance mechanism which will assist the DEM in crafting appropriate programmes intended to enhance the capability of the DEO members and the overall community preparedness programme.
- To work with all DEOs to develop a strategic and operational plan of action for the community preparedness programme at the District level.

Community Preparedness Standing Committee

- To further strengthen the institutional framework and capacity of the community preparedness programme and by extension the National Emergency Management System
- Expected to provide strategic oversight of and advice to the community preparedness programme. This may include the identification of project initiatives, programme support and financial resources inter alia which could assist in enhancing the community preparedness programme.
- It will also advise the EMAC in all community emergency management matters as it relates to the community preparedness programme. These matters may include strategic planning, volunteer recruitment, training and awareness, emergency coordination and response at the community level

Community Disaster Management Unit

- To assist the Director in the development, implementation, evaluation and monitoring of the Community Preparedness Programme
- Enable DEM to provide the necessary guidance, management and oversight to ensure that the Barbadian populace benefits considerably from a robust community preparedness programme which will result in an island wide conglomeration of disaster resilient communities

Figure 36: Recommended elements for the restructuring of the Community Preparedness Programme (Source data: Hinds, 2011)

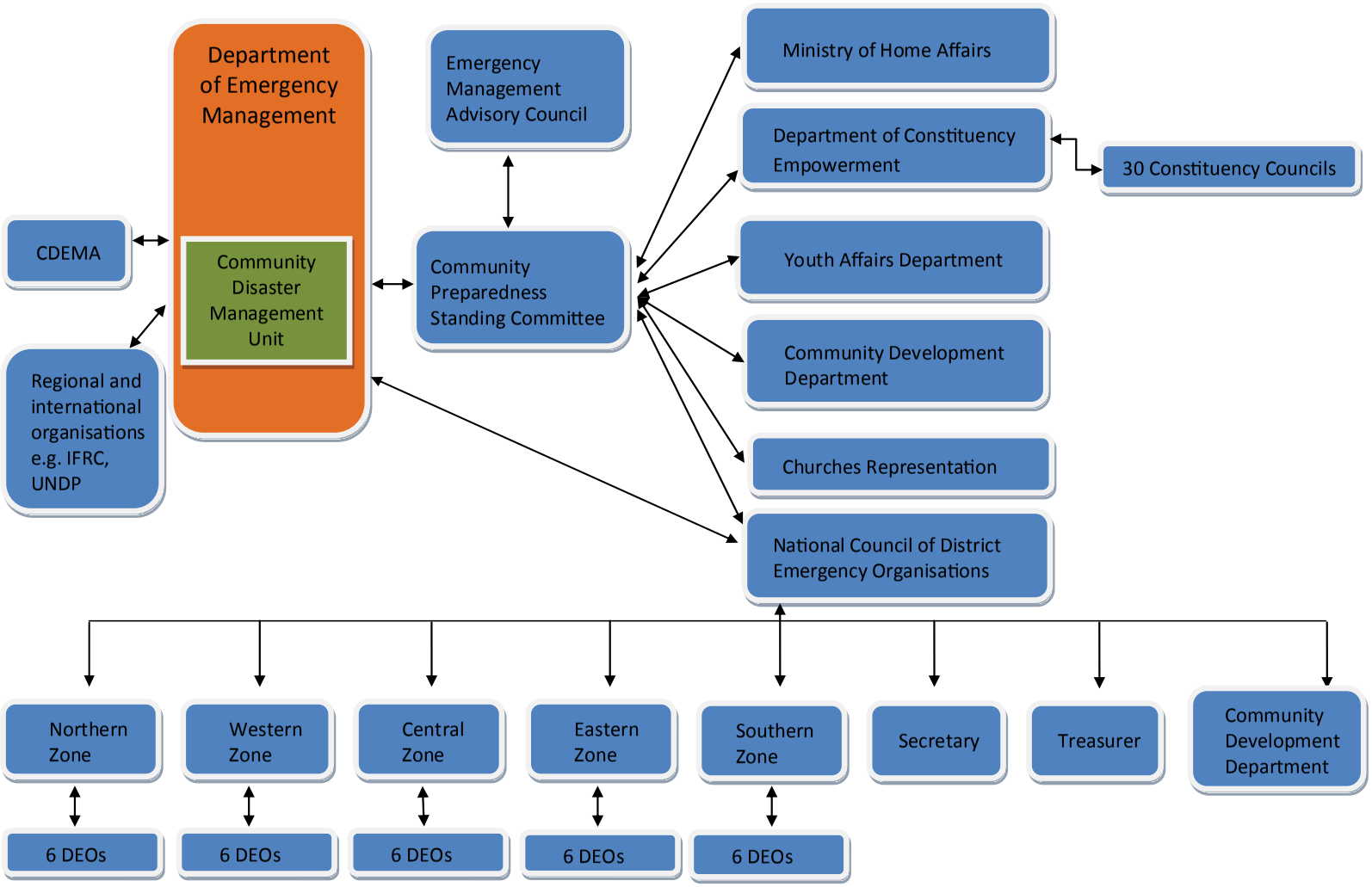


Figure 37: Proposed revision of the volunteer disaster management structure in Barbados (Source: Hinds, 2011)

Oil spills and hazardous chemicals

The Environmental Protection Department (EPD) is one of the key agencies with respect to managing and regulating the entry of hazardous chemicals into the environment. Among its roles, the EPD contributes to the Pesticide Control Board to prevent importation of hazardous chemicals, the National Occupational Health and Safety Committee and the National Oil Spill Response Committee to strengthen procedures and capacities to respond to incidents. Mechanisms used to govern the respective sectors include:

- Environmental sensitivity maps
- National Oil Spill Contingency Plan (revised 2013) with 3 tiers for response depending on severity
- Hazardous Chemicals Response Plan drafted by EPD
- National Chemical, Biological, Radioactive and Nuclear (CBRN) Response Plan being drafted by DEM describes roles of various actors in the event of an incident

Public awareness

Annually, public awareness messages are disseminated via mass media prior to and during the Atlantic hurricane season to encourage personal preparedness. There are also various opportunities to interact directly with the public, such as radio call in programmes. Cooperation also occurs with private sector entities. The Technical Standing Committee on Coastal Hazards has been making concerted efforts through public service announcements, lectures, etc in sensitising the public on this infrequent hazard.

Some of the key hazards, such as earthquakes and tsunamis, are virtually unknown to the general public, thus the effort required to bring the population to an acceptable level of awareness represents a significant challenge. While not a specific subject area in itself, DRR principles are incorporated into various subjects within the curricula at primary, secondary and tertiary levels. Moreover, there is good support for the development of school disaster plans and use of simulation exercises (DEM, 2013). The Public Education and Information Standing Committee has spearheaded the development of public education initiatives for floods and hurricanes, and utilised tsunami materials produced through CDEMA projects.

DISASTER RESPONSE

Local response

Status of the supplementary EOCs vary by DEO. Some have secured housing for their EOC and have obtained radios and equipment through DEM, in kind corporate donations, or their own fundraising efforts. Most are struggling to find space that fit the EOC criteria and expressed frustration at the lack of support from DEM to help them acquire space for their EOCs. Without EOC space, companies are unwilling to donate equipment to DEOs. Some were also frustrated at having to fundraise for equipment and trainings. Hope was expressed that the Constituency Councils could assist in these matters, and indeed, some DEOs have enlisted their Councils' assistance.

The DEOs are supposed to be trained and equipped to respond to emergencies within their communities; however this capacity varies across the country, as do participation in and engagement with the organisation. They have developed capacities in community profiling, conducting community vulnerability assessments, early warning systems for coastal communities, flood monitoring, and the integration of disaster risk reduction in key economic sectors e.g. tourism in relevant communities (DEM, 2010). However, as previously mentioned,

these capacities are uneven across the mechanism. The quarterly training activities in 2014 included sessions on tsunamis and hurricanes. Community disaster response team (CDRTs) have been trained with the support of the Barbados Red Cross Society and are in operation in several communities, including Charles Rowe Bridge, South District, Martin's Bay and Rock Hall.

With their current structure, the DEOs do not possess the authority or capacity to enforce regulations relating to risk reduction. The Ministry of Home Affairs as the civil protection agency responsible for DRR, is piloting the reform of the Community Emergency Management Programme with a new institutional governance, administrative and operational mechanism. The existing DEOs will be reformed and rebranded to encourage greater participation by society (see Figure 36). With these structures in place a more comprehensive DRR programme, including community-based development of disaster and DRR plans, and enhanced response operations, simulation exercises will be introduced. One key goal is to develop community EOCs for the decentralisation of the community responses, operations and resources (DEM, 2010).

The Roving Response Team is a volunteer organisation of emergency responders, working for over 2 decades to support national emergency services in the event of any incident across the country e.g. fire, oil spill, vehicular accident, flood, with a team of over 30 men on call 24 hours a day. They have a memorandum of understanding with the Ministry of Home Affairs with respect to their cooperation during disasters, receiving annual monetary subventions, and recently a vehicle donated by the DEM which be useful for traversing floods, hauling loads or during fires. The team works closely with the disaster response network, having received some training through the NEMS e.g. in first aid, emergency telecommunications, firefighting, hazardous materials and water rescue and even donated some supplementary equipment (Rawlins-Bentham, 2013b; Burnham, 2012; Carter, 2010; DEM, n.d.). There are discussions about the Roving Response Team to assist the DEOs with their preparedness and response functions, and even extending their services to the wider region (Gooding, 2013).

National response

The National EOC mechanism is fully operational (see Figure 38), being activated as the coordination centre for response and relief in a national emergency according to established multi-hazard SOPs. The DEM Director acts as NEOC Director in the stead of the Minister of Home Affairs or Prime Minister.

Inter alia, the SOPs address the:

- Authority and responsibilities of personnel in the NEOC during emergency/disaster operations
- Preparation and organisation of the NEOC for emergency/disaster operations
- The establishment of procedures for emergency/disaster operations to fulfil the responsibilities of the National Emergency Management Committee
- Reporting relationships between satellite EOCs
- Welfare needs of the emergency response personnel

The NEOC Operations Group provides technical guidance and resources for effective resolution of emergency situations. Typical membership is described in Table 20.

The emergency management structure is governed by an abundance of policies, operational and sector plans, and SOPs to ensure effective coordination during an emergency. These are described in section 4.3.

Within the EOC, emergency telecommunications are coordinated by the representatives of the Telecommunications Unit. In case the principal communication mechanisms (e.g. fixed lines, mobile phones,

fax, email, etc) fail, communications are relayed through the network of UHF/VHF and CB radios operated by the emergency services, the Amateur Radio Society of Barbados (ARSB) and the Barbados Citizens Band Radio Association (BCBRA), which can also reach operators regionally. The amateur societies receive government support through the Telecommunications Unit. Their members are often members of DEOs and support communication with the EOC. A trained radio operator from the DEOs is stationed at emergency shelters. There are also satellite flyaway systems, with capabilities of communicating via text, voice and fax, as well as satellite phones.

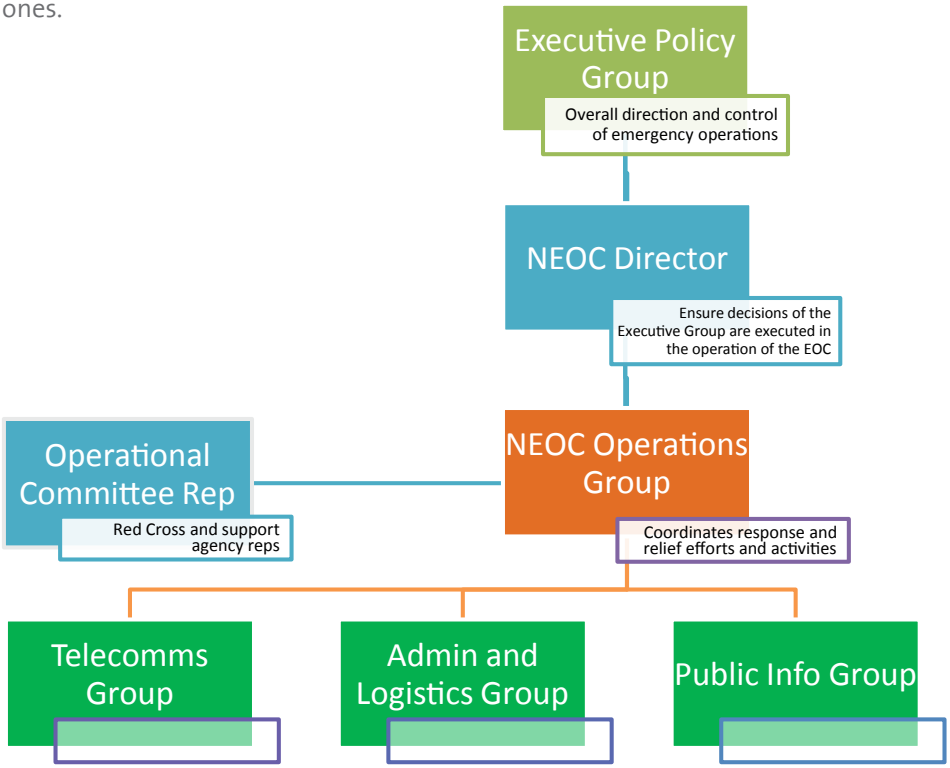


Figure 38: Functional components of the National Emergency Operations Centre (NEOC)

Table 20: General representation within the NEOC Operations Group (Source: GOB, 2011)

Stakeholder representative	Function
Royal Barbados Police Force	Head of NEOC Operations and Security
Barbados Defence Force	Head of NEOC Operations and Security and Complementary Services
Barbados Fire Service	Search and rescue, fire
Emergency Medical Services	Health and medical response
Barbados Statistical Service	Damage assessment and needs analysis (DANA)
Government Information Service	Public information
Ministry of Agriculture	Food and general supplies
Ministry of Education	Shelters
Ministry of Foreign Affairs	Foreign relations, liaison

Stakeholder representative	Function
Ministry of Public Works	Transport, road clearance
Ministry of Finance	
Utilities Committee	
BNRT Committee	
CDRU Coordinator	CARICOM Disaster Relief Unit (as required)

The Food and General Supplies Standing Committee is one of those represented within the EOC during an emergency. Like all other EMAC Standing Committee, it has governing SOPs, part of which outline roles, functions and actions during an operation. It has responsibility for supplying food to vulnerable groups and emergency personnel during a disaster. Some food is stored in warehouses at the Soil Conservation Unit and in the Scotland District which can be isolated if roads and bridges become impassable. Potential helicopter landing sites have been identified in the Scotland District to manage such occurrences. The Ministry of Agriculture has memoranda of understanding (MOUs) with various wholesale merchants (e.g. SBI Distribution, Hanschell Inniss, Brydens and Stokes) who stock above normal levels of supplies during the hurricane season. Hanschell Inniss, for instance, has a designated room such storage, which is secured by the RBPF and the Barbados Defence Force. Other warehouses are allocated for packaging and distribution of food baskets (for which simulation exercises are run periodically to improve efficiency). Vehicles from the Ministry of Agriculture and BADMC are used to transport personnel and food supplies. The School Meals Department is to provide 1 cooked meal a day to persons in shelters, with supplies provided from the warehouses. After Tomás in 2010, the Salvation Army provided support in this regard. Persons in shelters, geriatric and children's homes would also receive other food supplies. 3 persons assigned to every role. Bulk food material is also supplied to the emergency services when their meals supply runs out. The Ministry of Agriculture is desirous of renewing training in warehouse management with the Red Cross due to changes in personnel. Among other functions is the continued deployment of quarantine officers at the ports of entry to inspect relief supplies entering the country, and subsequent testing by the Government Analytical Laboratory.

The Tourism Emergency Management Committee (TEMC) was established in 2005 to facilitate the mainstreaming of disaster management in the tourism sector. This committee has been successful in establishing a fully functional Tourism EOC which provides centralised coordination and control of disaster response within the tourism industry (GOB, 2010). It comprises both private and public sector entities and a representative of the TEMC sits within the National EOC.

Trained national search and rescue (SAR) teams are established, with associated plans, SOPs and regular exercises.

The Fisheries Department is tasked with hauling fishing boats out of the sea in advance of threatening storms and for the management of berthing sites such as at Consett Bay, Oistins and Bridgetown. Further, the Department has designed incentives for fishers to improve their security; registration requires compliance with training and installation of special equipment on board such as emergency telecommunications, life vests and a flare gun. There are plans to install GPS devices on all boats, which will facilitate search and rescue as well as help monitor illegal activity.

The National Oil Spill Response Committee is strengthening procedures and capacities to respond to incidents, including use of environmental sensitivity maps, annual safety equipment checks periodic training overseas. For oil spill response, all oil companies have response plans, and cooperation agreements between them

facilitate response to Tier 2 incidents. Tier 3 spills require external assistance. The committee is working to develop a list of local personnel with response capacity.

Mass casualty and health emergencies are also within the remit of the national response system, with plans relating to dengue, SARS, pandemic influenza and anthrax, inter alia.

Response protocols have been developed, with the assistance of CDEMA and PAHO, for managing diseases imported via plant and animal material. This response involves the Ministries of Agriculture and Health, the DEM and the Sanitation Service Authority.

Regional response

CDEMA Participating States may request assistance in responding to any type of disaster (natural or anthropogenic) where the State determines that the situation overwhelms national response capacity. CDEMA is then responsible for soliciting and coordinating assistance from governments, organisations and individuals both within and outside the region for the most urgent resources or expertise e.g. relief supplies, emergency communications facilities, emergency management personnel and financial assistance. Other Participating States including the SRFP play an important role as they are often positioned to provide assistance because of their similarities, close proximity and relationships (CDEMA, n.d.c).

In such instances, the RRM is activated (Level 3). The levels of regional response are as follows:

1. No external assistance required and the affected state has capacity to manage the event
2. Some external assistance is required; a state of emergency may or may not be declared. CDEMA may provide technical assistance, support personnel, specialised equipment, etc
3. National capacities are overwhelmed and the RRM is activated (CDEMA, 2013)

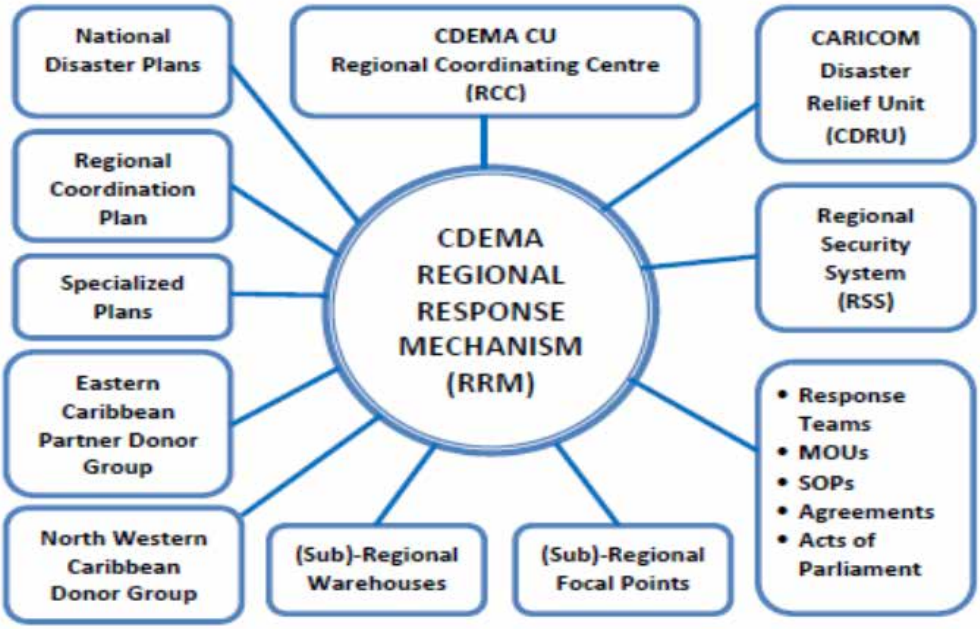


Figure 39: The Regional Response Mechanism (RRM)
(Source: CDEMA, 2013)

The Regional Security System activates and trains the CARICOM Disaster Relief Unit (CDRU), as well as providing emergency airlift for CDEMA teams and supplies and equipment. The CDRU comprises representatives from the military forces, police and fire services within CARICOM and its main responsibility is to conduct disaster response and relief operations in affected states, including emergency telecommunications and management of relief supplies. Personnel from the national SAR teams also participate in the RRM as needed.

RECOVERY, REHABILITATION AND RECONSTRUCTION

The recovery process involves the repair and enhancement of facilities, infrastructure, livelihoods, etc after a disaster. This may be considered in 3 phases – early recovery, rehabilitation and reconstruction. The underlying premises of the recovery process include address the needs of the most vulnerable and a strong incorporation of mitigation to build back better and avoid reconstructing the same risks.

In the event of a hazard impact, a cadre of trained staff from the Barbados Statistical Service, the TCDPO, Ministry of Public Works, Ministry of Agriculture, other agencies and volunteers collect and collate disaster loss data at national and sector levels to support decision making in recovery efforts. These function as a sub-committee of the Damage and Needs Assessment (DANA) Standing Committee (see Annex II). Unfortunately, disaster loss data is not yet mainstreamed into scientific and financial data streams to facilitate seamless transition from hazard and risk assessment, to analysis of disaster losses, to decisions on funding for recovery. Moreover, the data are not disaggregated by sex in order to better identify gender issues. Further, the process is not consistently applied with a standardised methodology to generate a single comprehensive analysis. Even with this team an economic assessment of the impact of Tropical Storm Tomás was not conducted. There are also disaster information systems within the DEM, CZMU, Lands and Surveys Department, TCDPO, BWA, Barbados Light and Power Company Ltd (BL&P) and CIMH (CDEMA, 2010; DEM, 2010), however their degree of integration is negligible, impeding a comprehensive outlook on hazards or vulnerability.

CZMU conducts pre and post-event monitoring of beaches in cases of winter swells and storms, including measuring beach profiles and volume, documenting damage and engaging with residents and businesses affected. The agency is seeking to formalise this damage assessment process.

The Eastern Caribbean Donor Partners Group (ECDPG), coordinated by the United Nations Resident Coordinator (UN RC), facilitates a collective response to national emergencies by the international development community serving the country. Agencies including UNICEF, PAHO, UNDP, USAID and FAO provide humanitarian assistance to the country in need through provision of relief supplies, supporting post-disaster damage and loss assessments, and reconstruction activities.

However, the country seems to lack an articulated comprehensive long term recovery programme, which can go on for 5 or more years. This would entail economic recovery of the productive sectors, restoration of social services, addressing vulnerable groups, and correcting drivers of vulnerability such as physical infrastructure and ineffective institutional and governance mechanisms. This is a process which requires strategic political leadership and multi-sector cooperation (Persad, 2014).

Risk transfer

Risk transfer is used to insure risk beyond the level which is considered acceptable[51] or manageable, and where minimisation of the risk is not feasible or cost effective, such that another party bears the financial

51 Acceptable risk is the level of potential losses that a society or community considers tolerable given existing social, political, economic, cultural, environmental and technical considerations (UNISDR, 2009)

consequences. Such mechanisms ensure that fiscal resilience is strengthened so that funds are readily available post-impact to repair damage or replace losses.

There are limited financial resources for mitigation, response and rehabilitation. Recovery and reconstruction are supported by a number of contingency funds:

- The national Emergency Management Fund: administered by the Cabinet Secretary and Head of the Civil Service; allows public and corporate contributions
- Caribbean Catastrophe Risk Insurance Facility (CCRIF): the world's first multi-country pooled risk transfer scheme, which uses a parametric insurance mechanism. Barbados is presently insured for hurricane damage, determined by losses due to wind and storm surge, and excess rainfall coverage as of 2014 (1 of the first 8 in the region), which is based on extreme rainfall regardless of whether it is due to a tropical cyclone (CCRIF, 2014a). Barbados received over US$8.5 million in the aftermath of Tropical Storm Tomás in 2010 (CCRIF, n.d.). Barbados was also assessed to receive a payout of US$1.2 million as a result of the trough system which passed in late November under its excess rainfall policy (CCRIF, 2014b). As a member of CCRIF, within the parametric insurance scheme, Barbados would receive any owed payouts within 14 days after an event is assessed to have exceeded the required threshold of the hazards for which it is insured. Insurance coverage can be defined within a specific area, such as the capital. Other products are also available, such as earthquake coverage and livelihood protection policies.
- Emergency Assistance Fund

On a smaller scale, there are insurance policies for private homes and businesses, as well as insurance of government assets. At a household level, often the most vulnerable populations do not acquire insurance, for instance, as is often reported when a wooden house is destroyed by fire.

The Disaster Rehabilitation Fund is a segment of the Agricultural Development Fund which provides loans to farmers to re-establish production in the event of flood, drought, pest, disease, fire, and even weeds. The Fund totals US$1 million, disbursed with a moratorium on repayment until production should have started, at a rate of 1-2%. However, it is not accessed often, possibly because it is a loan not a grant facility. The Agricultural Development Fund, established in 2001 provides loans for development of the sector up to US$500,000 based on assessment of the submitted business plan and the market. Loans may be accessed for technical assistance, sugar cane replanting scheme, and even grants to public institutions such as the BADMC. Sugar farmers usually have fire insurance and poultry farmers typically insure their buildings. Crops otherwise are not insured.

DEPARTMENT OF EMERGENCY MANAGEMENT

Admittedly, the technical and human capacities within the NEMS face several constraints, particularly within the DEM itself. From the perspective of the coordinating agency, the staff complement includes the Director and Deputy Director, 3 technical Programme Officers, 1 radio operator and 8 administrative staff to cover all designated functions, plus the Director of the Caribbean Tsunami Information Centre (CTIC). A 2010 baseline assessment (CDEMA, 2010) revealed that only 4 of the 13 permanent staff of the DEM were trained in CDM and its implementation. This represents a significant limitation in relevant capacities to effectively utilise available resources (tools, information, funds). For instance, constraints have been highlighted in:

- Meeting the needs of all non-government stakeholders for information and initiatives

- Utilisation of available datasets for planning and management e.g. sea level, beach profiles
- Delivery of required technical input to support integration of hazard impact assessments into the EIA process
- Slow flow of information, irregular updates of the DEM website and social media
- Insufficient training in M&E and results-based management (RBM); and lack of budgeted resources for M&E
- Inadequate information and communication technology (ICT) to meet needs, including GIS software

The proposed revisions to the Emergency Management Act have been reviewed by the EMAC and are due to be submitted to the Chief Parliamentary Council to update the legislation.

With regard to the DEM's facilities, while they are significantly improved from prior locations, there are still a number of concerns. These include: the single access road and its tendency for flooding and traffic congestion; absence of hurricane straps on the roof; lack of sleeping accommodations for NEOC personnel and limited bathroom facilities; and the need for increased security given previous equipment thefts.

An overall capacity needs assessment and institutional audit of the DEM to carry out its mandate is being finalised (CDEMA, 2010; DEM, 2010).

SUMMARY

The progress in mainstreaming DRR into development decision making since the adoption of the CDM approach in 2001 is still embryonic, with preparedness and response still the main focus of the NEMS (GOB, 2010). There is limited support from the national government for all elements of the disaster management cycle. While this reflects general resource restrictions, particularly since the global recession, it also potentially indicates: inadequate commitment to and/or understanding at the political level of the role of investment in mitigation in reducing post-disaster impacts and needed recovery; and the fact that there are initiatives being undertaken by various agencies which contribute to the mitigation of disaster risks, such as the CZMU and the Drainage Division , the majority of which are funded by international partners. However, accessing donor resources is becoming increasingly difficult with countries globally reducing the ODA offered since the onset of the global financial crisis, and especially noting Barbados' classification as a high middle income country based on GDP per capita, an inadequate indicator of development.

The availability of high quality, trustworthy data is a quintessential condition for effective management of natural risk. It fuels critical analysis, empowers strategic decision making and drives multi-sector integrated dialogue and planning. While data sharing protocols exist, apathy persists towards facilitating access to data and information by counterpart agencies and the public. For instance, while there are teams collecting post-disaster information, they use different methodologies and collect for their own purposes. While the Drainage Division collects photo documentation of flood hazard impacts, they are not geo-referenced or plotted in a GIS. Conversely, TCDPO uses mobile devices to geo-reference their field data and transmit to the office for upload. Streamlining of this and various other data collection process to create a culture of consistent and robust data collection and sharing would increase efficiency of operations and simplify coordination mechanisms.

Key outcomes of national risk assessments must be adequately implemented. Therefore, the regulatory agencies must have the capacity to address these matters in a timely manner. Socioeconomic data analysis is at present not sufficiently incorporated into risk assessments methodologies to inform decision making.

With respect to access to technologies, assistance is needed with respect to training and enhancing technical capabilities for surveillance, monitoring and early warning systems (GOB, 2010).

Enhancing the capabilities of the national EWS continues to be a focus, particularly for rapid onset hazards (e.g. tsunamis, earthquakes). There is a decided impetus toward using CAP-based EWS, as it exhibits certain clear advantages over traditional methods (see Figure 40 and Box 7).

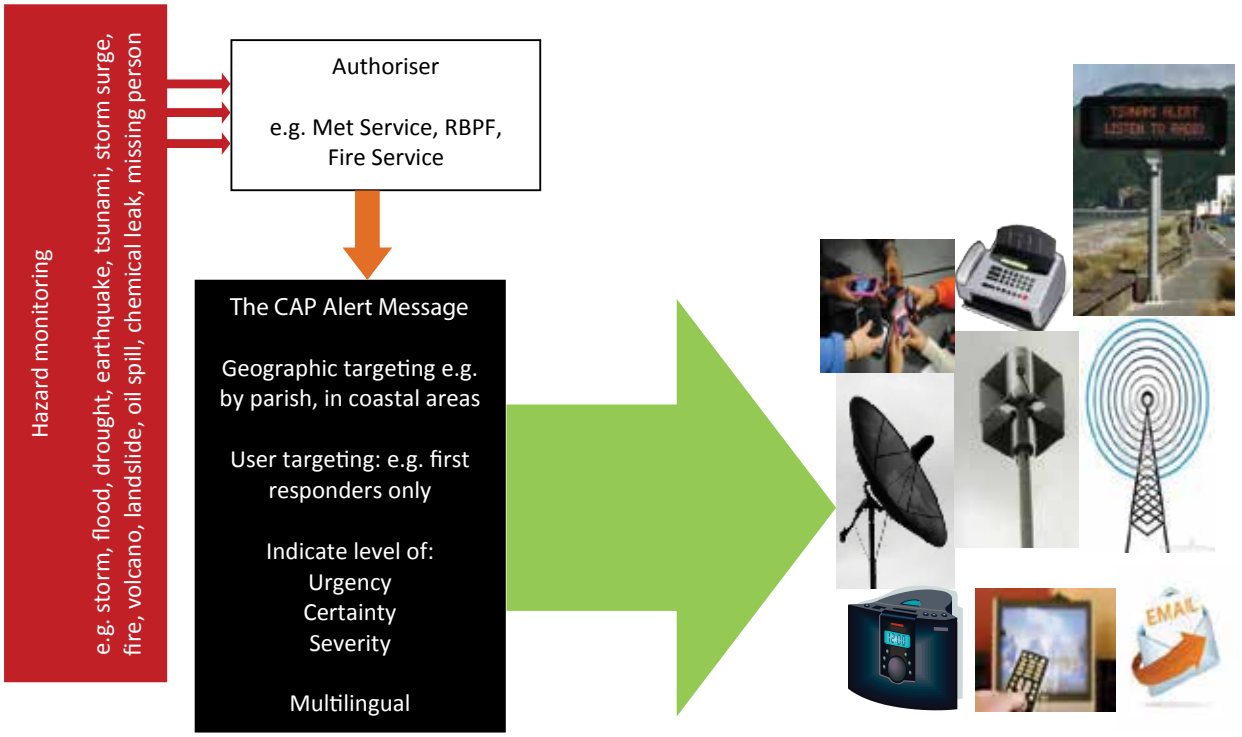


Figure 40: Schematic of a Common Alerting Protocol-based early warning system (CAP EWS)

The ability to disseminate a single warning message from a single point via multiple media increases the chances of reaching every member of the population, and reduces possibilities of errors in retransmission. The message is authenticated and disseminated by designated authorities, enabling increased trust by the public, with the hope of leading to more rapid and effective action. With the ability for receiving real-time notifications, it is also possible to build in automatic triggers for specific or rapid onset emergencies e.g. tsunami sirens may be triggered when a number of sea level gauges register a defined measurement.

Box 7: Design philosophy for CAP-based early warning systems (Source: OASIS, 2010)

Interoperability: provide a means for interoperable exchange of alerts and notifications among all kinds of emergency information systems

Completeness: Format should provide for all the elements of an effective public warning message

Simple implementation: The design should not place undue burdens of complexity on technical implementers.

Simple XML and portable structure: Although the primary anticipated use of the CAP Alert Message is as an XML document, the format should remain sufficiently abstract to be adaptable to other coding schemes

Multi-use format: One message schema supports multiple message types (e.g. alert, update, cancellations, acknowledgements, error messages) in various applications (actual, exercise, test or system message)

Familiarity: The data elements and code values should be meaningful to warning originators and non-expert recipients alike

Interdisciplinary and international utility: The design should allow a broad range of applications in public safety and emergency management and allied applications and should be applicable worldwide

Under the Tsunami Protocol and SOPs, the designated notification authorities are identified as the Barbados Meteorological Service, the RBPF and Barbados Fire Service and 24-hour agencies.

Natural resource management, especially with respect to mitigating the effects of drought demands stronger focus, particularly as the climate regime is expected to make such events more frequent. CDEMA advocates that water rationing, reuse and recycling be explored with greater emphasis for tackling dry periods (Best, 2014). This should form part of a comprehensive integrated water resource management strategy. At present, the National Water Conservation Plan promotes the reduction of losses in distribution and at the consumer level, and reduction in supply or increases in tariffs in emergencies (see Table 9).

While there is a range of legislation governing environmental protection, natural resource management, sustainable development and emergency management, along with a number of effective institutions, there still remain some inherent constraints:

- Overlap and duplication of the functions of some institutions for monitoring and control (ECLAC, 2010) leads to ineffective implementation and enforcement functions
- Some agencies lack the capacity to fully utilise the established legislative frameworks
- Poor enforcement of existing legislative framework accompanied by weak enforcement capacity (GOB, 2010)
- Limited inter-agency strategic and programmatic planning and information sharing

Inadequate promotion of the building code and setback requirements, poor enforcement of zoning and land use regulations and inadequate public education on and awareness of disaster risk contribute to the

perpetuation of vulnerability. A lack of high quality information on disaster risk in Barbados has also been a major constraint to the implementation of CDM (GOB, 2010).

Overall, the country is limited in its capability to capitalise on available programming and funding support. Thus stronger support from CDEMA as the regional coordinating mechanism is desired. Moreover, enhanced efforts are needed in the coordination between regional and international organisations, especially when interventions overlap in order to create synergies rather than duplicate (DEM, 2011).

While it seems that the country has self-sufficiency to cope with small hazard events such as localised flooding, the repeated effects of such events will increasingly inhibit future responses, and certainly impinge the ability to respond to more catastrophic events.

5.4.2 Institutional and coordination mapping

With the multiplicity of actors which must be actively engaged for DRR to be achieved, they operate in different modalities to achieve this result i.e. in prospective management of risk, corrective management, and reactive management or response. The relationship between these types of action and the phases of disaster management are illustrated in Figure 41.

Within the NEMS, the Standing Committees support the DEM by providing a broad base of technical expertise from the public and private sectors and community, and facilitating planning and implementation of risk reduction measures. Inter-ministerial consultation remains relatively weak, however, limiting the mainstreaming of DRR. Agency involvement is primarily driven by personality and needs to be better institutionalised, with the public sector at the forefront of the process. The attrition of technical staff in particular affects the quality and continuity of interventions (DEM, 2013).

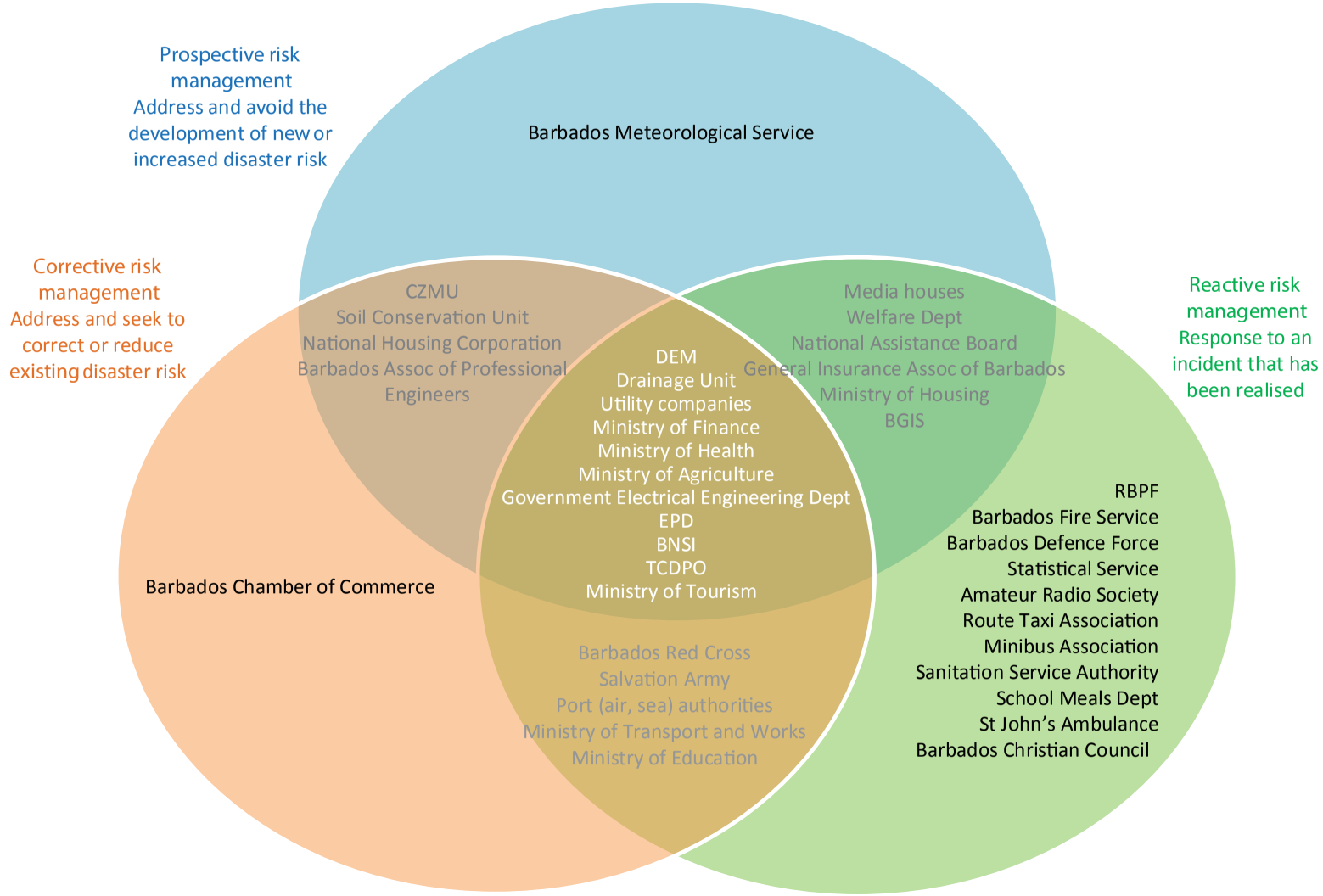


Figure 41: Roles of national agencies and organisations in disaster risk management in Barbados

5.4.3 Mapping of DRR programmes, initiatives and plans

Table 21 presents a non-exhaustive list of the major projects and initiatives being undertaken by DRR stakeholders in the country.

Table 21: Disaster risk reduction initiatives ongoing in Barbados

Implementing Agency	Programme/ Project	Goal/Objectives	Expected start date	Expected end date	Funds/US$	Source of funds
Ministry of the Environment and Drainage	Water Resource Management and Flood Resilience Climate Change Adaptation Programme	• Improved stormwater and flood management • Improved climate science systems • Increased awareness and public education	2014	2018	5,300,000	USAID
Ministry of Agriculture, Food, Fisheries and Water Resource Management	Agricultural health and food safety	• Piloting the national AHFS Authority to bridge work of multiple agencies under Codex Alimentarius (WHO/FAO) in implementing effective agricultural and manufacturing standards e.g. HAACP, ISO • Modernising relevant legislation • Improving government laboratories and their relationships with counterparts e.g. International Plant Protection Convention (IPPC)				Government of Barbados
Coastal Zone Management Unit (CZMU)	Coastal Risk Assessment and Management Programme (CRMP)	Building resilience to coastal hazards, incorporating disaster risk reduction and climate change adaptation in development planning, control and monitoring of the coastal zone: • Coastal risk assessment, monitoring and management • Coastal infrastructure • Institutional sustainability for the Integrated Coastal Risk Management (ICRM)	2011	2016	42,000,000 loan	IDB
Barbados Water Authority (BWA)	Water and Sanitation Systems Upgrade (WSSU) Project	• A modernised and institutionally strengthened water and sanitation sector • The preparation of the BWA for regulation by the Fair Trading Commission • An improvement of the BWA's financial position and viability as a commercially run company • An improvement in the water delivery infrastructure and the efficiency of the BWA's operations, resulting in at least a • 10% reduction of non-revenue water • The reduction of energy costs of the BWA by at least 5% • The improvement of the water production infrastructure which will result in the provision of high quality service and product through improved efficiencies; • The improvement of the wastewater treatment plants' infrastructure	2011	2016	50,000,000 loan	IDB

Implementing Agency	Programme/ Project	Goal/Objectives	Expected start date	Expected end date	Funds/US$	Source of funds
Caribbean Institute for Meteorology and Hydrology (CIMH)	Caribbean Regional Climate Centre	• Establish a Regional Climate Centre for the Caribbean, housed at CIMH and capable of providing tailored climate and weather services to support adaptation and enhanced disaster risk reduction region-wide • Improve climate and weather data collection regionally to fill critical information, monitoring and forecasting gaps • Establish a Caribbean Environmental and Climate Computational Centre to provide CIMH, regional scientists and end-users with needed resources to better understand and predict climate impacts • Build critical capacities at regional and national levels to access, analyse and use climate data to better inform decision-making in climate sensitive sectors.	2014	2016	5,085,000	USAID
United Nations Development Programme (UNDP)	Strengthening Public Investment in Disaster Risk Reduction and Climate Change Adaptation in the Eastern Caribbean	• Develop critical awareness of and commitment to incorporation of risk management strategies for natural hazards in public sector policies, plans and investments • Develop national databases on hazard impacts to generate the information for risk estimation and to inform public investment and development planning systems • Build capacity to assess and implement hazard specific risk mitigation strategies	1/2014	5/2016	779,420	World Bank, UNISDR
UNDP	Post-Disaster Needs Assessment (PDNA)	• Awareness of PDNA methodology for recovery planning and commitment to capacity building at national level. • Development of draft post disaster methodology and strategy for implementation • Developing mechanism for continued regional capacity development in PDNA, including establishing a roster of qualified practitioners • Enhancing the awareness of and linkages between gender, livelihoods and social exclusion with national recovery frameworks	1/2015	12/2015		World Bank
Government of Barbados/ Caribbean Tsunami Information Centre	Community-Based Early Warning Systems in Barbados	• Improved awareness to natural hazards through enhanced public education and awareness building initiatives in a community within the environs of Holetown • Reduced vulnerability to natural hazards through the enhanced alerting within the environs of Holetown • Enhanced national capacities for public warning following improved capacity for public warning	8/2014	7/2015	100,000	USAID (UNDP portfolio)

Implementing Agency	Programme/ Project	Goal/Objectives	Expected start date	Expected end date	Funds/US$	Source of funds
CDEMA	Integrating Disaster Management into the Education Sector	• Develop a model Safe School Programme for Caribbean schools • Prepare an education sector baseline study and upgrade the CDEMA disaster education kit	5/2014	11/2014		CDEMA
Ministry of Health	Piloting Climate Change Adaptation to Protect Human Health	To increase adaptive capacity of national health system institutions, including field practitioners, to respond to climate-sensitive health risks: • To enhance systems of early warning and early action • Build capacity of national actors; pilot specific health risk reduction interventions • Document and share lessons learned in addressing the health risks associated with climate change	2010	2014	550,000	GEF SCCF
Caribbean Disaster Emergency Management Agency (CDEMA)	CARICOM-Brazil Cooperation Programme with CDEMA Participating States	Phase 1 • Develop a DRM Knowledge Management Toolkit for children 5-16 • Pilot the Brazilian "Living Schools" concept and retrofit and equip Category 1 school shelters accordingly • Facilitate capacity building exercises in the selected schools Phase 2 • Develop electronic DM game for public education • Develop model Schools' Emergency Plan • Acquire first aid kits for shelters	4/2011	12/2013		Brazil (FAO)
CDEMA CTO CROSQ UWI	Regional Disaster Risk Management for Tourism in the Caribbean	To develop and adopt a Regional Public Good, that is, a regional risk management framework for the tourism sector in the Caribbean that contributes to the overall goal of reducing the vulnerability of the tourism sector to natural hazards and climate change		2010		IDB
CDEMA	Regional Monitoring and Evaluation System for Disaster Risk Management and Climate Change Adaptation in the Caribbean Tourism Sector	Following the completion of the IDB-financed Regional DRM Strategy and Action Plan, national governments of participating countries, through their respective tourism organisations and national disaster management agencies identified the need for a regional mechanism for monitoring, evaluating and reporting on the results of the implementation of the Regional DRM Strategy and Action Plan	2010		750,000	IDB
CDEMA	Tsunami and other Coastal Hazards Warning System (TCHWS) Project	• Creating an effective model for protocols and procedures for receiving and disseminating warnings to all stakeholder agencies and potentially affected communities • Developing public education and awareness materials for CDEMA Participating States	9/2007	3/2010	475,200	USAID

Implementing Agency	Programme/ Project	Goal/Objectives	Expected start date	Expected end date	Funds/US$	Source of funds
CDERA (CDEMA) CERO (DEM)	Caribbean Disaster Management (CADM) Project	• Establishment of a national mechanism for the preparation of hazard maps and community disaster management plans • Establishment and strengthening of the flood hazard mapping system through the support of regional and national stakeholders • Enhancement of community disaster management planning through the development of community disaster management plans and the training of community members • Improvement of the capacity of the CDERA Disaster Information Warehouse	7/2002	3/2006	3,000,000	JICA

5.4.4 Tool inventory

Tables 22 and 23 present a non-exhaustive list of the available toolkits, guidelines, methodologies and resource libraries available on DRR, climate change and related subjects.

Table 22: Available toolkits, guidelines and methodologies on disaster risk reduction and related topics

Name	Purpose	Developer	Access
ADDRESSING CLIMATE CHANGE			
Caribbean Risk Management Guidelines for Climate Change Adaptation Decision Making	Developed to assist CARICOM country risk management practitioners in the decision-making process for the selection and implementation of feasible (optimal or most cost-effective) strategies for adaptation to climate change and reducing vulnerability, using a systematic and transparent process. Policies or initiatives that aim to reduce this vulnerability can be also designed to complement and support the goals of poverty reduction, sustainable development, disaster preparedness and environmental protection.	CARICOM Secretariat	
Guidance Tool for Mainstreaming Climate Change Adaptation into National CDM Work Programmes	Intended to lead to the development of work programmes which include climate change considerations	CDEMA	
IMPROVING RESILIENCE			
SMART Hospitals Toolkit	A practical guide for hospital administrators, health disaster coordinators, health facility designers, engineers and maintenance staff to achieve Smart Health Facilities by conserving resources, cutting costs, increasing efficiency in operations and reducing carbon emissions. This Toolkit offers a variety of instruments, including the Hospital Safety Index, to help ensure that new or existing health facilities are disaster-resilient; a Baseline Assessment Tool to collect reliable information on the building's performance and operations and how it measures up against current code, regulatory requirements and zoning regulations; and a Green Checklist that outlines feasible areas in which to introduce 'SMART' measures.	PAHO	http://www.paho.org/disasters/index.php?option=com_content&view=article&id=1742&Itemid=911 http://www.paho.org/disasters/index.php?option=com_content&view=article&id=964%3Asafety-index&catid=1026%3Ageneral-information&Itemid=911&lang=en

Name	Purpose	Developer	Access
Model National Recovery Framework	Template and adaptation guide for the recovery process. The process is led by Cabinet through the Recovery Coordinating Committee, chaired by the Minister of Finance and advised by the Director of the National Disaster Office. Actions are implemented through the National Recovery Task Force. It addresses emerging issues such as climate change and PDNA.	CDEMA	
COMMUNITY TOOLS			
Climate Smart Community Disaster Management Module	Designed to build the capacity of Caribbean communities to increase their resilience to climate change and to reduce the impacts of climate-related disasters, by providing practical, action-oriented tools and methods that they can use to understand their climate risk and vulnerability and develop and implement strategies for reducing them	CDEMA	http://www.cdemavl.org/handle/123456789/193 http://unfccc.int/files/adaptation/application/pdf/climate_smart_community_disaster_management_programme.pdf
Community Disaster Management Planning Manual	A guide to communities for creating their disaster management plans	CDERA	
Vulnerability and Capacity Assessment (VCA) Toolbox	Examines different participatory investigative tools that can be used to accomplish a successful VCA	IFRC	http://www.cadrim.org/#!library/c1ouf
Climate Change Adaptation Toolkit	Facilitates a Training for Facilitator's on climate change and its impacts relevant to in the Caribbean region; and also a sensitisation process in the community as a preliminary step to the Vulnerability and Capacity Assessment (VCA) process Piloted in Barbados November 2013	IFRC	
The Vulnerability Sourcebook: Concept and guidelines for standardised vulnerability assessments	Provides a standardised approach to climate change vulnerability assessments (VAs) covering a broad range of sectors and topics (e.g. water, agriculture, fisheries), levels (community, sub-national, national) and time horizons (e.g. present, medium or long term vulnerability). Offers guidance for designing and implementing a VA which covers the life cycle of adaptation interventions, using consistent proven methods.	BMZ	http://www.adelphi.de/files/uploads/andere/pdf/application/pdf/vulnerability_sourcebook_guidelines_for_assessments_adelphi_giz_2014.pdf
Community Selection of Vulnerable Communities Tool	Takes into account the context of the region and the associated populations and risks with appropriate criteria presented in an easy-to-use but thorough Beta tool where data can be input, calculated and analysed		
DISASTER RESPONSE			
CDRT Field Guide	To train all human resources with certified methodologies, and guarantee that Community Disaster Response Teams (CDRTs) maintain the highest level of professionalism in their response to disasters	IFRC	http://www.cadrim.org/#!library/c1ouf
INSARAG Guidelines and Methodology	Address international urban search and rescue (USAR) response in a cycle where the expectations of international USAR teams are described for each phase – preparedness, mobilisation, operations, demobilisation and post-mission	OCHA	http://www.insarag.org/en/capacity-building/capacity-building-leftmenu.html

Name	Purpose	Developer	Access
Natural Disasters: Protecting the Public's Health	Present a framework for decision making in managing the heath sector's activities to reduce the consequences of disasters, with adaptability to local conditions	PAHO	http://www.preventionweb.net/files/1913_VL206114.pdf
Emergencies and Disasters in Drinking Water Supply and Sewerage Systems: Guidelines for Effective Response	To help improve the organisational structure of the water supply and sewerage agencies and institutions and guide their response to any emergency	PAHO	http://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/PAHO/PAHO3%20-%20Emergencies%20and%20disasters%20in%20water%20and%20sewage%20systems%20-%20guidelines%20for%20effective%20response.pdf
HAZARD-SPECIFIC TOOLS			
Oil Spills: How Caribbean Disaster Managers Can Prepare and Respond	Describes the international legal framework for control of pollution from oil spills and the training programme implemented by the Regional Activity Center - Regional Marine Pollution Emergency, Information and Training Center (RAC/REMPEITC Caribe) which is accessible by Cartagena Convention Parties in the region	UNDP	http://www.bb.undp.org/content/dam/barbados/docs/projectdocs/Crisis_Prev/r3i/Oil%20Spills%20booklet.pdf
A Blueprint for CAP-Based Early Warning Systems: Overcoming the challenges in small island developing states	Guide to implementing all-hazard, all-media early warning systems using the Common Alerting Protocol (CAP) from system design to developing protocols to public awareness, based on the experience of Caribbean SIDS	UNDP	http://www.bb.undp.org/content/dam/barbados/docs/projectdocs/Crisis_Prev/r3i/Blueprint_for_CAP_based_Alerting_Systems.pdf
Reducing Landslide Risk Using Cut Slope Stability Maps	Applying slope analysis to generate recommended excavation angles on steep slopes to reduce the likelihood of failure and thus risk to businesses, settlements and livelihoods	UNDP	http://www.bb.undp.org/content/dam/barbados/docs/projectdocs/Crisis_Prev/r3i/Reducing_Landslide_Risk.pdf
Flood Hazard Mapping Manual	To provide a standardised methodology for developing flood hazard maps	CDERA	
National Tsunami Protocol and Standard Operating Procedures	Template tsunami warning protocol and SOPs for adaptation by countries	CDEMA	
Caribbean Drought and Precipitation Monitoring Network (CDPMN)	Provides early warning information by indicating the current and projected future drought severity in the Caribbean. Can be used to warn, inform and advise governments and water resource managers based on precipitation expectations for the coming months	CIMH	http://63.175.159.26/~cdpmn/cdpmn.html
Caribbean Climate Outlook Forum (CariCOF)	Produces seasonal forecasts (climate outlooks) and assesses likely implications of outlooks on most pertinent socioeconomic sectors. Review impediments to use of climate info, experiences and successful lessons on past application, enhance sector-specific applications. Lead to national fora to develop detailed national-scale climate outlooks and risk information	CIMH	

Name	Purpose	Developer	Access
MODELS AND FORECASTS			
PRECIS-CARIBE	Access to the results of the PRECIS Regional Climate Model scenario runs for Central America, Mexico and the Caribbean developed by the Cuban Meteorological Institute (INSMET)	INSMET	http://precis.insmet.cu/eng/Precis-Caribe.htm
Caribbean DEWETRA Platform	Real-time data and information integration system currently being used for hydrometeorological risk forecasting, environmental monitoring and disaster risk mitigation. Facilities the fusion of hazard and vulnerability information at different spatial and temporal scales to support DRM and DRR decision-making processes. Drought monitor and CID will be integrated	CIMH	
CATSIM (Catastrophe Simulation) model	To help policy makers, particularly in developing countries, devise public financing strategies for implementation in pre and post-disaster contexts (used in the establishment of CCRIF). Allows the user to define parameters for hazards, vulnerability and assets exposed, then assesses risk and generates costs and benefits of various financial risk management strategies.	International Institute for Applied Systems Analysis (IIASA)	http://www.iiasa.ac.at/web/home/research/modelsData/CATSIM/CATSIM.en.html
Comprehensive Approach to Probabilistic Risk Assessment (CAPRA)	Aims to strengthen the institutional capacity for assessing, understanding and communicating disaster risk, with the ultimate goal of integrating disaster risk information into development policies and programmes. Models exhaustive range of stochastic scenarios to generate loss excess curves (LEC), probable maximum loss (PML) and average annual loss (AAL). Contains modules for excessive rain, flood, earthquake, tsunami and landslide.	GFDRR World Bank IDB UNISDR	http://www.ecapra.org/
Caribbean Weather Impacts Group (CARIWIG)	A decision-making support tool providing quantitative climate information to support climate change impact assessments and planning in various sectors e.g. water, agriculture, coastal protection. Outputs can be generated in the form of tables, graphs and GIS shape files for integration into planning tools.	CCCCC, UWI, Newcastle University, University of East Anglia, INSMET	http://www.cariwig.org
FOR VULNERABLE GROUPS			
CARICOM Regional Framework of Action for Children 2002-2015	Among broader development goals for children, provides specific guidelines for care and protection of children affected by emergencies and climate change, e.g. in design and management of emergency shelters, inclusion of children in disaster prevention, and incorporation of GCC in school curricula	CARICOM	
A Practical Guide to Gender Sensitive Approaches to Disaster Management	Used to incorporate effective gender-sensitive and inclusive approaches into their disaster management strategies when assisting communities prepare for, respond to, and recover from disasters	IFRC	http://www.cadrim.org/#!library/c1ouf

Name	Purpose	Developer	Access
Enhancing Gender Visibility in Disaster Risk Management and Climate Change in the Caribbean	To acknowledge gender vulnerability to climate change, to animate discussion in the Caribbean region on integration of a gender perspective into disaster risk reduction, response and recovery strategies, policies and plans as a key aspect of effective risk management. The recommendations aim to move forward the discussion into concrete actions which recognise the importance of gender as a crucial element in addressing climate change, creating efforts to mitigate it and developing successful adaptation practices.	UNDP	http://crmi-undp.org/en/genderstudy/index.php
Guidelines for Mainstreaming the Needs of Older Persons in Disaster Situations in the Caribbean	Provides an overview of considerations to ensure that this group of people has the required response to their needs in disasters. Older persons, as a group, are frequently identified as among the most vulnerable segments of a population. Much more needs to be done to meet their particular needs, while at the same time recognising that they have unique capacities and contributions to make in preparing for and responding to disasters. It is important to keep in mind that a large segment of the over-60 population has one or more disability, whether physical, mental or sensory, increasing to more than 50% in the over-80 group.	PAHO	http://www.paho.org/disasters/index.php?option=com_content&view=article&id=1657%3Aguidelines-for-mainstreaming-the-needs-of-older-persons-in-disaster-situations-in-the-caribbean&catid=895%3Abooks&Itemid=895&lang=en
PUBLIC AWARENESS			
A Winning Campaign: Public Outreach in Early Warning Systems – Lessons Learned in Small Island Developing States	Seeks to provide senior management and communication/public outreach and education professionals in Caribbean countries and territories with recommendations, advice and suggestions that can help inform disaster-alerting public outreach and education (POE) activities in each of their countries	UNDP	http://www.bb.undp.org/content/dam/barbados/docs/projectdocs/Crisis_Prev/r3i/A%20Winning%20Campaign%20_%20Public%20Outreach%20in%20Early%20Warning.pdf
Edu4Hazards	Uses interactive navigation that direct the visitor to different types of hazards children may experience	Disaster and Development Centre	www.edu4hazards.org

Table 23: Disaster risk reduction resource libraries and databases

Developer	Name and Purpose	Access
IFRC	Caribbean Disaster Risk Management Reference Centre (CADRIM) Works to promote effective disaster management in the Caribbean, within a broader vision of building community resilience through early warning and early action	http://www.cadrim.org/#!library/c10uf
UWI ECHO	Caribbean Disaster Information Network (CARDIN) Provide linkages with Caribbean disaster organisations, to widen the scope of the collection of disaster related information and to ensure improved access to such material	http://www.mona.uwi.edu/cardin/home.asp
CIMH	Caribbean Climate Impacts Database (CID) (under development) Historical database of impacts (hydrometeorological, drought, floods, tropical cyclones, heat waves) and response mechanisms (e.g. SOPs)	
UNDP	Caribbean Risk Management Initiative (CRMI) Good practices, lessons learned, technical documents, links to online resources and a range of relevant information in the areas of disaster risk reduction, climate change adaptation and gender perspective in disaster management	http://crmi-undp.org/en/index.php/document-center

Developer	Name and Purpose	Access
UNISDR UNDP EU	DesInventar Disaster Information Management System[52] Developed for the systematic collection, documentation and analysis of data about losses caused by disasters associated with natural hazards, particularly at local/sub-national levels, based on four types of events: landslides and debris flows, floods and storms, seismo-tectonic, and others.	http://www.desinventar.net/index_www.html
PAHO	Knowledge Centre on Public Health and Disasters Contains a wide range of information relating to disasters and the health sector, including general concepts and the various stages of the disaster management cycle.	http://saludydesastres.info/index.php?lang=en
CDEMA	Mainstreaming Climate Change Adaptation into Disaster Risk Management for the Caribbean Region (CCDM) Resource repository with training and programming resources, protocols, reports and other information relating to CCA and DRM in the region	http://cdema.org/ccdm/
UNISDR	PreventionWeb Designed to serve the information needs of the DRR community, including the development of information exchange tools to facilitate collaboration	http://www.preventionweb.net/english/
OCHA	ReliefWeb Collects and delivers updates and analysis (e.g. disaster assessments, situation reports, maps, financial data, job announcements, learning opportunities) as well as develops new information products and services to enable humanitarian partners to analyse situations and strengthen decision-making	http://reliefweb.int/
CDEMA	We Ready Centralised information site for education, news and toolkits for home, children, business and the media on Comprehensive Disaster Management and all hazards affecting the region – earthquakes, hurricanes, tsunami and other coastal hazards.	http://weready.org/

5.5 Reduction of underlying risk factors

Patterns of poverty and increasing extensive risk translate into low resilience and very high losses even from small events, which are compounded due to frequent occurrence of these events. Evidence shows that about 90% of all natural hazards are small events, 66% of which are hydrometeorological in nature. The GAR 2009 intimates that vulnerable rural livelihoods, poor urban planning, ecosystem decline and climate change are key drivers of risk which undermine resilience (UNISDR, 2009).

Given that disaster risk is correlated with social, environmental and economic vulnerabilities and exposure of populations, assets and livelihoods, reducing that risk cannot solely be vested in and achieved by the DEM and emergency services. Sector and national development planning and programmes must address the underlying factors that contribute to risk. Specifically, means of generating economic growth must not accelerate exposure or vulnerability or accumulate risk.

Risks from natural hazards should be incorporated into economic projections and the work of all sectors because:

- There are high opportunity costs associated with diverting scarce resources to relief and reconstruction
- Disasters can severely impinge the budgetary planning process

52 Currently does not contain data for Barbados, however, it is being updated through the Coastal Risk Assessment Management Programme (CRMP) and should be populated by 2015 with the data presently available.

- The high demand on international aid diverts these resources from development activities (Benson and Clay, 2004)

Adaptive capacity refers to the ability of a system to adjust to a changing environment, thus conferring resilience; generally applied in the context of ecosystems or human systems. Natural resource management therefore takes into account the strategic, policy and institutional frameworks, data collection and research, technical knowledge and financial resources. This then extends to disaster and climate risk management. It requires determination of trade-offs between stakeholders and the articulation thereof to the involved parties in order to achieve a sustainable, pragmatic and flexible solution to management of natural resources and adapting to climate change. The perceived legitimacy and subsequent adherence to said solution must be developed in consultation with the stakeholders, addressing their various perceptions of risk and vulnerability supported by education, evidence and transparency.

SUSTAINABLE ECOSYSTEMS AND ENVIRONMENTAL MANAGEMENT

The pending status of the Environmental Management Act represents a barrier to the institutionalisation of joint DRR and environmental initiatives.

CZMU conducts routine monitoring and analysis of oceanographic conditions around Barbados, hydrographic surveys, GIS data management, coral reef and water quality monitoring. Capacities are being strengthened under the CRMP with high resolution mapping of the coastal zone using remote sensing, hazard maps and models. The ICZM Plan and EIA process generally provide effective management, aside from unregulated sources of land-based pollution. Climate change, pollution and physical damage continue to adversely affect the health of the reef ecosystems around Barbados. Artificial reefs have successfully been used at sites for re-colonisation of coral on the south coast, and have withstood high energy wave action (specifically during Hurricane Ivan) thus having additional potential as shoreline defence (Miller et al, 2008).

There are two marine Protected Areas at Carlisle Bay and Folkestone, and a proposed National Park for the Scotland District.

Management of illegal dumping is a persistent challenge, with little apparently forthcoming in terms of surveillance or prosecution. This continues to pose a threat for groundwater quality and downstream flood risk.

The process of upgrading over 100,000 commercial, residential and production meters with the implementation of the Water and Sanitation Systems Upgrade (WSSU) Project (see Table 21) is improving the BWA's monitoring of the water resource (BWA, 2013). The increase in tariffs starting in 2005 better reflect the scarcity and operational costs of supplying the resource, as well as alleviating a significant subsidy from the government budget. Although the 2009 increase of 60% was significant, at the time BWA was indebted by as much as US$75 million with arrears of US$13 million, caused by borrowing due to the financial losses in the previous 13 years (Cashman, 2011). Pertaining to management strategies for the future, the BWA is currently adapting its institutional framework with the view of being regulated by the Fair Trading Commission like all other utilities. Notably, only 15.6% of the surveyed population is in favour of privatisation as a strategy for more efficient management. While the majority support household rainwater harvesting (85.5%), it is not widely perceived as a measure for supplementing primary resource use (2%) or for coping with shortages and drought (1.5%). Only 4.6% and 8.1% considered drought and pollution due to illegal dumping respectively as problems for water management (Emmanuel, n.d.).

DRR STRATEGIES INTEGRATED WITH CLIMATE CHANGE ADAPTATION

The draft Climate Change Policy (GOB, 2014) bears very strong linkages between climate change, land use, natural resources, disaster management and risk reduction. Currently undergoing national review, the policy calls for research, vulnerability assessment and consequent adjustment of development control procedures and DRM plans. Nevertheless, projects are being implemented in communities and at the national level in concert with the elements of the document. The approval of this document is expected to yield considerable vulnerability reduction through land use planning with comprehensive integration of DRR in its mechanisms.

LAND USE PLANNING AND BUILDING CODES

The planning and management of settlements has seen incremental improvements, particularly since the Environmental Management and Land Use Planning for Sustainable Development (EMLUP) Study and the subsequent revisions of the Physical Development Plan.

While the EIA process is operational and includes aspects of disaster risk, the results of the EIA do not always lead to the recommended outcome or implementation of all associated conditions and remediation measures. Further, the DEM (2013) reports that the costs and benefits of disaster risk are not adequately accounted for in the design and operation of major projects, particularly by actors external to the country. The regulation of developments in relation to coastal hazards is within the remit of the CZMU and CZM Policy; non-coastal hazards however are not as efficiently controlled.

Again, without formalisation of the Building Code, compliance with certain recommendations is voluntary. Land use and ownership legislation needs to be revisited to ensure squatting, particularly in unsafe locations, is not encouraged. Nevertheless, investment in drainage infrastructure, slope stabilisation works, and provision of hurricane straps have helped to mitigate some disaster risk.

FOOD SECURITY FOR RESILIENCE

The importance of the agricultural sector is increasingly being felt, even though it has declined significantly in its contribution to GDP over the last several decades. To reduce the dependence on imported products, there have been efforts to strengthen the market for local farmers through partnerships with the tourism industry and certification initiatives to ensure retailers can identify and purchase from authentic growers.

Uptake of technology and stakeholder partnership for forward planning has been limited, even though some resources are already available, for example, through the Ministry's extension officers and the CIMH. Greater education is needed among farmers in a number of areas. For instance, to facilitate understanding of the intricacies of how farming practices increase vulnerability to natural hazards, the repercussions of excessive fertiliser and pesticide application in groundwater contamination and marine pollution, and how agriculture can be and is being affected by climate change. Flood and drought continue to have significant impacts on the sector. The prolonged passage of a trough system in late November 2014 has negatively affected the yields of some crops such as lettuce, watermelons and tomatoes, and may affect the costs of others as waterlogged soils will increase post-harvest expenses (Madden, 2014).

Praedial larceny continues to be a problem, despite the Praedial Larceny (Prevention) Act, Cap 142A, with cited issues including enforcement as a serious offence by the RBPF. Further, the Act does not define praedial

larceny, but focuses on being able to identify the rightful owners of the produce as opposed to theft implicitly. The fine for conviction is US$2,500, a paltry sum in the eye of farmers, further highlighted in comparison to Jamaica's Act with fines of US$20,000. This discourages many from entering or continuing in the sector given the high losses that can be accrued. Nevertheless, there has been progress in completion of the draft policy, and there are efforts to revise the legislation, as well as align it closely with other instruments such as the Theft, Criminal Damage, Trespass to Property and Evidence Acts. There are also proposals to increase fines to the levels of those imposed for marijuana, and create a Praedial Larceny Squad within the RBPF as is seen in other jurisdictions such as Florida. The existing Praedial Larceny Desk received reports of incidents; the Ministry of Agriculture is working to obtain a hotline and develop a monitoring system for actual losses. The RBPF is also encouraging the formation of a neighbourhood watch type system amongst the farmers and enforcement of the system of requiring certification when purchasing produce, noting that farm workers and other farmers are often themselves the perpetrators. Further, the theft is not only limited to produce, but also includes feed, fertiliser, irrigation lines and other equipment.

Inputs to the industry such as water, electricity and fertiliser, tend to be quite costly, lowering the competitiveness of local products with imports developed in larger economies of scale. The cost effectiveness and sustainability of production are among the main factors that will dictate the viability of the industry and its penetration into local homes as a preferred option. Progress on shaping a more sustainable sector has been mixed. The Agricultural Incentives Programme includes over 100 grants, rebates, capital injections, technical assistance and tax holidays to facilitate development of the industry. There are also over 80 duty free concessions on animals, planting material, machinery and equipment, tools, chemicals, vehicles, generators, etc. Still, some farmers continue to use poor tillage and cultivation practices, and many of the agricultural lands are vulnerable to land slippage. Drip irrigation and the use of solar photovoltaics have been used to improve the cost-effectiveness and efficiency of some operations, but the capital investment needed for these measures is out of the reach of many small farmers. The Agricultural Development Fund and its Disaster Rehabilitation Fund exist to support the evolution or recovery of legitimate agricultural operations, but uptake is varied.

The sugar industry is poised to embark on a US$250 million revitalisation through the Sugar Industry Restructuring Programme (Joseph, 2014b), with investment in a co-generation plant which uses bagasse and other biomass (river tamarind principally) to produce 25MW of electricity. It is foreseen that this will in future replace the Barbados Light and Power's diesel generation plants as base load. The plant will produce specialty refined sugars as well as high grade molasses for the rum industry, both of which are currently imported. There are initiatives at present to feature local sugar products in hotels and in the tourism sector more widely. The products will also be available for local consumption instead of all being exported to meet EU quotas as in the past. With this, proposals are under discussion for an incentive mechanism for farmers to return acreage to sugar production. However, negotiations with financing entities have encountered obstacles with the continuing downgrades of the Barbadian economy by international credit rating agencies.

The sector is well-supported by the umbrella stakeholder organisation, Barbados Agricultural Society (BAS), and several commodity groups such as the Barbados Egg and Poultry Producers Association. The BAS and the Barbados Manufacturers' Association have been strong advocates for consumers to buy local goods and for diversification of the local products to increase export potential and competitiveness.

VULNERABILITY REDUCTION WITH DIVERSIFIED INCOME OPTIONS

Risk management strategies should consider the challenges and opportunities arising as a result of increasing globalisation. This trend has opened options for risk diversification.

The tourism sector leads in mainstreaming of DRR, and the incentives to the tourism sector are usually taken up by the sector to reduce vulnerability. Attempts to achieve the equivalent in the agricultural sector are being made. Initial consultations were held with the World Food Programme (WFP) and CDEMA in providing model planning for DM and DRR in this sector; however the adaptation process is pending (DEM, 2013).

PROTECTION OF CRITICAL PUBLIC FACILITIES

DRR in relation to the planning of critical infrastructure such as schools, fire stations and hospitals is being actively integrated. The most recent schools and fire stations (Blackman and Gollop Primary and the Arch Hall Fire Station) have incorporated DRR/CDM measures, and the plans for a new hospital have taken into account the PAHO Safe Hospital guidelines. However, retrofitting existing structures presents a challenge.

For many other types of major developments such as hotels, ports and marinas, many of the elements of hazard analysis to be considered relate to the coastal or marine environment, and are thus ably governed by the CZMU's development control policies, plans and enforcement procedures (DEM, 2013).

RECOVERY SCHEMES AND SOCIAL SAFETY NETS

Livelihood security and social safety nets are mechanisms designed to ensure the income and strengthen the resilience of the most vulnerable in a crisis situation. Property insurance, micro finance, micro insurance, and cash transfers are some of the means through which this is accomplished in Barbados. However, the effectiveness of these mechanisms and their breadth of adoption are not clear.

Contingency funds are used in the post-disaster recovery process, such as the US$8.5 million after Tropical Storm Tomás. The Welfare and Relief Standing Committee is intimately involved in planning, response and recovery activities for disasters. The Housing Committee engages in the rehabilitation and reconstruction processes, and is charged with developing a Housing Recovery Programme in the immediate, short and medium term following a disaster. TCDPO advises on restricted areas for rebuilding due to high risk. These systems should ensure that infrastructure is 'built back better' with mitigation approaches in the construction methods.

Access to financial and other resources to reduce the difficulties experienced by vulnerable communities limits significant direct and programmatic contribution in DRR in these areas. Technologies that reduce the vulnerability of persons with special challenges are not yet being introduced on a wide scale e.g. radio receivers for early warning messages can display in text or can trigger an alarm.

FINANCIAL RISK-SHARING MECHANISMS

Of course, owners of homes and businesses may employ mitigation measures independently based on their analysis of the risk. However, research (Kunreuther, 2001) cites several reasons why homeowners do not adopt cost-effective (i.e. relative to structural damage to the property) risk mitigation measures:

- Desire for short timeframe for return on investment (ROI) e.g. if they only plan to stay in a house 3-5 years
- High discount rates for ROI e.g. reluctance to invest in capital intensive energy efficient appliances or renewable energy despite the lowered electricity cost
- Underestimation of probability such that it is perceived to be so low (i.e. 'it won't happen to me') that the mitigation is unjustifiable
- Aversion to upfront costs due to budget constraints
- Truncated loss distribution, where persons believe they will be financially responsible for only a small portion of their losses should a disaster occur e.g. having relatively few assets, or they expect government to heavily subsidise relief efforts

The Building Code is poised to be used as a key instrument in encouraging investment in risk mitigation. For example, financial institutions could require inspection and adherence to the Code as a prerequisite for insurance. Contractors could be required to undertake specialised courses and receive certification to support their implementation of the Code.

A range of risk transfer options is required to deal with potential losses at various scales. Combined with reinsurance and catastrophe bonds, building codes serve as an effective policy instrument once enacted.

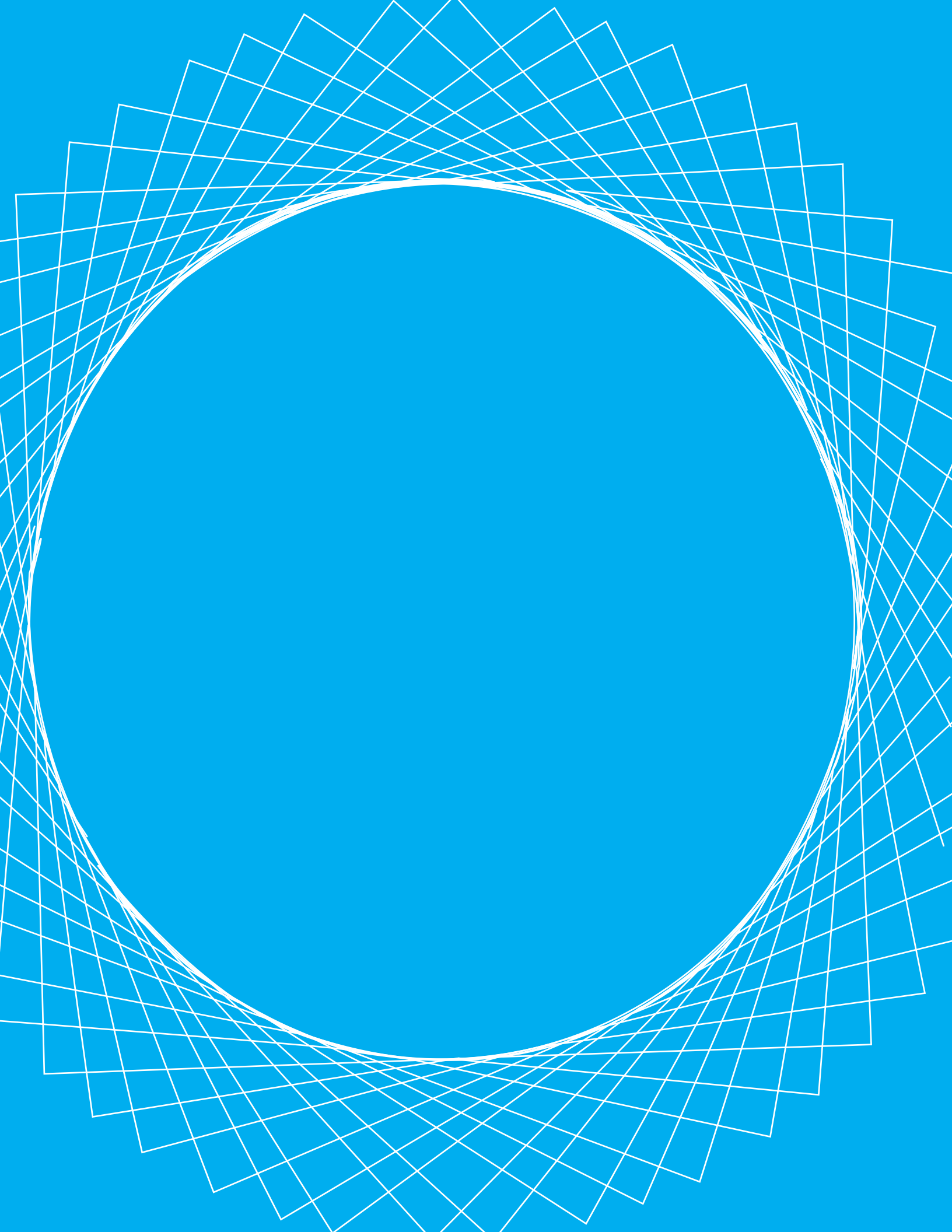
PUBLIC-PRIVATE PARTNERSHIP

The private sector is a perennial partner with the DEM, especially in driving public awareness during the hurricane season. Recovery crews working on housing repairs draw expertise from both public and private sectors. The Barbados Association of Professional Engineers and the Barbados Chamber of Commerce are both actively engaged within Standing Committees of the NEMS, providing key technical expertise and insight.

Private enterprises should continue to be encouraged and supported in enhancing their knowledge of natural hazard risk, and in adopting appropriate risk management tools.

RURAL DEVELOPMENT PLANS AND DRR

The 2003 PDP designated specific areas as rural and urban with the view of managing development such that they maintain their characteristics and to prevent any new risks due to development in inappropriate and highly vulnerable locations. The PDP also highlights the preservation of agricultural lands from further undue encroachment by urban developments. This contributes to maintaining permeable surfaces for infiltration to allow groundwater recharge and reduce flooding.



6. Disaster Risk Analysis

Risk is a function of the potential loss and/or damage based on the exposure to a hazard and the likelihood of its occurrence (e.g. an active volcano) and the vulnerability of assets to be adversely affected by this hazard based on their characteristics (e.g. location of farms on volcanic slopes due to fertile soils). This is typically expressed as:

Risk = Hazard x Vulnerability

A hazard can be described by varying intensities, whereas vulnerability encapsulates concepts of exposure and physical susceptibility, socioeconomic and ecological fragilities, and lack of resilience to cope and recover. Thus, a disaster is a social-environmental manifestation of socially constructed risk. First order effects describe potential damage to physical infrastructure and the environment, while secondary effects consider the potential socioecological and economic impact on communities and organisations (Cardona, 2014)

Risk reduction focuses on anticipatory planning to minimise the likelihood of hazards and/or their interaction with the environment and society, thus aiming to lower hazard exposure and reduce vulnerability to them across the society and economy. Hence, this must be applied in policy formulation and development planning, in addition to the post-impact recovery and reconstruction phase.

6.1 Analytical criteria and methodology

The IDB has developed a System of Indicators to measure disaster risk and risk management, designed to evaluate the variables related to the potential impact of extreme events and the capacity of society to withstand such. This System of Indicators has been developed to help to reveal disaster risk in different ways for diverse decision-makers and identify the causes of risk to be able to assess the effectiveness of corrective and prospective mitigation measures. They are intended to:

- Improve the use and presentation of information on risk with identification of its essential social and economic characteristics, thus assisting policymakers in formulating adequate DRM policies and actions, identifying investment priorities to reduce risk and guide the recovery process
- Measure key elements of vulnerability, identify national capacities and provide data to evaluate the effects of policies and investments on risk management
- Promote the exchange of technical information for public policy formulation and risk management programmes

These fall under 4 indices[53]:

- Disaster Deficit Index (DDI) measures the potential macroeconomic loss from disasters compared to the government's financial capacity to cover these losses in the event of a catastrophic event i.e. a 1 in 50, 100 or 500 year event (e.g. Haiti earthquake in 2010; previous event in Port-au-Prince was 1785).

53 These represent a summary of the main indicators, however each indicator is based on a family of sub-indicators, more thoroughly explained in IDB, 2010a

This requires an estimation of the critical impact during a given exposure time and the finances to cope. For DDI >1.0 the country has insufficient resources to cover losses or replace capital stock, with a greater gap with increasing value. Where a country has restricted ability to access debt, it implies that recovery is impossible.

$$DDI_{PML} = \frac{\text{maximum considered event loss}}{\text{economic resilience}}$$

- Local Disaster Index (LDI) attempts to capture social and environmental risk that result from recurrent small-scale events (extensive risk) that chronically affect sub-national and local levels, especially low-income groups. Permits identification of areas where hazards are more persistent. A higher relative value of the index means a greater magnitude and distribution of the effects of various hazards among municipalities. Dispersion and persistence of local effects reflects increasing vulnerability and environmental degradation. LDI reflects persistence of the effects caused by different types of events on livelihoods and local development, perpetuating poverty.

$$LDI = LDI_{deaths} + LDI_{affected} + LDI_{losses}$$

Prevalent Vulnerability Index (PVI) defines the exposure of human and economic activity in disaster-prone areas, socioeconomic fragility and lack of social resilience, and the human and social capacity to absorb impacts. It describes aspects that favour the direct impact and indirect and intangible impact where a hazard event occurs. Scores range from 0 to 100; <20 indicates low vulnerability, 20-40 medium, 40-80 high, and >80 very high.

$$PVI = \frac{PVI_{exposure} + PVI_{fragility} + PVI_{lack\ of\ resilience}}{3}$$

Risk Management Index (RMI) describes the country's risk management performance qualitatively based on targets and benchmarks measuring on a scale of low, incipient, significant, outstanding and optimal; reflecting the organisation, development, capacity and institutional actions taken to reduce vulnerability and losses, to prepare for crisis and to recover efficiently from disasters. A value of <50 is considered unsatisfactory, 50-75 is satisfactory, >75 is outstanding. Low = <15, incipient = 5-30, significant 20-70, outstanding 60-80, optimal over 80.

$$RMI^{54} = \frac{RMI_{RI} + RMI_{RR} + RMI_{DM} + RMI_{FP}}{4}$$

For Barbados, the DDI values have progressively increased from 2000 to 2008 across events for all return periods. In 2008, for a 1:100 year event ($DDI_{100,2008}$) the DDI was calculated at 3.15. For a 1:500 event, $DDI_{500,2008}$ = 5.75.With all values at or above 1.0, the analysis clearly demonstrates that the country has insufficient resources to cover losses and/or feasible financial capacity to face losses and replace the capital stock affected. In 2008, if contingent liabilities to the country were covered by insurance (annual pure premium), the annual investment by the government would need to approach 12% of capital expenditure to cover future disasters.

While there was insufficient data to evaluate LDI, it was noted that the most recurrent and isolated phenomena, such as landslides and floods, cause frequent effects at the local level and largely go unnoticed or unquantified.

54 RI = risk identification, RR = risk reduction, DM = disaster management, FP = financial protection.

Barbados' PVI values showed some improvement from 45.5 in 1985 to 39.3 in 2007. Vulnerability due to socioeconomic fragility showed a general declining trend, and resilience improved slightly.

The RMI improved significantly from 11.98 in 1995 to 44.9 in 2008. This is primarily attributed to progress in land use and urban planning, environmental protection, overall disaster management and reinsurance coverage. Significantly, performance was incipient in relation to social safety nets and funds response, and there was no progress in budget allocation and mobilisation.

Overall, notwithstanding improvements in many areas, the effectiveness of risk management at the time of assessment was considered incipient, thus requiring improvement in the capacity to anticipate, to cope and to recover. Analysis of the various sub-indicators gives specificity as to the areas needing attention.

Disasters represent non-explicit contingent liabilities, for which government retains most of the risk. If future losses are not incorporated into planning and investment, sufficient budgetary resources will not be available to reduce potential loss. It is clear that economic and social characteristics of the country have substantially been altered since 2008. Consequently, the indicators are currently in the process of being updated through the CRMP. The results should be available by mid-2015.

6.2 Definition of risk scenarios

With an expansion of populations and highly valuable assets in areas of hazard exposure, the nature of risk is changing; likewise, the measures to address these changing risks will need to be amplified. To propel and support such action, the characteristics of such risks need to be defined. Box 8 shows some of the scenarios that have been utilised within the last 5 years to test national disaster response structures; however, risk scenarios have not been constructed to be applied to developmental planning.

Box 8: Risk scenarios used in national-level testing exercises

Tsunami scenarios

- SRU of the UWI is monitoring increased seismic activity from Kick-em-Jenny. Readings are consistent with the movement of subterranean magma and may indicate the volcano is about to enter an active phase. Thus the alert status has been upgraded to Orange and anticipate to Red if activtiy intensifies. Past 24 hours seismometers have recorded premonitory earthquake swarms and significant T-phase signals emanating from Kick-em-Jenny; seismic event recorded.
- M8.5 earthquake north of Aruba at a depth of 10km. Forecast wave run-up 0.3-1m.
- M8.5 earthquake off Portugal at a depth of 5km. Travel time approximately 7h.
- M7.6 earthquake W of Puerto Rico at a depth of 7km. Travel time 1h 38mins. Forecast offshore wave height 0.05m.

Epidemic scenario

- Confirmed H1N1 influenza cases in the southern cone of South America. Influenza migrates north via travellers and commerce. WHO declares Pandemic Alert Phase 5, triggering national EOC activation. Possible effects on food, fuel and tourism.

Subsequent updates of the Country Document should be able to complete a detailed risk scenario development with a broad stakeholder group. The scenario should be able to define the hazard parameters, the affected population (location and numbers), vulnerable assets and infrastructure, and expected impacts. These scenarios would then form the basis of planning and prioritisation of risk management strategies that help to reduce vulnerabilities. This should be accompanied by a special analysis of areas vulnerable to multiple hazards. An example is shown in Figure 42.

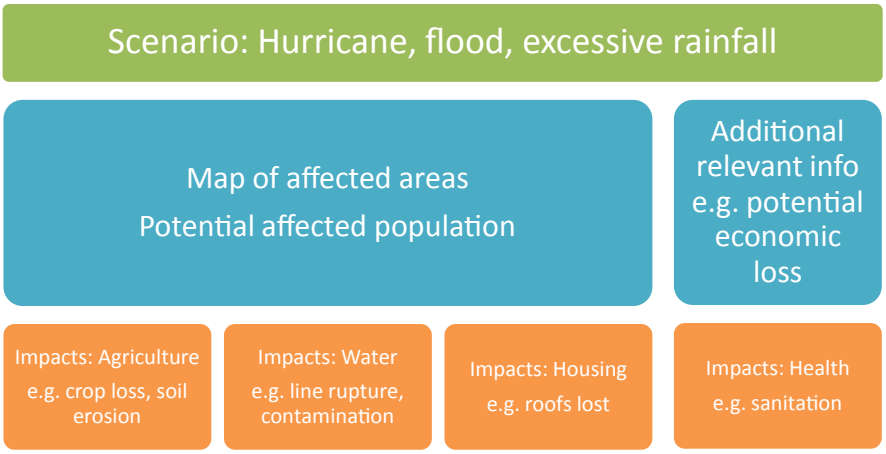


Figure 42: Example of risk scenario

6.3 Prioritisation of risk scenarios and areas for intervention

Climate-related hazards (storms, drought, floods, etc) generally show a quasi-cyclical pattern. Historical climatological and hydrological records allow assignment of risk probabilities that can be taken into account in public and commercial investment decisions. The recurrent nature of these hazards stimulates adaptation measures in economic and social activities, such as housing, agriculture, and water management, at the micro and sector levels. Conversely, from a planning perspective, geophysical hazards can be considered more stochastic and of low and uncertain probability, typically <1% in any given year (Benson and Clay, 2004). However, the damage and disruption can be extremely devastating to power, communications, transport, productive capacity and social infrastructure across the entire country. Additionally, the analysis of the hydrometeorological hazards should bear in mind the uncertainty of climate variability and climate change.

Based on historical impacts and stakeholder experience, the most frequently occurring and important hazards identified by stakeholders were tropical cyclones, storm surge and floods. Seismic hazards (i.e. tsunamis and earthquakes) have low frequency but very high impact potential; however these have been considered less significant. Drought continues to be underestimated in its potential for devastating impact. Notably, there were significant events in 1994-1995, 2002-2003 and 2009-2010, none of which have been assessed for their social and economic impact, neither have they been captured by international records such as EM-DAT. Moreover, the attendant and far-reaching effects of climate change hold multi-faceted and potentially overwhelming consequences. However, as Barbados' contribution to greenhouse gas emissions is small, risk reduction will of necessity mainly take the form of adaptation. Coastal areas and the Scotland District were identified as being exposed to multiple hazards.

A qualitative matrix has been structured (Table 24) to capture the risk as it relates to each hazard, based on the IDB indicators as well as the foregoing research, analysis and consultation. The scoring considers the type of impact (social, environmental, economic), whether impacts are on a local or national scale, the frequency of occurrence and whether secondary hazards are generated. The perception of risk is significantly skewed by probability of occurrence, and therefore so is the impetus to pursue mitigation actions. Thus frequency of occurrence has been weighted more heavily than other factors.

Table 24: Qualitative analysis of risk by hazard type

Hazard	Type of impact			Scale of impact		Frequency of occurrence	Secondary hazards	Aggregate score (of 80)
	Social	Environmental	Economic	Local	National			
Climate change	9	10	10	8	10	18	9	74
Tropical cyclones	7	8	8	4	8	10	8	53
Flood	7	7	8	8	2	17	3	52
Drought	6	8	8	6	8	12	1	49
Vector-borne disease	7	5	4	7	8	17	1	49
Earthquake	6	8	10	5	10	1	8	48
Land degradation	5	8	7	8	6	10	2	46
Tsunami	8	9	10	5	9	1	3	45
Wildfires	7	6	5	8	2	15	2	45
Groundwater contamination	9	7	7	8	6	5	1	43
Water-borne disease	6	5	4	7	8	7	1	38
Landslide	5	6	6	7	3	8	2	37
Oil spills	4	8	6	8	3	5	1	35

Scoring: severity of impact (type, scale, secondary hazards) – 1 = low, 10 = high; probability (frequency) of occurrence – 1 = low, 20 = high.

The assessment of risk should transition into decisions on how the risk will be managed. Figure 43 demonstrates the shift in risk reduction strategy from mitigation to transfer to risk retention as the expected losses and return periods increase. The loss exceedance curve (LEC) describes the probability that a certain level of loss will be exceeded in any given year.

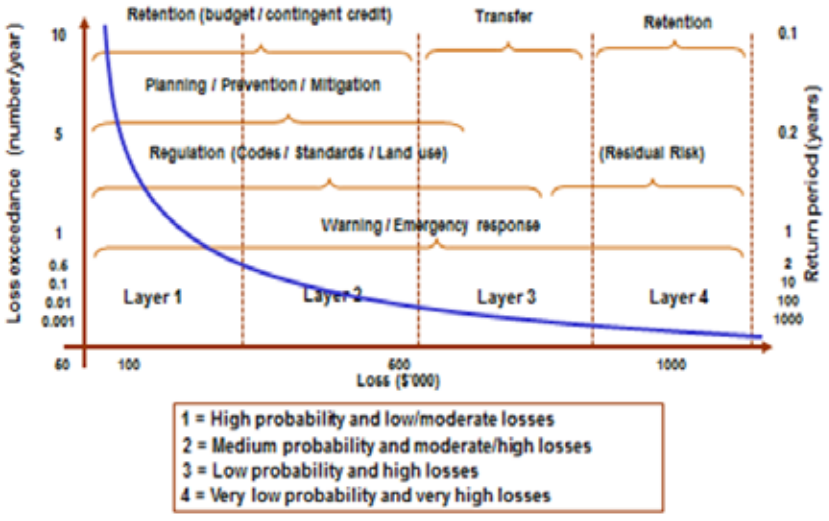
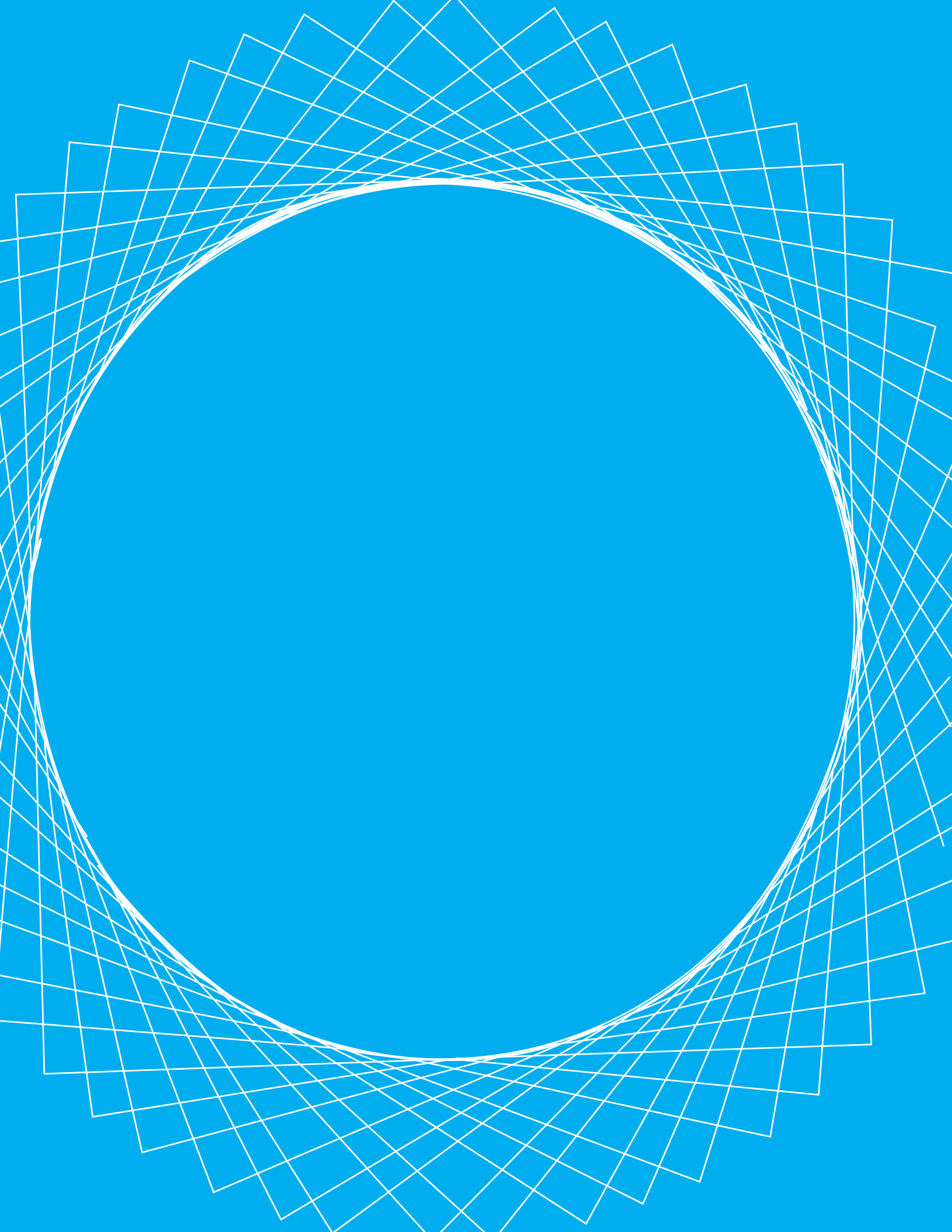


Figure 43: Loss exceedance curve for natural hazards and possible responses or actions (Source: Cardona, 2014)

Probabilistic risk models and empirical models can be used as tools to develop a methodology that quantifies the real benefits of corrective and prospective interventions to address intensive and extensive risk. The risk management policy should be contextualised by national priorities and linked to development planning, land use planning and budget execution (Cardona, 2014). Linking risk assessment to the risk management process in this manner requires an understanding of the nature of the problem and its importance, the characterisation of the risk, and the affected parties and their decision making processes, leading to evaluation of alternative strategies for risk management (Kunreuther, 2001).

Future changes in environmental and social systems, such as increased water demand or greater conversion of land to housing, will be predictable to varying degrees. In some cases the probability of occurrence of a particular scenario will not be able to be assigned. Decision making strategies in this realm would focus on no-regrets risk reduction options i.e. where benefits outweigh the costs of the intervention regardless of the actual change, and vulnerability-based decisions which aim to lower or eliminate vulnerability variables to a given threshold regardless of the conditions. Thus, with high levels of uncertainty, mitigation and investment decisions should adopt an approach where they would be favourable under a wide range of possible future conditions. An alternative approach is designing worst case risk scenarios for planning. With support from the World Bank, UNDP will be working with countries in the region to strengthen capacities in using loss accounting and hybrid loss exceedance curves for incorporating risk mitigation strategies into national development planning and investment.



7. Strategic Directions for Disaster Risk Reduction

DRR has been shown to be one of the more cost-effective development interventions, by saving lives and protecting valuable and scarce resources such as food, livestock and property. Crucially, it also promotes anticipatory and cost-effective responses to climate change risks, which will be progressively required on an accelerating scale (Back et al, 2009). Reducing disaster risk is important to maintain progress in poverty reduction, sustainable livelihoods and sustainable development. Particularly given the current economic situation, Barbados can ill-afford to fall into a situation where public funds must be diverted to relief and reconstruction and serviced through additional external debt. Such actions may lead to the postponement or abandonment of planned investments and projects, reduced public services, and further deferment of wage and salary increases and of staff appointments. The short term decline in GDP post-disaster due to slowed economic activity can contribute to depleted foreign reserves, economic instability and uncertainty, deterring investment, more so if the country's credit rating is also depressed (Benson and Clay, 2004) as is the current case.

A number of obstacles exist in the area of disaster risk management. Awareness of the need for the more cost-effective preventive approach to disaster risk management is still incipient at most levels of public administration. In addition, there is an apparent apathy toward enacting the appropriate legislation that provides the requisite authority and institutional framework for disaster risk reduction. These challenges will be accentuated in the face of the impacts of climate change.

Addressing these barriers will require a reorientation of the national approach to managing natural hazards and disasters, where integrated disaster risk management is embraced and owned by all sectors.

UNISDR has designed a Matrix of Criteria is an instrument to accompany ex-ante analysis processes to DRR planning profiles, based on observation and rapid analysis of relevant information available from national and international information sources. The instrument is designed for medium-term programme ex-ante processes and, therefore, is not suitable for project monitoring, performance measurement or ex-post assessments. The DEM has opted to use this instrument as a means to identifying national priorities for DRR through stakeholder consultation.

The criteria for prioritising DRR actions identified the following priority areas in Figure 44 (aggregated results from consultations are displayed in Annex VII).

There were some limitations in the application of the methodology. Principally these were due to a narrow range of respondent agencies actually completing the questionnaire or participating in the final stakeholder consultation. While the engagement of agencies in the general consultative process was good, some key players were unavailable. Thus the priorities may not reflect a truly representative picture of the complete DRR situation, but the input from the participating agencies was indeed rich and invaluable, and contributed significantly to the analysis. Moreover, without disaggregated indicators for different components e.g. multiple hazards, the results may mask many nuances that exist in reality.

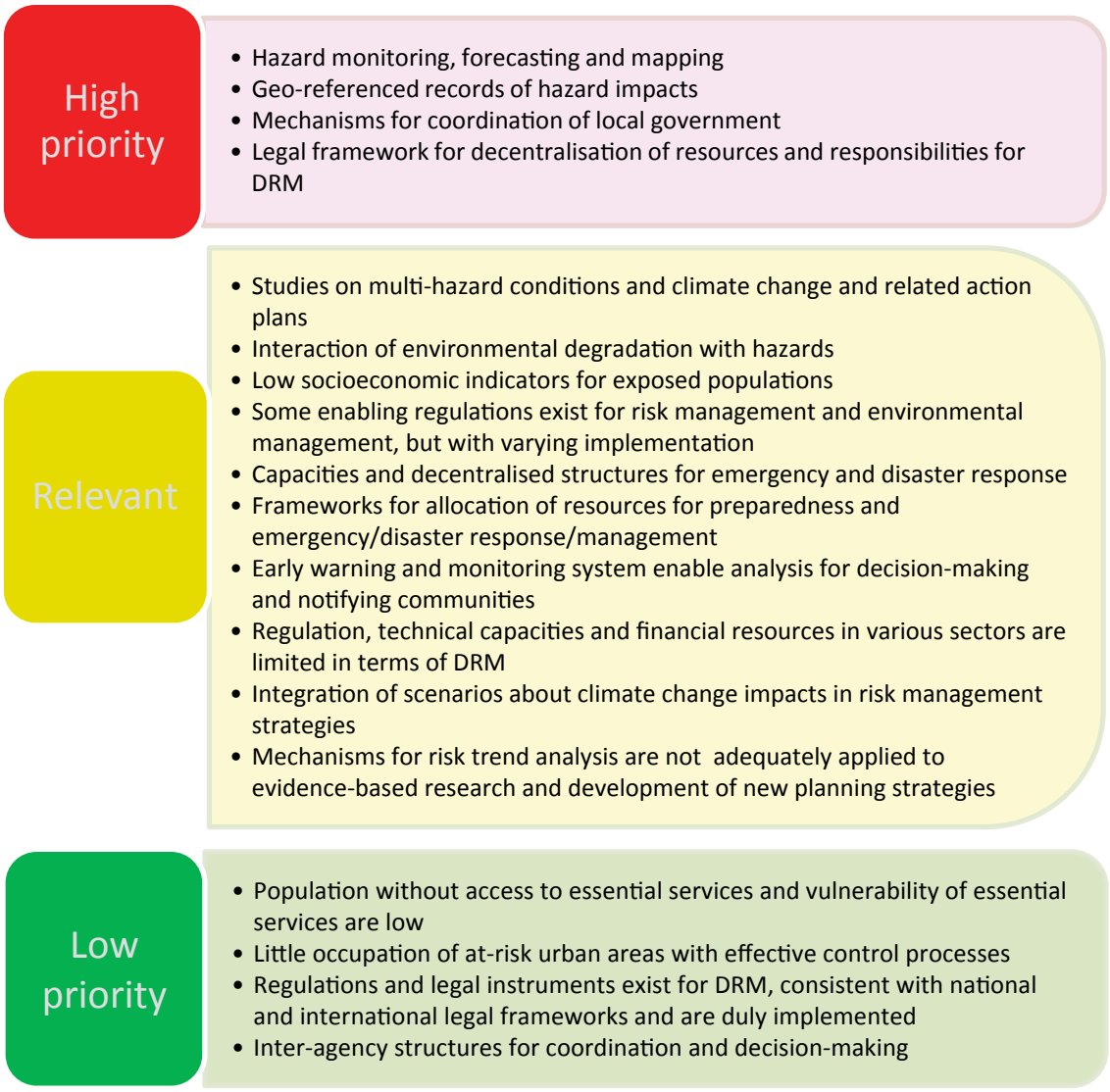


Figure 44: High, medium and low priority areas for disaster risk reduction in Barbados based on stakeholder consultation.

Based on the risk scenarios and the high priority areas identified by stakeholders, the following strategic directions have been proposed for advancing DRR in Barbados:

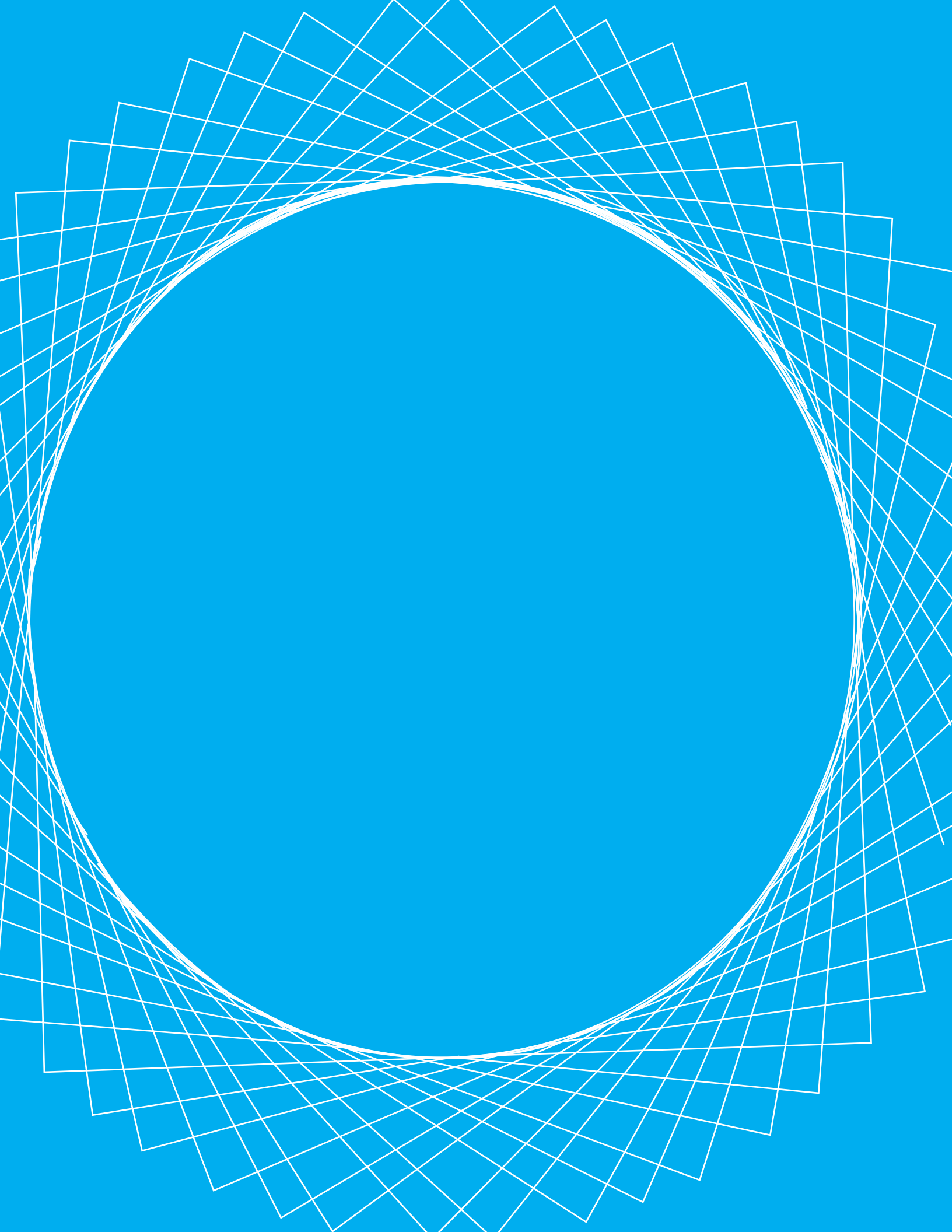
Table 25: Proposed strategic directions and priority actions for disaster risk reduction in Barbados

Key issues	Proposed actions	Suggested lead agency	Timeframe for completion
Capacities for hazard monitoring, forecasting and mapping are inconsistent across hazards and agencies Lack of adherence of agencies to data sharing protocols Apparent lack of understanding within agencies of usefulness of data to other parties Lack of dedicated monitoring and research personnel Inability to access datasets from multiple agencies for comprehensive analysis and planning Limited compilation capabilities inhibits comprehensive analysis for effective planning	Protocols development for consistent data collection and transformation (Building a culture of information as a public good. Potential for designating specialised research and data collection personnel, and sharing between agencies with similar needs to maximise scarce resources)	Data Processing Department	Jun 2015
	Build a multi-sector hazard monitoring network	Barbados Meteorological Service	Dec 2015
	Mapping of floods and tsunami risk areas and identification of evacuation routes	Coastal Zone Management Unit	Dec 2015
	Education on the functionality and benefits of the DEWETRA platform, such as the capacity to integrate GIS layers, hazard monitoring information and forecast models towards its greater and consistent use	Lands and Surveys Department with support from CIMH	Dec 2015
	Development of guidelines or protocols for integration of data and analysis into specific decision making processes (non-restrictive, non-exhaustive)	Data Processing Department	Mar 2016
Variable tools and methods employed by agency teams in damage and needs assessments Inconsistent methodologies impede comparability of data	Standardise methodology for post-disaster data collection and input of metadata across agencies, including use of geo-ref equipment e.g. the UNDP-World Bank Post-Disaster Needs Assessment (PDNA) project being rolled out across the Eastern Caribbean	Barbados Statistical Service	Oct 2015
	Sharing of best practices and tools among agencies	Town and Country Development Planning Office	Jan 2016
	Training of field operatives on standardised methodology	Lands and Surveys Department	May 2016
Inconsistent capacities across DEOs Absence of clarity on the roles and responsibilities of Constituency Councils in DRM; potential conflict with DEOs Constituency Councils and DEOs are aligned along electoral boundaries, which are not applicable in the context of environmental risk management e.g. watersheds	Instituting regulations for the Emergency Management Act Cap 160A to empower the DEM	Office of the Attorney General	Dec 2015
	Institutionalisation of the new Community Emergency Programme	Department of Emergency Management	Jun 2016
	Modify disaster framework to empower communities to conduct assessments and make decisions at a local level (e.g. as in Speightstown with the flood EWS)	Department of Emergency Management	Jun 2016
	Provide standardised training for community teams to ensure safety and accountability	Barbados Fire Service Ministry of Health Environmental Protection Department	Dec 2016

Regionally, the following priorities have also been identified[55], and show strong correlation with the high and medium level actions for Barbados in Figure 44:

- Strengthen EWS at national and community levels
- Improve understanding and action on seismic risk, particularly in an urban context
- Formalise or improve the national systems for coordination among partners for risk identification and mitigation
- Engage in more joint programmes with private sector participation
- Develop or strengthen alignment of laws and policies with regional and international frameworks.

55 During the Regional DIPECHO Workshop, 16-17 October 2014 in Jamaica



8. Recommendations and Conclusions

Overall, the state of disaster risk reduction in the country can be characterised as positive, with many areas showing progressive improvements with a strong system of coordination within the NEMS. There are competent technical agencies with mandates that for protection of the environment, public health and land development control. Social policies and protection programmes create a support system for vulnerable groups such as the elderly and the poor.

However, there are limited technical personnel in many agencies. In many cases, the regulatory framework is weak and inhibits the effectiveness of their regulation and enforcement. Although institutional capacities are weak, and government resources severely constrained, the attempts to decentralise functions and decision making have been limited.

Crafting a resilient society demands clear understanding of the multi-dimensional spheres of vulnerability, including poverty, natural hazard risk, energy and food insecurity, environmental degradation, poor infrastructure, and weak governance. A resilient country should look like the model below:

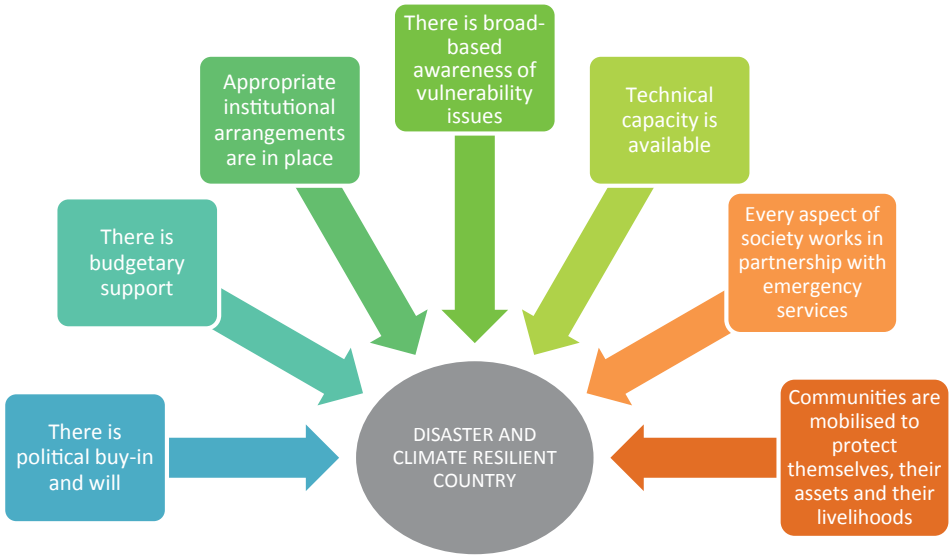


Figure 45: Characteristics of a resilient country (Source: Jackson, 2014)

Following are additional recommendations for actions to improve the culture of risk reduction, some of which originate from the national HFA report for 2011-2013 and the Regional Climate Change Framework.

REDUCING VULNERABILITY AND EXPOSURE

1. Develop a broad-based incentive scheme to stimulate individual behavioural change with respect to resilience. This should be driven by public education and transparency to increase understanding of risk

and vulnerability. For instance, this could build on the incentive scheme of the Ministry of Agriculture, which encourages farmers to clean suck wells to support aquifer recharge and drainage, to engage in contour farming, and to plant khus khus grass to reduce erosion.

2. Prioritisation of investments in climate change adaptation measures should be adopted e.g. in ecosystem conservation or restoration, which will also serve to secure investments in economic sectors through reduction of disaster risk.

3. Establish clear policies and methodologies for increasing the participation of resource users and vulnerable groups in the management and protection of terrestrial and marine ecosystems.

4. An inventory of vulnerable housing infrastructure must be compiled, so that impact zones may be delineated for wind and flash flood hazard assessments. The preliminary analysis during the Bridgetown tsunami demonstration project provides a good starting point for expanding the methodology, and already began the classification and digitisation of buildings (types, function and construction material).

5. Noting the vulnerability and exposure of the agricultural sector to both flood and drought, as well as several other secondary effects, and attendant implications for food security and emergency supplies, increased focus should be directed toward evolution of a climate-smart agricultural sector through risk mitigation and climate adaptation measures such as water storage, improved drainage and efficient irrigation, as well as research into more resilient crops and varieties. The recommendations of the EU study on climate change adaptation with the Ministry of Agriculture will be useful in this regard, to be presented in early December 2014.

6. With multiple potential impacts on the integrity of transport infrastructure due to natural hazards and climate change (UNCTAD, 2014 pp.114), potential adaptation strategies for the sea and airports should be examined, including engineering and technological solutions, management systems and insurance.

7. Attention should be given to the strengthened application of science and technology and emerging research and development. This includes in the analysis of risk and solving problems of vulnerability and exposure. Cognisance should also be lent, at the same time, to the wealth of knowledge built from community experience, which cannot be discounted.

8. Decision making processes across all sectors need to be empowered and flexible to effectively incorporate risk assessment and vulnerability analysis into planning and investment. Cost-benefit analysis coupled with risk models, incorporating disaster risk, ecosystem services and climate change, must feature prominently throughout government planning and budgeting processes and private sector development to avoid creation of new risks. Socioeconomic data analysis must also be incorporated into risk assessments methodologies to inform decision making. The EIA process should also be strengthened with the incorporation of hazard impact and socioeconomic assessments.

IMPROVING THE LEGAL, NORMATIVE AND POLICY FRAMEWORK

9. Regulations are needed under the Emergency Management Act, Cap 160A governing the roles and responsibilities of the national disaster management and risk reduction systems. This will clarify specific roles of key agencies and actors in DRR forging greater cooperation and collaboration, as well as stimulate broad sector participation.

10. Accelerate the establishment of the Hazard Mitigation Council and the development of the national Hazard Mitigation Plan as the multi-sector roadmap for DRR. Institute the Hazard Mitigation Policy and inaugurate the Mitigation Council and develop a work plan and implementation schedule within the upcoming fiscal year. A National Drought Management Committee should be established as a sub-committee of the Hazard Mitigation Council, to govern the national drought management framework which integrates risk assessment, hazard monitoring and early warning and response and recovery responsibilities, with a potential structure as shown in Figure 46.

11. Accelerating the enactment of the Barbados Building Code and the enforcement mechanism must be an integral part of any short to medium-term implementation plan for hazard and risk assessments. An examination of practices for reducing seismic risk should be considered as an amendment to the Code.

12. Update and enact the Environmental Management Act to confer effective powers of governance and regulation for natural resource management and risk resilience.

13. The government should review all existing strategies, policies and action plans to ensure they align, are consistent with, and contribute to successfully building resilience and creating a low-carbon economy, within the context of a changing climate. Further, these governing and regulatory instruments should show clear alignment with regional and international frameworks for risk resilience and sustainable development. Policy frameworks and action plans should be cognisant of and promote a holistic approach to sustainable development with engagement of multiple actors across all sectors, NGOs, the private sector and the general public. This should also include social policies relating to vulnerable groups. There should be buy in across these stakeholder groups as well as all political parties to ensure continuity.

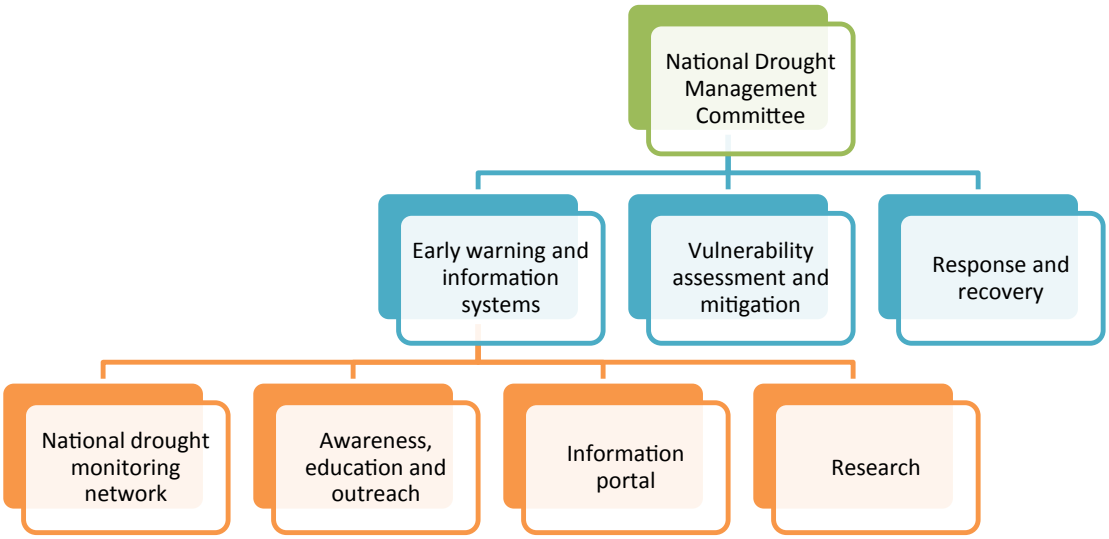


Figure 46: Proposed framework for national drought management (Source: Trotman, 2013)

14. Monitoring, evaluation and reporting frameworks should be connected to policies and action plans, particularly any Medium Term Development Strategy and National Strategic Plan, with public disclosure to examine ongoing progress.

INFORMATION AS A PUBLIC GOOD

15. There are considerable benefits to public funding of hazard monitoring and information dissemination, and while costs are moderate, they are largely recurrent. The cost-benefit patterns make sustaining funding in an environment of budget constraints challenging (Benson and Clay, 2004). Nevertheless, many of the upfront costs (e.g. software, equipment, training) are generally borne by donor-funded projects, therefore the bulk of the effort is required in institutionalising the process of consistent data collection and standardisation of methodologies.

16. Data collection an research protocols should include focus on sets of indicators that can be collated across several specialisations and which serve to simultaneously address national and international monitoring requirements e.g. IDB System of Indicators, HFA Monitor, CDM Monitor.

17. Attention should be given to reinforcing the awareness of agencies, and strengthening their capacity to fully engage in the use and application of the climate, natural resource and disaster information and data already existing and being developed. Agencies should take advantage of the technical expertise available in regional and research institutions for guidance (e.g. CIMH, CCCCC, CERMES).

18. A centralised national GIS would provide a single point of access for geospatial data, facilitate hazard mapping and risk assessment and contribute to sustainable development planning. The recent LiDAR survey of the coastal zone could be one of many layers. The work of the Telecommunications Unit on creating a single ICT space for government would be an integral component to such an initiative to facilitate sharing between ministries and agencies and with the public.

19. The DEWETRA platform should be more effectively utilised as an accessible resource where hazard impact and vulnerability information can be added to permit analysis alongside hazard forecasts. This could serve as an alternative to a centralised GIS.

20. Government should develop 'clearing house' facilities with free access to data and information. This should extend to information supporting development proposals, for example, baseline data and analysis provided in EIAs and socioeconomic surveys. Donors, international financial institutions and project sponsors should always release all data and information (within established protocols that recognise some information may be sensitive).

CAPACITY ASSESSMENT AND DEVELOPMENT

21. Greater use must be made of the supporting technical capacities and diversity of tools, models, and other resources already available, many at no cost. Capacities must be built and maintained in the collection of key data and indicators for national and international monitoring.

22. Capacity must be enhanced to ensure that all users of the risk data and information platform are able to fully utilise the available resources for decision making. Regulatory agencies must have the capacity to efficiently implement key outcomes of national risk assessments.

23. Inventory of all existing national DRR initiatives should be made to provide a baseline for monitoring and evaluation of the country's readiness.

24. Complete the institutional review of the Department of Emergency Management with the view to provide relevant resources to fully implement CDM.

25. Institutionalisation of the Safe Building Course should be prioritised, with inclusion of elements to reduce seismic risk, as well as improve overall building efficiency (e.g. energy and water conservation, passive cooling). The course should be aligned to the Building Code, and successful completion should be a prerequisite for professional registration of architects, draughtsmen and contractors (and eventually foremen and all artisans).

26. Cultivate wider local capacities to conduct VCAs and increase their rollout across communities, with priority on multi-hazard areas.

27. Strengthen skills within government agencies and NGOs to understand natural hazard and climate risk issues and to construct project concept and applications to access international funding.[56]

EARLY WARNING

28. Continue the expansion of the EWS to incorporate current technology for mass dissemination of warning information. Target specific vulnerable communities and vulnerable groups, and enhance local communications systems to augment the national early warning systems. CAP-based EWS facilitates the integration of multiple dissemination technologies which can be activated simultaneously from a single point for all hazards. This is about to be piloted at the community level in Barbados, with potential for replication and further upscaling to the national level. The tsunami and coastal hazards EWS is designed to be CAP-based, however sourcing of funding is presently an issue.

29. Secure funding through government budgetary provision and/or donor funding to further strengthen and enhance the EWS for multi-hazards, including drought and seismic hazards, through capacity building and equipment upgrades.

MULTI-SECTOR ENGAGEMENT AND COOPERATION

30. Institutional strengthening is necessary for improved understanding and integration of disaster risk management and climate change adaptation at the national level and sector levels, including a multi-institutional, multi-sector approach to risk resilience with appropriate roles for the CZMU, the DEM, planning, finance, environment, agriculture, water and other public and private sector agencies. One mechanism could involve the evolution of a joint national strategy and/or action plan for DRR and CC adaptation, grounded in the respective regional strategies and international agreements, as have been advanced in Tonga, the Marshall Islands, the Maldives and Tuvalu. National Adaptation Programmes of Action (NAPAs) and National Adaptation Plans (NAPs) are also potential mechanisms, used under the UNFCCC. Platforms for regular engagement between these actors should be formalised.

31. To support the growth of agriculture and build resilience of the industry to substantive losses, a working group should be constituted to meet at least twice a year to discuss issues, develop and lead action plans relating to climate predictions, water resource availability and sustainable management techniques. The BAS members, BWA, Ministry of Agriculture, Meteorological Service, EPD and CIMH should form the initial base of this consultative and advisory group.

56 Climate Policy Initiative (2014) Global Landscape of Climate Finance 2014
http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2014/

32. In accelerating the reform of the Community Preparedness Programme, and promoting widespread participation in DRR and increased volunteerism, greater integration must be sought with the Constituency Council mechanism and community-level sustainable development. Engagement with community members and subsequent intervention should be based on an expanded application of the VCA methodology. Spaces must be created to give ear to the voice of the community to capture their unique and traditional knowledge and experiences, especially the elderly and the vulnerable.

33. The private sector must be increasingly viewed and engaged as a key partner in risk resilience. This would be conducive to helping them to understand their own vulnerability and exposure and subsequently reduce their risk to enable more rapid economic recovery in the event of a significant hazard impact. Such investment may even redound to increased attraction of foreign investment. Further, the mandates of several entities can be leveraged to contribute to national disaster management processes in the service of the public good. For instance, much interest is turning toward the regional telecommunications providers to support EWS through text messaging (SMS) and cell broadcast. The private sector can also be a major driver of research, development and innovation in finding solutions to challenges of vulnerability and exposure.

FINANCIAL RISK MANAGEMENT

34. Improved financial risk management is needed to build the resilience of the country through the macroeconomic and sustainable development process. Risk assessment should be incorporated into national budgeting, accounting and physical and environmental planning processes to reflect the true costs of development and inaction. Consequently, concerted effort should be made to promote the perception of risk resilience as an investment as opposed to a cost or burden. Determined political fortitude is paramount to prioritise resilience over potential short term economic gain, especially given the compounding effects of frequent localised hazard events and anticipated increase in extreme events. Of note is the emerging initiative by the World Bank and UNDP to build capacity of countries in the region to apply hybrid LECs and disaster loss accounting. Peru and Mexico are among the countries that have been spearheading efforts in recent years to actively incorporate risk analysis into their investment decision making.

35. Crop insurance should be further explored as a resilience mechanism for the agricultural sector and food security. Building on the proposal from the Insurance Corporation of Barbados Ltd to analyse the risk, traditional and non-traditional avenues should be explored. Incentive mechanisms for vulnerable groups should be explored to address challenges of lack of and under-insurance. Additionally, new and non-traditional options for risk transfer should be explored in a broader national context.

36. Engage in national fund raising efforts on an annual basis, particularly in years with no hazard impacts to help lessen the resource gap during an incident. Solicit support from the private sector for the Emergency Assistance Fund.

37. Provide a framework for the DEM and the wider Emergency Management Programme to develop revenue-generating programmes that enable self-sustainability.

38. Prioritise the adaptation of the Model National Recovery Framework, with emphasis on internalising recovery actions throughout the early recovery, rehabilitation and long term reconstruction processes into existing institutions.

CONCLUSION

Strategic investment in key areas, including strengthening the capacity of technical staff and enhancing inter-agency coordination and strategic planning, enhanced involvement of key economic sectors, adaptation of social policies for vulnerable groups, and emphasis on climate change adaptation will make strides to reducing the risks faced at community and national levels.

Even as preparations continue for the World Conference on Disaster Risk Reduction in 2015, the Zero Draft of the post-2015 framework for DRR (Figure 47) correlates strongly with Barbados' needs and priorities, emphasising that renewed attention is needed on:

- Understanding disaster risk
- Strengthening governance and institutions to manage disaster risk
- Investing in economic, social, cultural and environmental resilience
- Enhancing preparedness for effective response and building back better in recovery and reconstruction

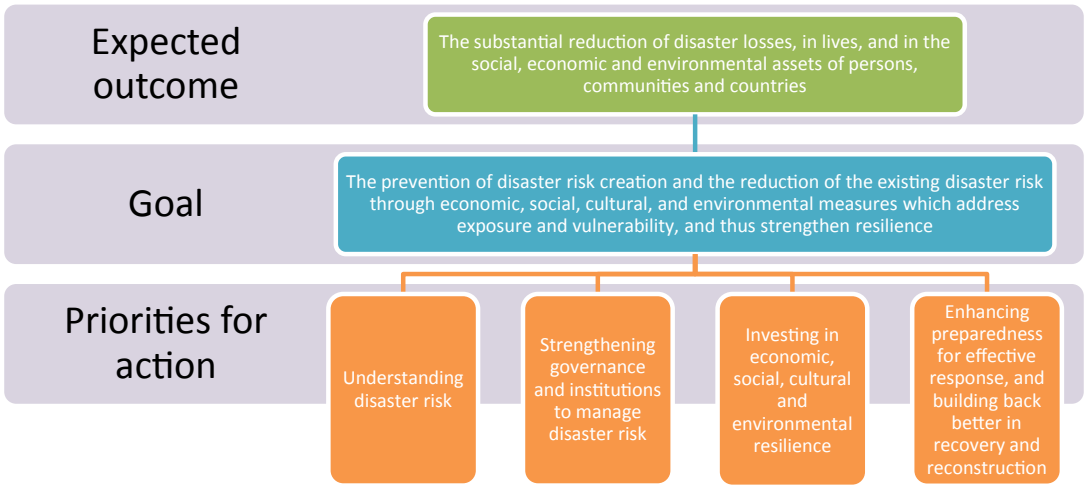


Figure 47: Outline of the Zero Draft of the post-2015 framework for disaster risk reduction as of October 2014 (Source: http://www.wcdrr.org/uploads/1419081E.pdf)

Stakeholders consider the value of the Country Document to lie within its potential for strengthening inter-agency coordination as a contextual framework and a strategic planning guide. It would also be useful as a benchmark for understanding of DRR by technical operatives across all sectors, and as a research tool.

For the subsequent update of the Country Document, the stakeholders agreed in consultation that it be aligned with other 5-year cycles in the country, such as the revision of the PDP and political elections. This would give a time period within which hazard impacts are likely to have occurred and progress within the DRR arena should be have been made and be discernible and measurable.

ANNEXES

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Annex I: Stakeholder Consultations

Climate Related Tools for Sustainable Planning, Adaptation and Mitigation in the DRM Sector 11 September, 2014		
Name	**Position**	**Organisation**
Gale Morgan, Capt	ICT Administrator	Barbados Defence Force
Hampden Lovell	Director	Barbados Meteorological Services
Maryam Hinds	Director, Drug Source	Barbados Drug Service
Ricardo Gittens	Division Officer	Barbados Fire Service
Wayne Davis	Senior Field Investigator	Barbados Statistical Service
Gayle Drakes	Education and Training Specialist	Caribbean Disaster Emergency Management Agency
Adrian Trotman	Agrometeorologist	Caribbean Institute for Meteorology and Hydrology
Cedric Van Meerbeeck, PhD	Climatologist	Caribbean Institute for Meteorology and Hydrology
Shelly-Ann Cox	Research Associate	Caribbean Institute for Meteorology and Hydrology
Theron Lumsden	Intern	Caribbean Institute for Meteorology and Hydrology
Nkese McShine	Intern	Caribbean Institute for Meteorology and Hydrology
Judy Thomas	Director	Department of Emergency Management
Danielle Skeete	Programme Officer	Department of Emergency Management
Joy-Anne Johnson	Programme Officer	Department of Emergency Management
Selwyn Brooks	Chairperson	St James Central District Emergency Organisation
Esther Scott	DEO Member	St James South District Emergency Organisation
Rodney Garnes	DEO Member	St John District Emergency Organisation
Lianda Chapman	Environmental Technician	Environmental Protection Department
Reynette Royer	CADRIM Coordinator	International Federation of Red Cross and Red Crescent Societies
Paul Collymore	Manager Information Systems	Lands and Surveys Department
Gina Belle	Project Coordinator	Ministry of Environment and Drainage
Shanise Taylor	Tourism Development Officer I (Ag)	Ministry of Tourism and International Transport
Mary Waldron	Deputy Director	National Library Service
Ian Branch	Inspector	Royal Barbados Police Force
Clive Lorde	Disaster Risk Management Service	Roving Response Team
Theron Sealy	GIS Technician	Town and Country Development Planning Office
Sheldine Sehntwali	Senior Training Officer	Training Administration Division
Edwin Lawrence	Senior Training Officer	Training Administration Division
Alexcia Cooke	Regional Liaison Officer	United Nations Office for Disaster Risk Reduction (UNISDR)/ United Nations Development Programme
Rico Knight	Intern, Disaster Risk Reduction	United Nations Development Programme
Danielle Evanson	Consultant	United Nations Office for Disaster Risk Reduction (UNISDR)/ Department of Emergency Management

Indicators of Disaster Risk and Risk Management 15 September, 2014		
Name	**Position**	**Organisation**
Hampden Lovell	Director	Barbados Meteorological Service
Donna Pierre	Mitigation, Preparedness Programme DRM Specialist	Caribbean Disaster Emergency Management Agency
Anthony Hutchinson	Director	Coastal Engineering Partnership
Lorna Inniss, PhD	Director	Coastal Zone Management Unit
Allison Wiggins	Deputy Project Manager	Coastal Zone Management Unit
Ramon Roach	Coastal Information Systems Manager	Coastal Zone Management Unit
Fabian Hinds	Coastal Planner	Coastal Zone Management Unit
Rachel Worrell	Coastal Engineer	Coastal Zone Management Unit
Richard Suckoo	Water Quality Analyst	Coastal Zone Management Unit
Kareem Sabir	Research Officer	Coastal Zone Management Unit
Terry Hutchinson	Draughtsman	Coastal Zone Management Unit
Judy Thomas	Director	Department of Emergency Management
Kerry Hinds	Deputy Director	Department of Emergency Management
Tracy Marshall	Programme Officer	Department of Emergency Management
Clifford Bostic	Deputy Chief Telecoms Officer	Ministry of Energy and Telecommunications
Mark Durant	Senior Economist	Ministry of Finance and Economic Affairs
Nicole Alleyne	Chief Tourism Development Officer	Ministry of Tourism and International Transport
Shanise Taylor	Tourism Development Officer I (Ag.)	Ministry of Tourism and International Transport
Avery Green	Chief Project Analyst	Public Investment Unit
Eucklyn Thompson	Assistant Commissioner of Police	Royal Barbados Police Force
Bruce Rowe	Assistant Superintendent	Royal Barbados Police Force
Danielle Evanson	Consultant	United Nations Office for Disaster Risk Reduction (UNISDR)/ Department of Emergency Management-

Validation Focus Group 17 October, 2014		
Name	**Position**	**Organisation**
Sonia Nurse	Deputy Director	Barbados Meteorological Service
Kareem Sabir	Research Officer	Coastal Zone Management Unit
Joy-Anne Johnson	Programme Officer	Department of Emergency Management
Charles Yearwood	Senior Technical Officer	Drainage Division
David Binks, Major		Roving Response Team
Peter Gibson	Inspector	Royal Barbados Police Force
Rudy Headley	Senior Town Planner	Town and Country Development Planning Office
Kayrene Heallis	Secretary, Vulnerable Persons Committee	National Assistance Board
Danielle Evanson	Consultant	United Nations Office for Disaster Risk Reduction (UNISDR)/ Department of Emergency Management

Emergency Management Advisory Council Meeting 24 October, 2014		
Name	**Position**	**Organisation**
Adriel Brathwaite, QC	Minister of Home Affairs; Attorney General	Ministry of Home Affairs
Mrs Gayle Francis-Vaughan	Permanent Secretary	Ministry of Home Affairs
Ms Deborah Payne	Deputy Permanent Secretary	Ministry of Home Affairs
Colonel Alvin Quintyne	Chief of Staff	Barbados Defence Force
Mr Errol Maynard	Chief Fire Officer (Ag)	Barbados Fire Service
Mr Llydon Phillips	Deputy Chief Fire Officer (Ag)	Barbados Fire Service
Mr David Griffith	Disaster Manager	Barbados Red Cross Society
Lorna Inniss, PhD	Director (Ag)	Coastal Zone Management Unit
Mr Curtis Gilkes	Senior Administrative Officer	Defence & Security, Prime Minister's Office
Kerry Hinds	Deputy Director	Department of Emergency Management
Joy-Anne Johnson	Programme Officer	Department of Emergency Management
Danielle Skeete	Programme Officer	Department of Emergency Management
Mr Clifford Bostic	Deputy Chief Telecommunications Officer	Division of Energy and Telecommunications
Barton Clarke	Chief Agricultural Officer	Ministry of Agriculture, Food, Fisheries and Water Resource Management
Ms Paula M. Jackman	Deputy Permanent Secretary (Ag)	Ministry of Environment and Drainage
Joy St John, Dr	Chief Medical Officer	Ministry of Health
Mrs Angela Jean-Baptiste	Administrative Officer I (Ag)	Ministry of Home Affairs
Ms Ernesta Drakes	Permanent Secretary	Ministry of Social Care, Constituency Empowerment and Community Development
Mrs Celia Pollard-Jones	Deputy Permanent Secretary (Tourism)	Ministry of Tourism and International Transport
Mr John Skinner	Senior Administrative Officer	Ministry of Transport and Works
Mark Cummins	Chief Town Planner	Town and Country Development Planning Office
Raul Salazar	Regional Programme Officer	United Nations Office for Disaster Risk Reduction (UNISDR)
Danielle Evanson	Consultant	United Nations Office for Disaster Risk Reduction (UNISDR)/ Department of Emergency Management

Annex II: EMAC Standing Committees

Emergency Services	Public Information and Education	Damage and Needs Assessment	Health Services (Medical and Public Health)	Food and General Supplies
Coordinate the preparation of a national disaster plan and its subsequent implementation	Ensure access to relevant and vital information before, during and after a disaster	Devise a system for the collection and collating of damage statistics	Ensure that all health facilities are adequate to meet the need of the society in an emergency	Ensure that adequate supplies of food are available in the event of a disaster
• Director, Department Of Emergency Management – Chairperson • Commissioner of Police – Deputy Chairperson	• Chief Information Officer (GIS) – Chairperson • Caribbean Broadcasting Corporation, Public Education Officer (TV and Radio) – Deputy Chairperson	• Director, Statistical Services – Chairperson • Chief Technical Officer, Ministry of Public Works – Deputy Chairperson	• Chief Medical Officer – Chairperson • Chief Public Health Officer – Deputy Chairperson	• Chief Agricultural Officer –Chairperson
• Barbados Fire Service • Barbados Defence Force • Ministry of Health • Ministry of Public Works	• Ministry of Health (Disaster Coordinator or Health Education Officer) • STARCOM Network • Caribbean Media Corporation • The Advocate Newspaper • The Nation Newspaper • Barbados Meteorological Services • Barbados Broadcasting Services • Caribbean Broadcasting Union • Ministry of Education • Audio Visual Aids Department • Barbados Chamber of Commerce • Government Printery • Cable & Wireless • Barbados Light & Power Co. Ltd. • Barbados Water Authority • District Emergency Organisation	• Ministry of Housing • Data Processing Unit • Ministry of Agriculture • Town and Country Development Planning • Welfare Department • National Housing Corporation • National Assistance Board • Royal Barbados Police Force • Barbados Water Authority • Barbados Light & Power Co. Ltd. • Cable & Wireless • Ministry of Economic Affairs • Barbados Association of Professional Engineers • District Emergency Organisation	• Queen Elizabeth Hospital • Barbados Defence Force • Barbados Red Cross • St. John Ambulance Association • Emergency Ambulance Service • Registered Nurses Association • Environmental Protection Department • Ministry of Environment • Private Hospitals – Bay View Hospital • Medical Evacuation Services – Bajan Helicopters • FMH • Get Help Services	• School Meals Department • Barbados Chamber of Commerce • Barbados Agricultural Development and Marketing Corporation • Salvation Army • Caribbean Conference of Churches • Barbados Red Cross • Provision merchants • Commission merchants • Ministry of Consumer Affairs • Welfare Department • Comptroller of Customs • Royal Barbados Police Force • Barbados Defence Force • Airport – Operations • Barbados Port Authority • District Emergency Organisation

Public Utilities	Emergency Transport	Road Clearance and Tree Trimming	Welfare Services	Shelter Management
Ensure coordination and management of utilities sector as it relates to disaster preparedness	Ensure that an operational plan for the utilisation of emergency transport services is developed and maintained	Assist with the evacuation of persons from premises that are damaged or otherwise potentially dangerous	Ensure that the proper facilities and supplies exist to meet the needs of the population before, during and after a disaster	Ensure that adequate arrangements are made to house evacuees before and after a disaster
• Ministry of Energy and Public Utilities – Chairperson	• Chief Technical Officer, Ministry of Public Works – Deputy Chairperson • Transport Board – Deputy Chairperson	• Chief Technical Officer, MPW – Chairperson • Chief of Staff, Barbados Defence Force – Deputy Chairperson	• Chief Welfare Officer – Chairperson • Chief Community Development Officer – Deputy Chairperson	• Chief Education Officer – Chairperson • Chief Technical Officer, National Housing Corporation – Deputy Chairperson
• Cable & Wireless • Digicel • Barbados Light & Power Co. Ltd. • Barbados Water Authority • National Petroleum Corporation • Barbados Fire Service • Government Electrical Engineering Department	• Ministry of International Transport • Minibus Association • Royal Barbados Police Force • Barbados Fire Service • Samuel Jackman Prescod Polytechnic • Barbados Chamber of Commerce • Barbados Transport Coop. Society • Bajan Helicopters • Trans Island Air • Barbados Defence Force • Route Taxi Association • Barbados Port Authority • Grantley Adams International Airport	• Barbados Fire Service • Sanitation Service Authority • National Conservation Commission • Royal Barbados Police Force • Government Electrical Engineering Department	• Barbados Red Cross • National Assistance Board • St. John Ambulance Association • Salvation Army • Barbados Christian Council • Evangelical Association of Barbados • Caribbean Conference of Churches • East Caribbean Conference of Seventh Day Adventists • Ministry of Education • School Meals Department • District Emergency Organisations' Representative • Ministry of Agriculture	• Chief Welfare Officer • National Housing Corporation representative • Barbados Association of Professional Engineers • Barbados Christian Council • Barbados Citizens Band Radio Association • Barbados Red Cross • District Emergency Organisations • Ministry of Housing and Lands • Ministry of Transport and Works • Insurance Corporation of Barbados • Barbados National Standards Institute (BNSI) • Ministry of Agriculture

Telecommunications	Emergency Housing and Rehabilitation	Tourism Emergency Management	Coastal Hazards	Hazard Mitigation
Ensure that an adequate communication system is established and maintained to cope effectively in a disaster	Ensure that adequate stocks of building materials are available for emergency repairs	Establish and maintain communication and coordinate activities with the DEM and other organisations that can contribute to disaster and emergency response	Develop hazard assessment, early warning preparedness, mitigation, public education and awareness	Develop a common mitigation plan to facilitate coordinated action; facilitate implementation of the most cost effective, technically feasible, appropriate and equitable mitigation projects towards achievement of a shared vision for risk reduction
• Chief Telecommunications Officer – Chairperson • Barbados Defence Force – Deputy Chairperson	• Chief Technical Officer, National Housing Corporation – Chairperson • Chief Welfare Officer – Deputy Chairperson	• Ministry of Tourism – Chairperson • Barbados Hotel and Tourism Association – Deputy Chairperson	• Director, Coastal Zone Management Unit – Chairperson • Director, Department of Emergency Management – Deputy Chairperson	• Chief Town Planner – Chairperson

• Royal Barbados Police Force
• Amateur Radio Society of Barbados
• Barbados Citizens Band Radio Association
• Caribbean Broadcasting Corporation – radio and TV
• STARCOM Network
• Cable & Wireless
• Airport – Director of Operations and Technical Director Aviation
• Director of Meteorological Services
• Barbados Fire Service
• Barbados Broadcasting Service
• Fisheries Division
• Government Information Service
• Barbados Port Authority
• Barbados Light & Power Co. Ltd.
• Transport Board
• Emergency Ambulance Service
	• Chief Housing Planner
	• Director of Finance & Planning
	• Senior Agricultural Officer – Soil Conservation
	• Chief Agricultural Officer
	• Chief Technical Officer – Ministry of Public Works
	• Representative National Assistance Board
	• Chief Community Development Officer
	• Barbados Red Cross
	• Chief Town Planner
	• Barbados Association of Professional Engineers
	• The Barbados Institute of Architects
	• Barbados National Standards Institute (BNSI)
	• Government Electrical Engineering Department
	• The Barbados Building Authority
	• Representative Barbados Defence Force
		• Barbados Tourism Authority
		• Ministry of Foreign Affairs and Foreign Trade
		• Airlines Association (Barbados) Inc.
		• Royal Barbados Police Force – Tourism Liaison Officer
		• Grantley Adams International Airport Inc.
		• Barbados Port Inc.
		• Ministry of Health
		• Ground Handling Companies:
		  ○ Elegant Resorts
		  ○ St. James travel
		  ○ Bajan Rep Services
		  ○ Virgin Holidays
		  ○ West Indian International Tours Ltd.
			• Barbados Meteorological Services
			• Barbados Building Authority
			• Town Planning Department
			• Royal Barbados Police Force
			• Barbados Defence Force
			• Barbados Port Inc.
			• Fisheries Division of Ministry of Agriculture & Rural Development
			• Telecommunications Unit
			• Ministry of the Environment
				• Barbados Association of Professional Engineers
				• Barbados Chamber of Commerce
				• Barbados Red Cross
				• Coastal Zone Management Unit
				• Department of Emergency Management
				• Drainage Division
				• Environmental Protection Department
				• General Insurance Association of Barbados
				• Ministry of Finance and Economic Affairs
				• Ministry of Tourism
				• Town and Country, Development Planning Office
				• University of the West Indies, CERMES

Annex III: Historical Hazard Impacts in Barbados

Sources: compilation by Evanson, D. 2014 and extracts from compilation by Boruff, B. J., 2006

Summary

Hazard Type	Time Period	Events	Return Period
Drought	1946-2009	22	2.86
Flooding	1886-2000	34	3.35
Tropical systems	1786-2010	20	11.20
Earthquake (and felt shocks)	1670-2014	10	34.40
Landslide	1901-2000	8	12.38
Tsunami	1751-2000	7	35.57

DROUGHT

Date	Cause	Reference
1650s		Tucker, R.W.T. 1940. "The economic geography of Barbados." The Journal of the Barbados Museum and Historical Society. Vol. VII. No. 2. Pp 85
1777	Rain deficit	The Journal of the Barbados Museum and Historical Society. Vol. 10. No. 1. pp 26
Jun 1841	Rain deficit	The Journal of the Barbados Museum and Historical Society. Vol. 10. No. 1. pp 26
1894-1895	Rain deficit	Richardson, B.C. 1997. "Economy and the environment in the Caribbean: Barbados and the Windwards in the late 1800s." University Press of Florida: Gainesville. pp. 294
1898	Rain deficit	Richardson, B.C. 1997. "Economy and the environment in the Caribbean: Barbados and the Windwards in the late 1800s." University Press of Florida: Gainesville. pp. 294
1946-1947	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1959-1960	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1962	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1964-1965	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1968	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1972-1973	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1974	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1977-1978	Rain deficit	Pelling, M. 2003. The vulnerability of cities: natural disasters and social resilience. Earthscan Publications LTD.: London. Pp 212.
1982-1983	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1989	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1994-1995	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
1997	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
2002-2003	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service
2009	Rain deficit	Annual rainfall data 1942-2013, Barbados Meteorological Service

FLOOD

Date	Location	Cause	Reference
Aug 1886			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1886. "Letter to the Editor" The Times. Bridgetown: Barbados. Vol. 25 (2682). 18 August. pp. 2
July 1901			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Aug 1918	Southern Barbados	Tropical system	Skeete, C.C. 1934. "Weather observations and records in Barbados 1924-33" The Journal of the Barbados Museum Historical Society. Vol. 1, No. 2, pp 115-136
Aug 1919	Waterford, St Michael	Tropical system	Skeete, C.C. 1934. "Weather observations and records in Barbados 1924-33." The Journal of the Barbados Museum Historical Society. Vol. 1, No. 2, pp 115-136 Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
1938	Delamere Tenantry (now QEH), St Michael	Tropical depression	Watson, K. 2003. Barbados first: the years of change. Cole's Printery Limited: Bridgetown, Barbados.
Aug 1949		Tropical system	Watson, K. 2003. Barbados first: the years of change. Cole's Printery Limited: Bridgetown, Barbados. Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1949. "Heaviest rains since 1898 push down bridge: houses swept away" Barbados Advocate. 2 September. pp. 1-7 1949. "Another flood victim found: damage may be $30,000; 8 dead; 2 in hospital" Barbados Advocate. 3 September. pp. 1-7
Oct 1960	St Andrew St Thomas	Thunderstorm	1960. "Extracts from the Barbadian Newspaper" The Journal of the Barbados Museum Historical Society. Vol. 28, No. 1, pp 17
Oct 1960	St Joseph (Frizer Plantation)	Thunderstorm	1960. "Extracts from the Barbadian Newspaper" The Journal of the Barbados Museum Historical Society. Vol. 28, No. 1, pp 17
Oct 1962	Speightstown	Heavy rains	1966. "Extracts from the Barbados Globe." The Journal of the Barbados Museum Historical Society. Vol. 30, No. 1, pp 47-48
Sept 1970		Heavy rains	1970. "Heavy flooding affects island." Barbados Advocate. Bridgetown: Barbados. September, 5. pp. 1-8
Oct 1970		Tropical cyclone	CRED. 2004. "EM-DAT: the OFDA/CRED international disaster data base" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: April 8, 2004. Found at: http://www.em-dat.net/ Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1970. "Millions of $$ Damage by Floods." Barbados Advocate. 4 October. pp. 1-15 1970. "Heavy damage up North from floods" Barbados Advocate. 6 October. pp. 8-9 1970. "Downpour causes flooding" Barbados Advocate. 15 October. pp. 1
Oct 1970			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
1975			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Aug 1980			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology

Date	Location	Cause	Reference
Oct 1981			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1981. "Wotton residents get complete wash-out." Barbados Advocate. 11 October. pp. 1 1981. "Wotton families moved to Wildey." Barbados Advocate. Bridgetown: Barbados. Oct. 12. pp. 1
Oct 1984			CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: April 8, 2004. Found at: http://www.em-dat.net/ 1984. "Three houses suffer damage." Barbados Advocate. 3 October. pp. 1
Oct 1984			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1984. "Flooding in the north" Barbados Advocate. 1 November pp. 1 Springer, J. 1984. "Residents tell about 'night of fear'" Barbados Advocate. 2 November. pp. 1 1984. "25 St. Peter families homeless'" Barbados Advocate. 2 November. pp. 1
Nov 1984			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1984. "Damage continues – one death: roads flooded, walls tumble'" Barbados Advocate. 3 November. pp. 1 Brathwaite, J. 1984. "St Andrew hard-hit by flood waters." Barbados Advocate. 3 November. pp. 1 Scott, A. 1984. "Residents of flood area clean up shop." Barbados Advocate. 3 November. pp. 1 1984. "$700,000 in road damage: government starts work on bridges" Barbados Advocate. 5 November. pp. 1
Oct 1985			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Nov 1985			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology Phillips, W. 1985. "More St. Peter flooding: water as high as five feet." Barbados Advocate. 12 November. pp. 1 1985. "Plan to tackle flooding: gov't to dig 170 suck wells." Barbados Advocate. 13 November. pp. 1
Nov 1985			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1985. "St. Philip family face water problem" Barbados Advocate. 22 November. pp. 1
Sept 1988		Tropical depression 80km N	Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1988. "Drenched!: Schools and offices closed, CERO sounds flood alert" Barbados Advocate. 10 September. pp 1-2 1988. "Rains hampering water service." Barbados Advocate. 12 September. pp 1
Sept 1988			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Oct 1988			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology Austin, S. 1988. "Flooding, slippage as the rains come." Barbados Advocate. 20 October. pp 3
Sept 1989			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1989. "Safe – for now" Barbados Advocate. 4 September. pp 1 1989. "Surprise showers." Barbados Advocate. 5 September. pp 4-5
Sept 1989			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology

Date	Location	Cause	Reference
Sept 1989			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology Austin, S. 1989. "Under water!" Barbados Advocate. 28 September. pp 1 Austin, S. 1989. "Flooded!" Barbados Advocate. 28 September. pp 12-13
Nov 1989			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
May 1990			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1990. "May Day rally called off" Barbados Advocate. May. pp. 14-15
Oct 1990			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology 1990. "Waterlogged!" Barbados Advocate. 4 October. pp. 1-2 Jackson, E. 1990. "Classrooms still wet" Barbados Advocate. 6 October. pp. 3 1990. "Heavy rains drench Barbados." Barbados Advocate. 3 October. pp. 1
Nov 1991			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Nov 1992			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology
Aug 1995			Farnum, F.C., and Narayan, K. 2004. Personal communication, 20 May. Chief Hydrologist and Hydrologist. Caribbean Institute of Meteorology and Hydrology Jackson, E. 1995. "Shocking: Arthur declares Weston a disaster area." Barbados Advocate. 4 August. pp. 2 1995. "Rains take Bajans by storm." Barbados Advocate. 4 August. pp. 6-7 1995. "'Help fellow citizens.'" Barbados Advocate. 4 August. pp. 8 1995. "'Twas total chaos as the rains came pouring down" Barbados Advocate. 5 August. pp. 7 Dear, K. 1995. "In mourning" Barbados Advocate. 6 August. pp. 6
Oct 1998			Pelling, M. 2003. The vulnerability of cities: natural disasters and social resilience. Earthscan Publications Ltd.: London. pp 212
Oct 2010	Central and northern Barbados	Low pressure system	Tudor, C. 2010. "Third day of flooding" The Nation Newspaper 4 October http://www.nationnews.com/index.php/articles/view/third-day-of-flooding/
Apr 2011	St Peter St Lucy	Low level trough	CDEMA, 2011. Situation Report 1 – Flood Event in Barbados, Grenada and St. Vincent and the Grenadines http://reliefweb.int/report/barbados/situation-report-1-%E2%80%93flood-event-barbados-grenada-and-st-vincent-and-grenadines (retrieved 27.09.2014)
May 2011	Christ Church St Michael	Heavy rains	Bradshaw, M. 2011. "Wotton flooded out" The Nation Newspaper 1 May http://www.nationnews.com/articles/view/wotton-flooded-out/ Martindale, C. 2011. "Flooding across Barbados" The Nation Newspaper 1 May http://www.nationnews.com/articles/view/flooding-across-barbados/
May 2012	St Michael	Trough system	2012. "Flooding – as rains come" The Nation Newspaper 5 May http://www.nationnews.com/articles/view/flooding-as-rains-come/
Sept 2013	Northern and western Barbados	Heavy rains	2013. "Flooding in north, west of island" The Nation Newspaper 20 September http://www.nationnews.com/index.php/articles/view/flooding-in-north-west-of-island/
Nov 2014		Trough system	CCRIF. 2014. Trough System (21-22 November 2014) Excess Rainfall Event Briefing

STORM

Date	Cause	Reference
Sept 1786	Hurricane	Shephard, C. 1971. An historical account of the island of St. Vincent. Frank Cass and Company Limited: London. pp 216
Aug 1831	Hurricane	"The Hurricane of August 1831" The Journal of the Barbados Museum Historical Society. Vol. 31, No. 4, pp 180-189
Sept 1875	Tropical system	Inspector General's Office. 1875. "Casualties" The Times. Bridgetown: Barbados. Vol. 14 (1706). September, 18. pp. 2
Aug 1886	Tropical system	"Letter to the Editor" The Times. Bridgetown: Barbados. Vol. 25 (2682). 18 August. pp. 2
Sept 1898	Hurricane	"Hurricane Janet at Barbados" The Journal of the Barbados Museum Historical Society. Vol. 23, No. 4, pp 153-164 Richardson, B.C. 1997. "Economy and the environment in the Caribbean: Barbados and the Windwards in the late 1800s." University Press of Florida: Gainesville. pp. 294
Sept 1931	Hurricane	Caribbean Disaster Mitigation Project (CDMP). 1997. "Planning to mitigate the impacts of natural hazards in the Caribbean: Mitigation planning manual (Appendix: Natural Hazards in the Caribbean)." Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance, and Organization of American States: Washington, D.C. pp 11. Found on: 7 June, 2004. Found at: http://www.oas.org/en/cdmp/publist.htm
Aug 1949	Hurricane	1949. "Heaviest rains since 1898 push down bridge: houses swept away" Barbados Advocate. 2 September. pp. 1-7
Sept 1955	Hurricane Janet	Watson, K. 2003. Barbados first: the years of change. Cole's Printery Limited: Bridgetown, Barbados. CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database." Center for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: 8 April, 2004. Found at: http://www.em-dat.net/ 1955. "Hurricane Janet" Barbados Advocate. 23 September. pp. 1-4. 1955. "Hurricane Janet" Barbados Advocate. 24 September. pp. 1-5. 1955. "Hurricane Janet" Barbados Advocate. 27 September. pp. 5. 1956 "Hurricane Janet at Barbados" The Journal of the Barbados Museum Historical Society. Vol. 23, No. 4, pp 153-164
Sept 1961	Hurricane Hattie	Caribbean Disaster Mitigation Project (CDMP). 1997. "Planning to mitigate the impacts of natural hazards in the Caribbean: Mitigation planning manual (Appendix: Natural Hazards in the Caribbean)." Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance, and Organization of American States: Washington, D.C. pp 11. Found on: 7 June, 2004. Found at: http://www.oas.org/en/cdmp/publist.htm
1963	Hurricane Edith	Poncelet, J.L. 1997. "Disaster Management in the Caribbean" Disasters. Vol. 21(3). Pp 267-279
Sept 1974	Hurricane Carmen	Caribbean Disaster Mitigation Project (CDMP). 1997. "Planning to mitigate the impacts of natural hazards in the Caribbean: Mitigation planning manual (Appendix: Natural Hazards in the Caribbean)." Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance, and Organization of American States: Washington, D.C. pp 11. Found on: 7 June, 2004. Found at: http://www.oas.org/en/cdmp/publist.htm
Sept 1974	Hurricane Fifi	Caribbean Disaster Mitigation Project (CDMP). 1997. "Planning to mitigate the impacts of natural hazards in the Caribbean: Mitigation planning manual (Appendix: Natural Hazards in the Caribbean.)." Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance, and Organization of American States: Washington, D.C. pp 11. Found on: 7 June, 2004. Found at: http://www.oas.org/en/cdmp/publist.htm
Aug 1980	Hurricane Allen	CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: 8 April, 2004. Found at: http://www.em-dat.net/ 1980. "Hurricane Allen" Barbados Advocate. 5 August. pp. 1-2 1980. "No water of two days in north" Barbados Advocate. 6 August. pp. 2-3 Harris, M. 1980. "Chaos hits Careenage as 20 vessels sink." Barbados Advocate. 5 August. pp. 1-3 Harris, M. 1980. "Allen wrecks farm" Barbados Advocate. 7 August. pp. 1

Date	Cause	Reference
Aug 1980	Tropical system	1980. "Storm causes damage" Barbados Advocate. 6 October. pp. 1-2 1980. "Clean-up continues" Barbados Advocate. 7 October. pp. 1
Sept 1987	Tropical Storm Emily	CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: 8 April, 2004. Found at: http://www.em-dat.net/ 1987. "Tropical storm Emily." Barbados Advocate. 22 September. pp. 1-7
Sept 1989	Hurricane Gabrielle	Vasco, P. 1989. "It's too rough at Cattlewash" Barbados Advocate. 5 September. pp 2-5 1989. "Clean-up time on east coast" Barbados Advocate. 6 September. pp 24
Sept 1995	Hurricane Marilyn	CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: 8 April, 2004. Found at: http://www.em-dat.net/
Sept 2002	Hurricane Lili	CRED. 2004. "EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium. Found on: 8 April, 2004. Found at: http://www.em-dat.net/
Sept 2004	Hurricane Ivan	CRED. 2014. Barbados Country Profile. EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium http://www.emdat.be/ (retrieved 31.08.2014)
Oct 2010	Tropical Storm Tomás	CRED. 2014. Barbados Country Profile. EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium http://www.emdat.be/ (retrieved 31.08.2014)

SEVERE WAVE ACTION

Date	Location	Cause	Reference
Apr 1958	East and west coasts	Nor'easter in the Northern Atlantic	1961. "Severe sea surges at Barbados." The Journal of the Barbados Museum Historical Society. Vol. 28, No. 4, pp 137-140
Oct 1958	East coast	Extra Tropical Cyclone in the Northern Atlantic	1961. "Severe sea surges at Barbados." The Journal of the Barbados Museum Historical Society. Vol. 28, No. 4, pp 137-140
Sept 1989	Cattlewash, St Joseph	Hurricane Gabrielle	Vasco, P. 1989. "It's too rough at Cattlewash." Barbados Advocate. 5 September. pp 2-5

EARTHQUAKE

Date	Location	Magnitude	Reference
1670 1674 1675 1690 1700 1702 1720			Schomburgk, R.H. 1971. "The history of Barbados: comprising a geographical and statistical description." Frank Cass and Company Limited: London. pp 722 USGS. 2003. "Earthquake hazards program: Earthquake search." National Earthquake Information Center: Reston, VA. Found on: 10 April, 2004. Found at: http://neic.usgs.gov/neis/epic/epic.html
Dec 1816			Shephard, C. 1971. An historical account of the island of St. Vincent. Frank Cass and Company Limited: London. pp 216
Mar 1953	175 km NW of St. Lucia	7.1	Seismic Research Centre. 2003. "Earthquakes." University of West Indies: St Augustine, Trinidad Tobago. Found on: 11 April, 2004. Found at: http://www.uwiseismic.com
Nov 2007	156km off the coast of Martinique	7.4	CRED. 2014. Barbados Country Profile. EM-DAT: the OFDA/CRED international disaster database" Centre for Research on the Epidemiology of Disasters (CRED): Brussels: Belgium http://www.emdat.be/ (retrieved 31.08.2014)

LANDSLIDE

Date	Location	Cause	Reference
1901	Boscobel, St Peter	Heavy rains	Cumberbatch, E.H.S.J. 1969. "An assessment of the soils conservation scheme, Scotland District, Barbados 1957-1969." The Journal of the Barbados Museum Historical Society. Vol. 33, No. 1, pp 14-24 Richardson, B.C. 1997. "Economy and the environment in the Caribbean: Barbados and the Windwards in the late 1800s." University Press of Florida: Gainesville. pp. 294. Martin-Kaye, P. and Badcock, J. 1934. "Geological background to soil conservation and land rehabilitation measures in Barbados, W.I." The Journal of the Barbados Museum Historical Society. Vol. 30, No. 1, pp 3-13
1910	St Andrew	Tropical depression	Martin-Kaye, P. and Badcock, J. 1934. "Geological background to soil conservation and land rehabilitation measures in Barbados, W.I." The Journal of the Barbados Museum Historical Society. Vol. 30, No. 1, pp 3-13
1938	St Andrew	Tropical depression	Watson, K. 2003. Barbados first: the years of change. Cole's Printery Limited: Bridgetown, Barbados. Martin-Kaye, P. and Badcock, J. 1934. "Geological background to soil conservation and land rehabilitation measures in Barbados, W.I." The Journal of the Barbados Museum Historical Society. Vol. 30, No. 1, pp 3-13
1966	St Andrew St Joseph	Heavy rains	Cumberbatch, E.H.S.J. 1969. "An assessment of the soils conservation scheme, Scotland District, Barbados 1957-1969." The Journal of the Barbados Museum Historical Society. Vol. 33, No. 1, pp 14-24
1966	Hackleton's Cliff, St John	Heavy rains	Cumberbatch, E.H.S.J. 1969. "An assessment of the soils conservation scheme, Scotland District, Barbados 1957-1969." The Journal of the Barbados Museum Historical Society. Vol. 33, No. 1, pp 14-24
1977	Saddleback and Upper Parks, Joe's River, Scotland District		Hanna, L. 1996. "Environmental hazards in Barbados: perception and responses in the Scotland District and the west coast." Caribbean Geography. Vol. 7(1). pp 23-35
Oct 1990	Chimborazo, St Joseph	Heavy rains	1990. "...And the rains came tumbling down" Barbados Advocate. 5 October. pp. 1
1994	Saddleback and Upper Parks, Joe's River, Scotland District		Hanna, L. 1996. "Environmental hazards in Barbados: perception and responses in the Scotland District and the west coast." Caribbean Geography. Vol. 7(1). pp 23-35

TSUNAMI

Date	Cause	Reference
Nov 1751	Earthquake	NGDC. 2003. "Tsunami run-up database." National Geophysical Data Center: Boulder, CO. Found on: 5 April 2004. Found at: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml
Nov 1755	M8.5 earthquake off Lisbon, Portugal Run-up 1.5m	NGDC. 2003. "Tsunami run-up database." National Geophysical Data Center: Boulder, CO. Found on: 5 April 2004. Found at: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml Shepherd, J.B. 2001 "Tsunami Hazard in the Eastern Caribbean." Presented at the Workshop on Volcanic and Seismic Hazards in the Caribbean 28 May – 1 June
Mar 1761	M8.5 earthquake Run-up 1.2m	NGDC. 2003. "Tsunami run-up database." National Geophysical Data Center: Boulder, CO. Found on: 5 April 2004. Found at: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml
Apr 1767	Earthquake	NGDC. 2003. "Tsunami run-up database." National Geophysical Data Center: Boulder, CO. Found on: 5 April 2004. Found at: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml
May 1902	Eruption of Soufriere volcano, St Vincent Run-up 1.0m	Miller, J.M. 1902. "The Martinique Horror and the St. Vincent Calamity." Globe Bible Publishing Company: Philadelphia, PA. pp. 560 Shepherd, J.B. 2001 "Tsunami Hazard in the Eastern Caribbean." Presented at the Workshop on Volcanic and Seismic Hazards in the Caribbean 28 May – 1 June Anderson, T., J.S. Flett and T.M. McDonald. 1903. Report on the eruptions of the Soufriere, in St. Vincent, in 1902, and on a visit to Montagne Pelée, in Martinique. Part I. Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a mathematical or Physical Character. 208: 353-553

Date	Cause	Reference
July 1939	Eruption of Kick-em-Jenny volcano	Shepherd, J.B. 2001 "Tsunami Hazard in the Eastern Caribbean." Presented at the Workshop on Volcanic and Seismic Hazards in the Caribbean 28 May – 1 June
Dec 1969	M7.2 earthquake E of Guadeloupe at 7km depth Run-up 0.46m	Lander, J.F., L.S. White and P.A. Lockridge. 2002. A brief history of tsunamis in the Caribbean. Science of Tsunami Hazards. Vol. 20, No. 2, pp. 57-94 NGDC. 2003. "Tsunami run-up database." National Geophysical Data Center: Boulder, CO. Found on: 5 April 2004. Found at: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml Shepherd, J.B. 2001 "Tsunami Hazard in the Eastern Caribbean." Presented at the Workshop on Volcanic and Seismic Hazards in the Caribbean 28 May – 1 June

Annex IV: Modified Mercalli Intensity Scale

Intensity	Description	Magnitude	
I. Instrumental	Generally not felt by people unless in favourable conditions.	<2.0	
II. Weak	Felt only by a couple people that are sensitive, especially on the upper floors of buildings. Delicately suspended objects (including chandeliers) may swing slightly.	2.0-2.9	
III. Slight	Felt quite noticeably by people indoors, especially on the upper floors of buildings. Many do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration similar to the passing of a truck. Duration can be estimated. Indoor objects (including chandeliers) may shake.		3.0-3.9
IV. Moderate	Felt indoors by many to all people, and outdoors by few people. Some awakened. Dishes, windows, and doors disturbed, and walls make cracking sounds. Chandeliers and indoor objects shake noticeably. The sensation is more like a heavy truck striking building. Standing automobiles rock noticeably. Dishes and windows rattle alarmingly. Damage none.	4.0-4.9	
V. Rather Strong	Felt inside by most or all, and outside. Dishes and windows may break and bells will ring. Vibrations are more like a large train passing close to a house. Possible slight damage to buildings. Liquids may spill out of glasses or open containers. None to a few people are frightened and run outdoors.		5.0-5.9
VI. Strong	Felt by everyone, outside or inside; many frightened and run outdoors, walk unsteadily. Windows, dishes, glassware broken; books fall off shelves; some heavy furniture moved or overturned; a few instances of fallen plaster. Damage slight to moderate to poorly designed buildings, all others receive none to slight damage.	6.0-6.9	
VII. Very Strong	Difficult to stand. Furniture broken. Damage light in building of good design and construction; slight to moderate in ordinarily built structures; considerable damage in poorly built or badly designed structures; some chimneys broken or heavily damaged. Noticed by people driving automobiles.		7.0-7.9
VIII. Destructive	Damage slight in structures of good design, considerable in normal buildings with a possible partial collapse. Damage great in poorly built structures. Brick buildings easily receive moderate to extremely heavy damage. Possible fall of chimneys, factory stacks, columns, monuments, walls, etc. Heavy furniture moved.	8.0+	
IX. Violent	General panic. Damage slight to moderate (possibly heavy) in well-designed structures. Well-designed structures thrown out of plumb. Damage moderate to great in substantial buildings, with a possible partial collapse. Some buildings may be shifted off foundations. Walls can fall down or collapse.		
X. Intense	Many well-built structures destroyed, collapsed, or moderately to severely damaged. Most other structures destroyed, possibly shifted off foundation. Large landslides.		
XI. Extreme	Few, if any structures remain standing. Numerous landslides, cracks and deformation of the ground.		
XII. Catastrophic	Total destruction – everything is destroyed. Lines of sight and level distorted. Objects thrown into the air. The ground moves in waves or ripples. Large amounts of rock move position. Landscape altered, or levelled by several meters. Even the routes of rivers can be changed.		

Annex V: Emergency Shelters 2014

Listed below are the emergency shelters as designated for 2014, by parish. Note:

- Category 1 shelters: may be used during a hurricane or other hazard event.
- Category 2 shelters: may be used if they are still in reasonable condition after a hazard event or disaster.
- "Access for PWD" relates specifically to the location having bathroom facilities which are accessible by wheelchair.

ST LUCY

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Ignatius Byer Primary School	1	PU	60	Y	Y	Y	N
Connell Town Pentecostal House of Prayer	1	PR	50	N	N	N	N
Daryll Jordan Secondary School	2	PU	150	N	N	Y	N
Hope Road Nazarene Church	2	PR	150	N	N	N	N
St Lucy Parish Church	2	PR	150	N	N	N	N

ST PETER

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Coleridge and Parry School	1	PU	165	Y	Y	Y	N
Roland Edwards Primary School	1	PU	35	Y	N	Y	N
Alexandra School	2	PU	100	Y	N	N	N
All Saint's Primary School	2	PU	42	Y	N	Y	N
St Philip-the-Less Church	2	PR	45	N	N	N	N

ST ANDREW

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
A. Dacosta Edwards Primary School	1	PU	40	N	Y	N	N

ST JAMES

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Gordon Greenidge Primary School	1	PU	50	Y	N	Y	N
Queen's College	1	PU	100	N	N	Y	N
St James Primary School	2	PU	58	N	N	N	N
West Terrace Primary School	2	PU	100	Y	N	N	N

ST THOMAS

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Lester Vaughan School	1	PU	115	N	N	N	N
Holy Innocent's Primary School	2	PU	40	N	N	N	Y
Welches Primary School	2	PU	45	N	N	N	Y

ST JOSEPH

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Grantley Adams Memorial School	2	PU	135	N	N	Y	N

ST MICHAEL

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Charles F. Broome Primary School	1	PU	100	N	Y	N	Y
Combermere School	1	PU	100	N	N	N	Y
Westbury Primary School	1	PU	100	N	?	?	Y
Ellerslie Secondary School	1	PU	55	N	Y	Y	Y
George Lamming Primary School	1	PU	72	N	Y	N	N
St Leonard's Boys' Secondary School	1	PU	55	N	N	Y	N
St Matthew's Primary School	1	PU	45	N	Y	N	N
University of the West Indies	1	PU	100	Y	N	N	N
Black Rock Seventh Day Adventist Church	1	PR	80	N	N	N	N
Dalkeith Methodist Church	1	PR	34	Y	N	N	N
Barbados Community College	2	PU	178	N	N	N	N
St Paul's Primary School	2	PU	24	N	N	N	N
Deacons Primary School	2	PU	60	N	N	N	N
St Stephen's Primary School	2	PU	100	N	N	Y	N
Graydon Sealy Secondary School	2	PU	150	N	N	N	N
Luther Thorne Memorial School	2	PU	100	N	N	Y	N
Grantley Prescod Memorial School	2	PU	60	N	N	N	Y
Harrison College	2	PU	60	N	N	N	N
Hindsbury Primary School	2	PU	70	N	N	N	N
St Ambrose Primary School	2	PU	70	N	Y	N	N
St Mary's Primary School	2	PU	80	N	N	N	Y
Wesley Hall Junior School	2	PU	65	N	N	N	N
Wilkie Cumberbatch Primary School	2	PU	120	N	N	N	Y

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
The St Michael School	2	PU	105	N	N	N	N
Wesley Hall Infants' School	2	PU	30	N	N	N	N
Eagle Hall Primary School	2	PU	40	N	N	N	N
Chapman Street Church of God	2	PR	50	N	N	N	N
Government Hill Seventh Day Adventist Church	2	PR	60	N	N	N	N
St Barnabas Day Care Centre	2	PR	46	N	N	N	N
Fairfield Gospel Hall	2	PR	30	N	N	N	N
St Matthew's Church	2	PR	70	N	N	N	N

ST GEORGE

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Cuthbert Moore Primary School	1	PU	60	Y	N	Y	N
Ellerton Primary School	1	PU	100	N	N	Y	N
St George Primary School	2	PU	40	N	N	Y	N
St George Parish Church	2	PR	80	N	N	N	N

ST JOHN

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
St John Primary School	1	PU	55	N	N	Y	N
St Margaret's Primary School	2	PU	40	N	N	N	N

CHRIST CHURCH

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Arthur Smith Primary School	1	PU	75	N	Y	Y	N
Blackman and Gollop Primary School	1	PU	70	Y	Y	Y	N
Christ Church Foundation School	1	PU	75	N	Y	Y	N
Christ Church Girls' Primary School	1	PU	75	N	Y	Y	N
St Christopher Primary School	1	PU	75	Y	Y	Y	Y
Gordon Walters Primary School	1	PU	40	N	N	Y	N
Hawthorn Methodist Church	1	PR	60	N	N	N	N
Milton Lynch Primary School	2	PU	55	N	N	Y	N
St Lawrence Primary School	2	PU	100	N	N	N	N

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Christ Church Parish Church	2	PR	70	N	N	N	N
Salvation Armey Church, Wotton	2	PR	40	N	N	N	N
St Christopher Church	2	PR	55	N	Y	Y	N
St Matthias Church	2	PR	40	Y	N	N	N

ST PHILIP

Name	Category	Public/ Private	Numbers accommo-dated	Access for PWD	Water tank storage		Minor repairs needed
					Potable	Non-Potable	
Hilda Skeene Primary School	1	PU	32	N	N	Y	N
Reynold Weekes Primary School	1	PU	60	N	N	N	N
St Philip Primary School	1	PU	45	N	N	N	N
Six Roads Church of Christ	1	PR	40	N	N	N	N
Six Roads Seventh Day Adventist Church	1	PR	22	N	N	N	N
Bayley's Primary School	2	PU	30	N	N	N	Y
Princess Margaret Secondary School	2	PU	60	N	N	Y	N
St Catherine's Primary School	2	PU	40	N	N	N	N
Four Square Nazarene Church	2	PR	35	N	N	N	N
Gemswick Nazarene Church	2	PR	48	N	N	N	N
Ruby Nazarene Church	2	PR	30	N	N	N	N
St Catherine's Church	2	PR	40	N	N	N	N

Annex VI: Actions for Water Resource Management

Following is a summary of the recommendations submitted to CARICOM Heads of State at their meeting of July 2010 and the special meeting of the CARICOM Council for Trade and Economic Development (COTED) in September 2010 by Caribbean Institute for Meteorology and Hydrology (CIMH) and the Caribbean Environmental Health Institute (CEHI), extracted from Farrell et al (2010).

IMMEDIATE ACTIONS

Implementation of an aggressive public awareness programme to provide information (on water safety, conservation, demand management, etc.) for dissemination through the media. The core stakeholders in this action include national meteorological and hydrological services (NMHSs), water utilities, water resources managers, ministries of health and national emergency management organisations. Other groups that could support information dissemination include business leaders, community and church leaders and schools.

Prioritisation of critical water users and estimation of their critical demand through the rapid development of a critical users inventory. The critical users inventory may include but is not limited to essential services, health care institutions and diplomatic missions.

Implementation of water demand management and water restrictions should be initiated in accordance with existing legislation, statutes and rules of operation. It is expected that this would include appropriate measures to restrict all non-potable uses of potable water.

An assessment of suitable alterative water sources of potable water should be performed. If alternative sources can be converted to potable water in a cost-effective and efficient manner, provisions should be made to utilise the source and protect it from potential pollution.

Increase surveillance of potentially unsafe untreated water sources as it is possible that severely drought impacted persons may attempt to access water of marginal quality for various activities, thereby increasing the risk of exposure to water-borne diseases. The quality of such waters should be assessed and relevant usage rules supplied to the public.

Increase surveillance of unregulated water delivery systems such as trucks and barges whose operations are largely unmonitored in terms of safety of the operation as water rationing may lead to a greater demand for trucked water. Sources of trucked water should be checked, particularly where 'marginal' quality waters are easily accessible. In addition, the health status of the storage containers on such vehicles should be assessed to prevent chemical, bacterial and viral contamination.

Increase awareness of appropriate household water treatment options when receiving water from unregulated suppliers to prevent chemical, viral and bacterial illnesses.

Efficient and cost-effective infrastructure to augment the water supply system should be installed. In some islands where water is in surplus at various locations but there is no infrastructure to bring the water to where it is needed, this action may be considered especially if financial resources are accessible.

Acquisition of PVC tanks for storage of rainwater in vulnerable communities should be encouraged by governments, the regional private sector and NGOs. This should be encouraged through various legislative and institutional mechanisms.

Access surplus water production capacity from private sources by establishing relationships with business such as bottled water suppliers, hotels and other commercial enterprises with excess desalination capacity.

Transport water from countries with surplus capacity to those with water deficits if financially feasible and no other financially affordable options are available that are consistent with national water security objectives.

Procurement of small-scale package (containerised) desalination plants where the need is extreme and there are very limited financially viable options for access to potable water.

MEDIUM-TERM ACTIONS

Expansion of storage capacity by placing bulk storage water tanks in locations that can be used to serve communities in times of shortage. Although it will not be possible in all locations, it is preferable that the lands for siting these tanks are elevated so that flow can be via gravity.

Introduce temporary import duty waivers on water augmentation systems and equipment, including those that support water harvesting and transportation and storage of water. This should be supported by an aggressive national programme to encourage the practice of rainwater harvesting.

Improved leak detection and mitigation should be practiced to reduce losses within high priority sections of water distribution networks, particularly those through those communities with large populations.

Recycle grey water at hotels and other large institutions for irrigation use. This area represents great potential as a water resource, when properly treated.

LONG-TERM ACTIONS

Facilitate investment in major water system infrastructural upgrades as most water utilities in the Caribbean are significantly under-capitalised. This represents a significant concern which complicates development of a coordinated intervention in this area.

Develop and integrate local drought indices and indicators for water allocation into the standard operating procedures of water utilities. This requires the strengthening of national decision support systems through the flow of data and information between key agencies such as the meteorological office, water utilities, water resources agencies, ministries of health, agriculture, and tourism among others.

Develop Water Safety Plans (WSPs) by water service providers that seek to reduce hazards (including drought) along all points of the water supply chain. Water utilities and other water service providers must develop well-articulated plans to address heath concerns within the framework of a WSP.

PROPOSED POLICY INTERVENTIONS TO REDUCE RISK DUE TO CLIMATE CHANGE AND CLIMATE VARIABILITY

Adopt and implement the principles of integrated water resource management (IWRM), with specific attention to the development of national actions that address drought management plans. Such actions should be broad-based and include consideration of all aspects of fresh and coastal waters management. IWRM should be considered within the context of national and global climate change strategies.

Given the potential for increasing occurrences of drought in the future due to the combined effects of climate change and climate variability, countries are urged to perform comprehensive reviews of their water resources to ensure that clear regulations and policies related to Action Plans to be implemented under drought conditions are clearly articulated and that the necessary competencies to activate the actions are in place. In this regard, Member States should ensure that water resources management and regulatory agencies are familiar with climate change and climate variability predictions for respective Member States and to ensure that this information is included in planning and design activities.

Data and integrated analysis and decision making are critical in identifying the onset of droughts. Countries are urged to ensure that data collection networks and associated instrumentation are calibrated and are functioning effectively and efficiently. Countries are also encouraged to ensure that data collected from such networks are made available to national and regional institutions to support a broad range of investigations, including drought analysis and the impacts of drought on water resources and sectors sensitive to water availability. Furthermore, countries are encouraged to ensure that appropriate technical capacity to support decision making in the water resources sector and related sectors is available in national institutions. Where such capacity is lacking, countries are urged to utilise appropriate resources in regional Institutions. Regional institutions are urged to include in their research and development activities the development of early warning systems and appropriate indicators to support countries in their planning and adaptation strategies. In this regards, countries are encouraged to renew their various commitments to the activities of regional institutions.

Given the financial vulnerability of national and regional economies to droughts and the fact that such events may become more frequent, intense and extreme in the future, CARICOM Member States are encouraged to consider requesting the CCRIF to explore the possibility of offering drought insurance to national governments to offset financial losses from drought.

Decision making in one sector can have significant implications in other sectors. CARICOM Member States are encouraged to implement appropriate multi-sector national working groups to ensure that all sectors are familiar with the various sensitivities and needs of other sectors to ensure timely and effective decision making. A model for similar working groups currently exists among CARICOM institutions. Member States are encouraged to draw on the strengths of this model.

Given the increasing complexity associated with sustainable water resources management, Member States are encouraged to ensure that they have access to skilled professionals with investments in tertiary training and continuous professional development. Where resources are lacking, Member States are encouraged to utilise South-South bilateral relations or other regional cooperation arrangements.

Annex VII: Process of Application of Criteria to Identify Key Actions for National DRR Planning

USE OF THE TOOL

The Matrix of Criteria is an instrument designed to accompany *ex-ante* analysis processes to build Disaster Risk Reduction (DRR) planning profiles, based on observation and rapid analysis of relevant information available from national and international information sources. The instrument is designed for medium-term programme ex-ante processes and, therefore, is not suitable for project monitoring, performance measurement or ex-post assessments.

The matrix is organised into five categories with guiding questions. The answer to these questions is assessed according to its level of relevance: in the priority level, in an intermediate level that could turn into priority level and needs to be monitored, and a situation that is not considered critical, but needs monitoring to ensure external trends do not negatively influence the situation. The categories are:

1. **Apparent and immediately recognisable signs of hazard and exposure:**
   This category focuses on the obvious manifestations of disasters, without entering into a more complex risk analysis. The criterion is essential as it provides a first insight into the country situation and its sub-national and local levels. This criterion should be considered as an element of decision-making in the short term.

2. **Drivers of risk in the country and their configuration in the territory:**
   This refers to political, social and economic conditions underlying the social construction of risk. This concept stems from two central ideas: (i) the understanding of risk as a process, i.e. with a specific background and therefore not a spontaneous or casual situation, but rather a phenomenon that occurs when certain conditions of territorial sustainability are ignored in the development process; and (ii) that the processes underlying the construction of risk are essentially social, despite the fact that physical phenomena associated with disasters may be natural.

3. **Current capacities for risk management:**
   This category is extremely important as it prioritises observations about hazard and exposure: for example, a country with less hazard but unprepared compared with another with high risk of hazards but highly prepared. These conditions are observable through national and international reports and refer to how a country has or has not developed capacities at the national and sub-national level.

4. **Enabling regulations**:
   This refers to the existence of a regulatory framework for action on imminent risk conditions that facilitates and strengthens the capacity to manage risk. These regulations must be found within the legislation on disaster risk, but above all, in sector-specific and municipal regulations, customs codes, health legislation, building regulations and others.

5. **Trends and future prospects:**
   This category is designed to identify risk trends, particularly through the availability and management scenarios and forecasts on issues such as climate change. Every criterion question must be assessed and analysed separately as each country is embedded in its history and political and legal structure, and this might be the reason to assign different levels of importance to the same situation.

Relevance	Colour
HIGHLY RELEVANT / PRIORITY LEVEL: implies a determining state or condition for programmatic intervention for this area or criterion in the territory under review.	
RELEVANT / OBSERVABLE: represents a condition that must be carefully observed and compared with other inputs in order to make a final decision on whether to intervene.	
LOW RELEVANCE / NON-PRIORITY: implies an ideal or acceptable condition for the criteria evaluated in the territory, i.e. there is not a priority condition for programmatic intervention in the medium term.	

Perspective of the DEM

Based on review of the UNISDR matrix of criteria, the DEM determined to move forward with its application as an integral part of the consultative process in the articulation of the Country Document.

Feedback from stakeholders

The methodology was perceived as relatively robust, grounded in risk management principles with comprehensive coverage of the disaster management cycle.

Generally all stakeholders remarked on the difficulty in understanding and interpreting the questions. There were also comments relating to its lack of relevance for various agencies, but participants were guided to respond to the criteria that were applicable to their work. Some questions were therefore considered too technical given the diverse expertise. Data was not readily available for all components e.g. % population without access to essential services, and therefore deductions were agreed based on technical expertise and experience through discussion. It was further noted that the questions were difficult to apply to regional bodies operating within the country. A unique comment referred to the inappropriateness of global tools which attempt to be applied to the local context, particularly their inadequacy in capturing nuances of the small island context.

Application of the methodology

In coordinating the application of the tool a number of issues were identified which warrant further attention:

- The wording of the questions had a tendency to be convoluted and therefore interpretation was not clear. While the guidelines are useful, for those who do not relate their work to risk reduction the terminology may be unfamiliar.
- Guidance would be useful as to how the criteria should be approached by multiple stakeholders and for multiple hazards. For instance, an aggregate indicator for all hazards hides many weaknesses relating to specific hazards; therefore consideration could be given to a mechanism for capturing such details because the results may otherwise distort actual realities of the priority issues.
- In some cases, none of the criteria to be considered for decision making were a reasonable description of the situation in-country. Given the unique context and vulnerabilities of SIDS e.g. in terms of small size and limited human resource capacity and fiscal constraints, consideration could be given to modification or addition of questions to capture certain situations, understanding that it is impossible to encapsulate all possible nuances. For example, even if a small percentage (< 20%) of the population may be affected by a hazard or vulnerable, with such small populations this still represents a significant statistic and may therefore need to be a high priority.

A single column was added to the survey for each agency to specify how the work they did contributed to the topic and their prioritisation of the issues. This allowed clearer understanding of the mandates and capacities of each agency, and appreciation of gaps and deficiencies. Agencies were not expected to answer all questions, but what was relevant to their work. Some stakeholders needed some guidance as to which questions were applicable since they could not always see the connections to their work.

Stakeholder consensus

While various agencies had different perspectives on some issues, there was general consensus with the DRR priorities identified by the group. The tool was considered to be useful from the perspective of being a collective guidance mechanism to facilitate stronger coordination.

There were some limitations in the application of the methodology. Principally these were due to a narrow range of respondent agencies actually completing the questionnaire or participating in the final stakeholder consultation. While the engagement of agencies in the general consultative process was good, some key players were unavailable. Thus the priorities may not reflect a truly representative picture of the complete DRR situation, but the input from the participating agencies was indeed rich and invaluable, and contributed significantly to the analysis.

RESULTS

Following are the results of the feedback obtained from participating stakeholders. In summary, they indicate the following issues by priority:

HIGHLY RELEVANT	RELEVANT	LOW RELEVANCE
Hazard monitoring, forecasting and mapping	Studies on multi-hazard conditions and climate change and related action plans	Population without access to essential services and vulnerability of essential services are low
Geo-referenced records of hazard impacts	Interaction of environmental degradation with hazards	Little occupation of at-risk urban areas with effective control processes
Mechanisms for coordination of local government	Some enabling regulations exist for risk management and environmental management, but with varying implementation	Regulations and legal instruments exist for DRM, consistent with national and international legal frameworks and are duly implemented
Legal framework for decentralisation	Low socioeconomic indicators for exposed populations	Inter-agency structures for coordination and decision-making
of resources and responsibilities for DRM	Capacities and decentralised structures for emergency and disaster response	
	Frameworks for allocation of resources for preparedness and emergency/disaster response/management	
	Early warning and monitoring system enable analysis for decision-making and notifying communities	
	Regulation, technical capacities and financial resources in various sectors are limited in terms of DRM	
	Integration of scenarios about climate change impacts in risk management strategies	
	Mechanisms for risk trend analysis are not adequately applied to evidence-based research and development of new planning strategies	

A. Apparent and immediately recognisable signs of hazard and exposure			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
1. In the selected geographical areas, where there is a potential for destructive impact and/or a record of impacts, what are conditions that best describe the hazard and their monitoring?	a. Hazard/danger b. Record of impacts c. Monitoring of the hazard/danger	a. There are areas with recurring events, and there are records of previous impacts that have caused damages and losses, but do not have a map of the hazard (and/or danger) or forecasts based on probabilistic criteria.	
		b. There are areas with recurring events, and there are records of previous impacts that have caused damages and losses. There is a mapping of hazards and multi-hazards (and/or danger) or forecasts based on probabilistic criteria, but this information is outdated. An expert assessment is required to determine current conditions.	
		c. The historical and instrumental records do not show potentially destructive events, corroborated by the hazard (and/or danger) studies. OR There are zones with recurring events, and there are records of previous impacts that have caused damages and losses. There is a mapping of the hazard (and/or danger) or forecasts based on probabilistic criteria and with updated information.	
2. In the territorial areas selected, are there geo-referenced and territorially disaggregated records of frequent impacts of hazards related to seasonal events (droughts, floods or landslides)?	a. Geo-referenced records of impacts associated with seasonal events	a. There are zones without records of recurring impacts from seasonal phenomena. Recurring impacts are considered critical and high priority, although still without detailed studies.	
		b. Existing information but without territorially disaggregated information on the impact of disasters. The existence of this type of information is essential to improve the quality of decision-making.	
		c. There is territorially disaggregated data, and work is being carried out with risk management scenarios.	
3. In selected territorial areas, are there studies and action plans on multi-hazard or trans-border hazard conditions, including extreme climate variability events such as the impacts of climate change?	a. Exposure to trans-border hazards, multi-hazards and impacts of climate change b. Impact scenarios c. Action Plans	a. Historical information and hazard studies show the existence of multi-hazard zones or areas, but integrated scenarios and studies are not conducted for multi-hazard, trans-border hazards and/or impacts of climate change. There are no action plans.	
		b. There are clearly identified trans-border hazards (hurricanes, floods in major basins, droughts, volcanoes, and others), as well as risk scenarios and impacts of climate change, but has no actions plans that respond to the identified hazards and studies.	
		c. The multi-hazard, trans-border hazards and impacts of climate change are well identified both at trans-boundary and national and local levels, with corresponding scenarios and action plans.	

B. Drivers of risk present in the country and their configuration in the territory			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
4. In the selected areas, what are the characteristics of environmental degradation in areas with historical impacts or influenced by hazards?	a. Interaction of environmental degradation (*) and hazards (*) For the purposes of these Guidelines, environmental degradation will be understood as the actions that produce impacts such as deforestation; inadequate watershed, wetland and slope management; water stress (including water for irrigation and livestock); soil erosion, poor waste and pollution management.	a. Environmental degradation (*) presents high indicators of impairment that generate severe impacts and can interact with the hazards, increasing the exposure and vulnerability of the population.	
		b. Environmental degradation (*) can be severe but management measures are applied that reduce the negative impacts and interaction with hazards (decreased exposure and vulnerability), or environmental degradation is not severe and its interaction does not generate increased exposure and vulnerability.	
		c. Environmental degradation (*) produces low impacts, indicators are below national/regional averages. There is no interaction between the impacts of environmental degradation and the hazards. There is a significant investment to improve environmental conditions, producing a decrease in exposure and vulnerability.	
5. What is the composition of the population in terms of their socio-economic conditions and their exposure to hazards in the selected area?	a. Socio-economic situation of the exposed population (**) Indicators will be selected based on those identified in the Development Plan in force in each country, considering at least some indicators of poverty, health and education.	a. Socio-economic indicators (**) are predominantly low in exposed populations (over 50% of the population in the selected area).	
		b. The socio economic indicators selected (**) are low for 20% to 50% of exposed populations.	
		c. The socio-economic indicators (**) are low for less than 20% of the exposed population.	
6. In the selected territorial area, what are the essential conditions and access to services, and which are exposed to hazards?	a. Access to basic services (***) b. Exposure of essential services (***) (***)For the methodological purposes of these Guidelines, the essential services will be defined by consensus of the participants in the evaluation, however the following should be considered: water, health, sanitation, communication and road network)	a. The population without access to essential services (***) exceeds 50% in areas exposed to hazards from the selected areas. Essential services are highly vulnerable and have high exposure to identified hazards.	
		b. The population without access to essential services (***) is between 20% and 50% of the population in areas exposed to hazards from the selected areas. Essential services are vulnerable and exposed to the identified hazards, but actions are being developed for their management. The percentage of the population without access to improved sanitation infrastructure, to improved water sources and communication channels is equal to or less than the national/regional average.	
		c. The population without access to essential services (***) is less than 20% of the population in areas exposed to hazards from the selected areas. Essential services are less vulnerable and exposure to the identified hazards is less.	

B. Drivers of risk present in the country and their configuration in the territory			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
7. In the selected territorial area, what are the conditions and the implementation of the regulatory framework related to the Risk Management and Environmental Management, especially in those areas exposed to hazards?-	a. Implementation of the Regulatory Framework b. Accountability mechanisms for DRM and Environmental Management	a. There is no enabling regulatory framework for DRM or for Environmental Management in the selected territorial area (or national, regional or local regulatory framework), especially when: (I) there is no legislation governing the use and safe and orderly occupation of the urban and rural territory, (II) not regulated protection and watershed management, ecosystems, slopes and overall atmosphere, (III) the building and planning codes for reducing risks are not applied There are no formal accountability mechanisms by State agencies for Risk Management and Environmental Management.	
		b. There are enabling regulations for Risk Management (safe and orderly use and occupancy of urban and rural territory, protection and management of watersheds, slopes, ecosystems and environment, building and planning codes to reduce risks), but low or emerging implementation. Formal accountability mechanisms by State agencies are not implemented for Risk Management and Environmental Management.	
		c. There are enabling regulations for Risk Management (safe and orderly use and occupancy of urban and rural territory, protection and management of watersheds, slopes, ecosystems and environment, urban planning and building codes to reduce risks) and for environmental management implementation is effective in the selected territorial area. Formal accountability mechanisms by State agencies are implemented for Risk Management and Environmental Management.	
8. How are the processes of use, occupation and transformation of land in urban areas exposed to hazards in the selected territorial areas?	a. Use, occupation and transformation of territory at the urban level in areas exposed to hazards b. Control mechanisms for the occupation, use and transformation of the urban area	a. There is a high and increasing occupation of urban areas at risk (over 30% of the population of the analysis area) without planning processes or control over the implementation of the urban and rural land use planning regulations. Lack of physical control mechanisms for the occupation, use and transformation of urban landscape.	
		b. Moderate occupation of at-risk urban areas (between 5% and 30% of the population in the selected area) without planning processes or control with an increasing trend towards (unsafe) squatting in hazard-prone urban and suburban areas subject. Regulations and monitoring mechanisms are only partially implemented.	
		c. Little occupation of at-risk urban areas (less than 5% of the population in the selected area) and with effective control processes and mechanisms for urbanization and future population settlement.	

C. Capacities for the management of disaster risk			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
9. Are there capacities and decentralised structures for emergency and disaster response appropriate for existing hazards in the selected area?	a. Emergency and disaster response capacities	a. Areas with recurrent events and/or at high risk of disaster lack structures for preparedness and response, or these are emerging and have limited capacities (there are no integrated response plans or institutional and community-based preparedness plans).	
		b. Institutional response structures are present but lack plans, their capacity is limited to certain institutions but not integrated into the system. Community and institutional preparedness for emergencies and/or disasters exist in some institutions and communities.	
		c. A coordinated and participatory structure operates as part of the national system with de-concentrated and decentralised structures, community and institutional preparedness for emergencies and/or disasters is part of the system.	
10. Mechanisms for coordination of local governments (consortia, associations and commonwealths) based on basins, ecosystems productivity, etc. are in place in the selected area?	a. Coordination Mechanisms of local governments for DRM and Environmental Management	a. There are no coordination mechanisms of local governments in place for DRM and Environmental Management.	
		b. Coordination mechanisms of local governments are in place but not include DRM and Environmental Management among their priorities.	
		c. There are municipal associations or commonwealths in place that have coordination mechanisms for DRM and Environmental Management.	
11. What are the conditions of the resources for preparedness and emergency or disaster response/ management of relevant governments in the selected territorial areas? (Processes may be implemented by the central government)	a. Resources for response b. Structured processes for response	a. Governments do not have the funds, resources and/or streamlined and timely administrative processes for the preparedness and management of/response to disasters or emergencies.	
		b. There are legal frameworks in place that enable the allocation or reallocation of resources once a disaster or emergency has occurred; access to resources is not streamlined or administrative processes are ineffective.	
		c. Governments have funds and streamlined and timely administrative processes for preparedness and management/ response to disasters or emergencies.	
12. What is the status of early warning and monitoring systems that enable the analysis, monitoring and generation of timely information for decision-making and notifying communities about hazard conditions in the selected area?	a. Status of early warning and monitoring systems (EWS)	a. Areas of recurring impact or high exposure do not have early warning and monitoring systems in place; gaps in coverage and information delivery delays.	
		b. There are early warning and hazard monitoring system(s) in place, but they lack a multi-hazard approach and/or they are not linked to the National Early Warning System, if any; no clear criteria for management and territorial prioritisation for proper and timely dissemination of warning or appropriate and timely information.	
		c. There are multiple coordinated warning and monitoring systems and/or a consistent and proper warning system, providing full coverage in the selected area that includes multi-hazard criteria and is integrated to the National Early Warning System with effective mechanisms for disseminating appropriate and timely warnings and information.	

D. Enabling regulations			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
13. Are there appropriate legal frameworks for DRM? What is the state of implementation of these national, sub-national or local instruments (laws, regulations, decrees, etc.)?	a. Validity of the legal frameworks b. Implementation of legal instruments for DRM	a. Non-existent regulations and legal instruments for DRM or their validity is not consistent with national and international legal frameworks. Legal frameworks may exist in the said conditions, but they are not implemented.	
		b. Regulations and legal instruments exist for DRM, consistent with national and international legal frameworks, but they are not implemented.	
		c. Regulations and legal instruments exist for DRM, consistent with national and international legal frameworks and are duly implemented.	
14. What are the characteristics and conditions of inter-agency structures (platforms, management committees, coordination meetings, etc.) for coordination and decision-making in the selected area?	a. Characteristics of the coordination structures for DRM	a. There are no inter-agency structures linked to form a coordination and participation system, platform or body.	
		b. There are inter-agency structures linked to form a coordination and participation system, platform or entities, but its activation, capacity and work are limited and temporary (often activated only in case of emergency)	
		c. There are inter-agency structures linked to form a coordination and participation system, platform or entities with sound institutional capacities and ongoing operations.	
15. What are the characteristics of the sectoral capacity (regulation, technical and resources) in the selected area? (sectoral is understood as the ministries, public companies, institutions, etc.)	a. Sectoral capacity for DRM	a. Critical sectors have not assumed roles and responsibilities for DRM.	
		b. There are some sectoral institutions with internally assigned Risk Management responsibilities and specific planning but limited in terms of DRM as a comprehensive process of territorial development or focused primarily on the disasters or emergencies.	
		c. Sectoral bodies have assumed their roles and responsibilities with a vision of DRM as a key and integrated component and have the structure, experience and good practices for DRM.	
16. What are the characteristics of the legal bodies for the deconcentration of DRM towards territorial governments?	a. Legal deconcentration of responsibility towards local governments	a. There is no legal framework for DRM, or policy instruments that allocate responsibilities and resources to territories or local governments.	
		b. There are legal bodies that clearly define the responsibilities and powers of territorial authorities, however, they are unknown to the authorities, are not implemented and/or resources are not allocated.	
		c. Advanced level of decentralisation including the responsibilities of sub-national governments in risk management and the allocation of resources.	

E. Trends and future prospects			
Guiding question	**Variables**	**Criteria to be considered for decision making**	**Relevance**
17. What is the degree of integration of scenarios about the impacts of climate change in the Risk Management Strategies of the selected area?	a. Integration of climate change scenarios in DRM strategies [plans, policies]	a. There are no scenarios for the impacts of climate change.	
		b. There are scenarios about the impacts of climate change, but they are not coordinated or integrated into the risk management strategies.	
		c. There are scenarios about the impacts of climate change in Risk Management strategies.	
18. What is the status of mechanisms for risk trend analysis, and its relation to similar observatories or similar mechanisms for the analysis of development trends in the selected area [collection and use of historical info for evidence-based research and development of new planning strategies]?	a. Status of the risk analysis mechanisms and relationship with the analysis of development trends	a. There are no such mechanisms. There are no trend analyses, forecasts or risk scenarios.	
		b. There are mechanisms for risk trend analysis, but they are not linked to the development analysis and observatories	
		c. There are mechanisms for the analysis of development, the environment and risk and integrated scenarios of development trends are being developed.	

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