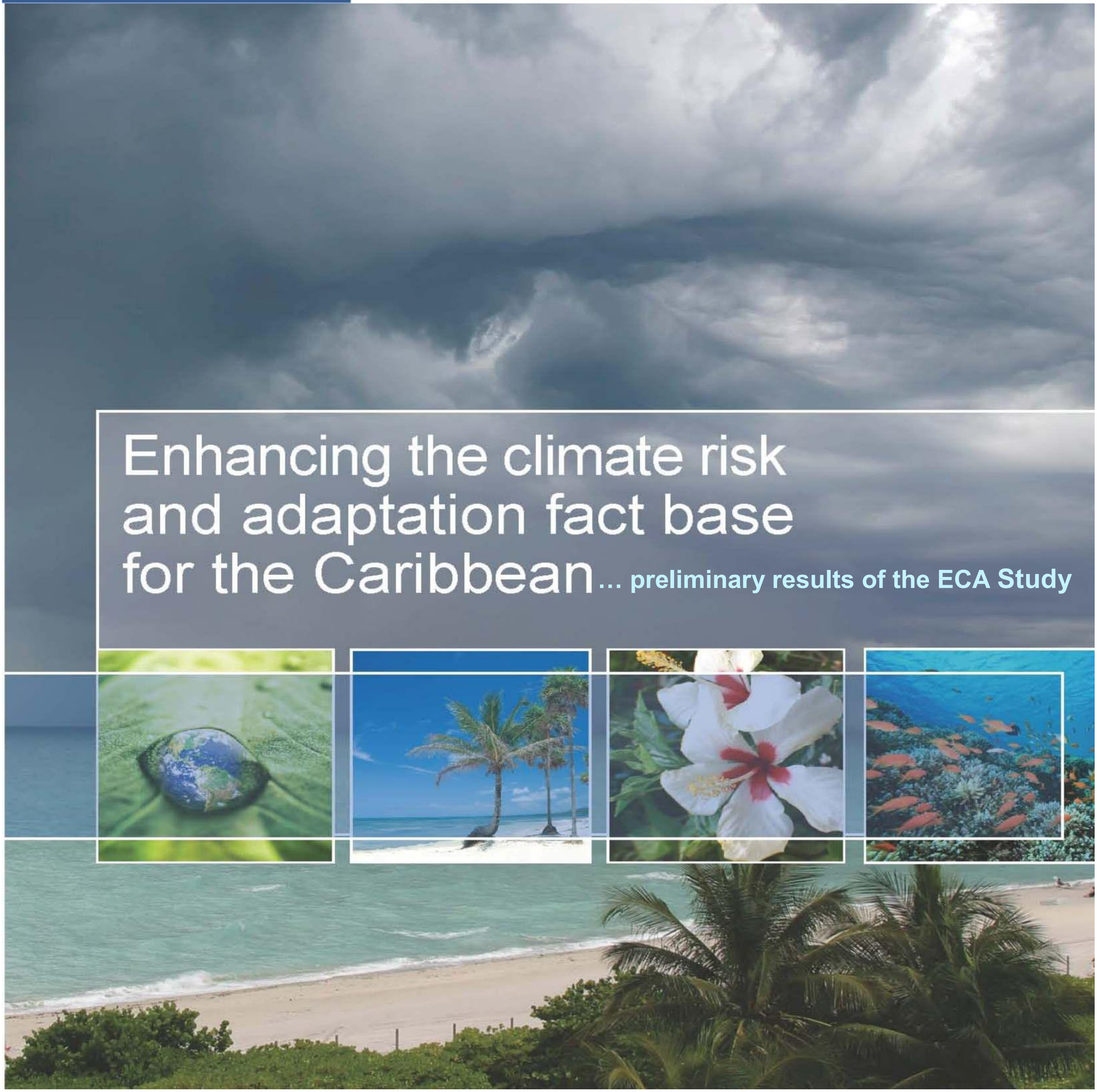


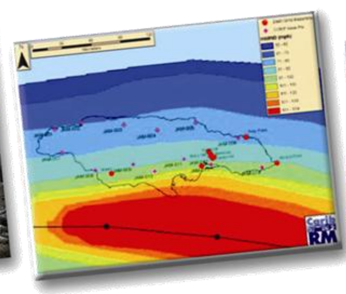
Enhancing the climate risk and adaptation fact base for the Caribbean

… preliminary results of the ECA Study

CCRIF's Economics of Climate Adaptation (ECA) Initiative

Enhancing the Climate Risk and Adaptation Fact Base for the Caribbean

An informational brochure highlighting the preliminary results of the ECA Study



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Cayman Islands

August 2010

Excerpt from the Foreword to the ECA Study Report

The “unequivocal” warming of the climate system reported by the Intergovernmental Panel on Climate Change (IPCC) has already affected the Caribbean. Temperatures in the Caribbean have increased by about 1°C during the last century, while sea level rise has reached about 2-3mm per year since 1980. These conditions were compounded by significant changes in precipitation patterns in the Region, thereby increasing the economic and social vulnerability of the entire Region. CARICOM Member States need lasting adaptation strategies that can help to provide security for the livelihood for our citizens and protection against an ever changing climate.

This Report on the Economics of Climate Change Adaptation in the Caribbean, which has been produced by the CCRIF, makes an important contribution to developing the capacity to address the climate change challenges facing the Caribbean. The Report focuses on the impact of climate risks and change on: a country’s physical infrastructure (including housing), its tourism, travel, agricultural, industrial and services sectors; establishes baseline risk scenarios in accord with the challenges facing the Caribbean; and provides quantitative cost-benefit analyses of risk mitigation and transfer measures. Such information will be of immense value to both Caribbean policymakers and the business sector, in their efforts to develop and implement sound adaptation strategies and plans.

Edwin W. Carrington,
Secretary-General, CARICOM

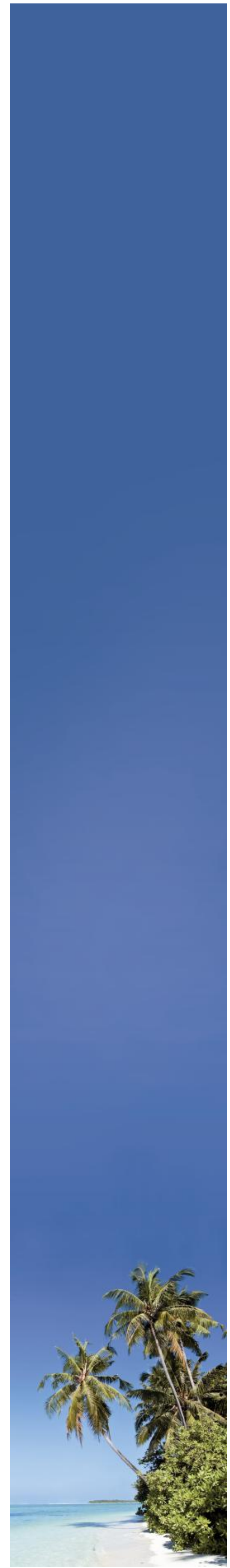
Message from CCRIF

We are very happy to present to our partners and stakeholders the preliminary results of this economics of climate adaptation study which we hope provide policy makers in the region with the facts and tools to incorporate climate adaptation strategies into their national disaster management regimes. The preliminary results presented here are for eight Caribbean countries.

I wish to acknowledge the vital participation of our partner organisations which ensured that the study was grounded in innovative research and that accurate data was collected. We thank all of you who contributed to this study through your input and by providing data as well as through your feedback at the regional workshop held in Barbados in May. We hope to be able to finalise the study later this year, but not before we engage with countries via individual workshops to obtain feedback on the initial results, verification and enhancement of input data and potential foci for higher-resolution work (e.g. main sectors or hazards of interest). This we refer to as phase 2 of the project.

Following phase 2 we hope to embark on a phase 3 which will involve working closely with regional institutional and funding partners to enable application of the methodology on an ongoing basis throughout the Caribbean. We believe that these preliminary results can assist with preparations for the approaching COP16 Climate Change Summit in Cancun, Mexico starting in November, 2010, where Caribbean and other small island developing states will engage in dialogue regarding positive actions on adaptation and disaster risk management, potentially garnering financial assistance for the region.

Milo Pearson,
Executive Chairman, CCRIF



About the Contributors to this Study

CCRIF	The Caribbean Catastrophe Risk Insurance Facility is a risk pooling facility, owned, operated and registered in the Caribbean for Caribbean governments. It is designed to limit the financial impact of catastrophic hurricanes and earthquakes to Caribbean governments by quickly providing short term liquidity when a policy is triggered. It is the world's first and, to date, only regional fund utilising parametric insurance, giving Caribbean governments the unique opportunity to purchase earthquake and hurricane catastrophe coverage with lowest-possible pricing. CCRIF represents a paradigm shift in the way governments treat risk, with Caribbean governments leading the way in pre-disaster planning. CCRIF was developed through funding from the Japanese Government, and was capitalised through contributions to a multi-donor Trust Fund by the Government of Canada, the European Union, the World Bank, the governments of the UK and France, the Caribbean Development Bank and the governments of Ireland and Bermuda, as well as through membership fees paid by participating governments. CCRIF recently launched a technical assistance programme which includes three components, one of which focuses on building technical capacity in the region for climate adaptation and under which this ECA Study falls. CaribRM, CCRIF's Facility Supervisor, supported the work of the ECA Team with contributions from regional partners including Caribbean Community Climate Change Centre and UN Economic Commission for Latin America and the Caribbean. Analytical support to the Study was provided by McKinsey & Company and Swiss Re.
CCCCC	The Caribbean Community Climate Change Centre coordinates the Caribbean region's response to climate change. It is the official repository and clearing house for regional climate change data, providing climate change-related policy advice and guidelines to the Caribbean Community (CARICOM) Member States through the CARICOM Secretariat. CCRIF and CCCCC are currently negotiating a Memorandum of Understanding.
UN ECLAC	The Economic Commission for Latin America and the Caribbean is concerned with assisting and promoting economic and social development in Latin America and the Caribbean. In February 2010, CCRIF and ECLAC signed a Memorandum of Understanding for the conduct of regional studies concerning the economics of climate change and the impact of natural disasters on particular sectors such as tourism; the development of decision-making tools by CCRIF and/or ECLAC to assist in mitigating the economic impacts of natural catastrophes; and, the elaboration of climate change adaptation strategies to facilitate decision making across the region.

Executive Summary – The Increasing Importance of Climate Adaptation in the Caribbean

Natural hazards already represent a significant risk to inhabitants and economies in the Caribbean. Annual expected losses from wind, storm surge and inland flooding amount to up to 6% of GDP in some countries. Climate change has the potential to greatly exacerbate these risks, and could increase expected loss by 1 - 3% of GDP by 2030. Climate change thus poses one of the most serious threats to development prospects in the Caribbean.

Numerous adaptation measures are available to decision makers to respond to the growing threat of climate change. These can be organised by two main levers: risk mitigation and risk transfer. Depending on each country's characteristics, risk mitigation initiatives can cost-effectively avert up to 90% of the expected loss in 2030 under a high climate change scenario. Risk transfer or insurance measures also play a key role in addressing the financial consequences of low-frequency, high-severity weather events such as once-in-100-year catastrophes.

This document provides an overview of the preliminary results of a study on the potential economic impact of climate change in eight Caribbean countries. It describes how these results can support the region's efforts to increase resilience against climate hazards, including preparing for the upcoming COP-16 Climate Change Conference in Cancun, Mexico and presents the next steps in finalising the results and expanding the initiative to include all Caribbean countries.

Small island and coastal nations of the world have long been recognised as being among the most likely to be affected by the potential impacts of global climate change. Climate change is considered to be the most pervasive and truly global of all issues affecting humanity, posing a serious threat to the environment as well as to economies and societies - the impacts of which are likely to adversely affect sectors such as tourism and agriculture.

CCRIF's Economics of Climate Adaptation Initiative

Historically, the discussion around climate change has mainly been focused on mitigating climate change. However, the importance of climate adaptation is growing rapidly as demonstrated, for example, by the rise in funding available for adaptation measures. In the past, less than 20% of overall climate change finance has been geared towards adaptation. This balance could alter substantially as contributing countries increasingly focus on adaptation[1]. The

[1] Project Catalyst estimate. For more details, see http://www.project-catalyst.info/

Copenhagen Accord called for fast-start funding of USD 30 billion between 2010 and 2012, to be divided appropriately between adaptation and mitigation. The Commonwealth countries, for example, recently agreed to allocate 50% of their fast-start funding (USD 2.7 billion) to adaptation activities. Germany intends to allocate around 30% of its fast-start funding (USD 5.4 billion) to adaptation, compared to a previous share of 20%. Global institutions that play a significant role at a regional level, such as AOSIS (Alliance of Small Island States), have also continued to call for both mitigation and adaptation in the international arena.

Recognising that decision makers need a quantitative fact base to draw up sound adaptation strategies and business cases against this backdrop, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) launched a study for the Caribbean region in February 2010. The study is being implemented by CCRIF and regional partners including Caribbean Community Climate Change Centre and UN Economic Commission for Latin America and the Caribbean, with analytical support provided by McKinsey & Company and by Swiss Re.

Based on the Economics of Climate Adaptation (ECA) methodology developed by the ECA Working Group[2], the study provides the facts and tools required to develop quantitative adaptation strategies that can be incorporated into national development plans to increase resilience against climate hazards. The fact base is built around two elements:

- **A risk baseline**, providing transparency on current and future expected losses from climate risks for three climate scenarios. The assessment of the future risk baseline is based on the concept of total climate risk, i.e., the total future risk that could arise from adding the effects of climate change and economic growth to the current risk level

- **An assessment of adaptation measures** that could be taken, including an analysis of the expected costs and benefits of risk mitigation and transfer measures

The methodology applied in this study is unique in its positioning across different knowledge sectors, spanning climate science, the financial industry and economic research. The analysis relies on four interconnected elements:

1. Climate change scenarios based on the most recent available scientific evidence
2. Hazard models forecasting the occurrence of hurricanes and other events with high damage potential
3. Economic damage functions linking the intensity of events to economic impact
4. Value distribution models describing each country's economic and population exposure to hazards in a precise, granular manner

A description of the methodology applied in the study is contained in Appendix 1.

The ECA study focused on the following eight pilot countries:

Anguilla
Cayman Islands
Antigua and Barbuda
Dominica
Barbados
Jamaica
Bermuda
St. Lucia

[2] A consortium of public and private sector institutions including the Global Environment Facility (GEF), UNEP, Swiss Re, the Rockefeller Foundation, Climate Works, Standard Chartered, McKinsey & Company, and the European Union. See Appendix 1 for the methodology used.

The analysis focused on quantifying the potential impact of climate change on three relevant natural hazards:

- Hurricane-induced wind damage
- Coastal flooding/storm surge
- Inland flooding due to both hurricanes and non-tropical systems

The initiative is being implemented in three phases. In Phase 1, which has been completed, the study focused on eight pilot countries: Anguilla, Antigua and Barbuda, Barbados, Bermuda, the Cayman Islands, Dominica, Jamaica, and St. Lucia.

For each country, we examined the impact of the selected key hazards on different economic sectors, ranging from its infrastructure (including housing) to tourism and travel, industry, and service sectors. A summary of country-specific results is contained in Appendix 2.

Additionally, we analysed the economic impact of climate change in the agriculture sector for a few selected countries including detailed analyses for Belize and Jamaica, and assessed the risk of salinisation of groundwater due to changes in rainfall patterns and rising sea levels in Jamaica. A summary of the agriculture sector analysis is contained in Appendix 3.

Next Steps in the Economics of Climate Adaptation Initiative

The results presented here were generated involving regional stakeholders and experts as well as several country representatives. The next step in the process is to subject the results to a broad syndication and consultation process on a country-level. Phase 2 of the initiative will include further engagement with countries via individual workshops to obtain feedback on the initial results, verification and enhancement of input data and potential areas for more detailed work (e.g. main sectors or hazards of interest). At that time, the final results – including the results of the groundwater analysis, not included in this document – will be published and disseminated.

Following this consultation and subsequent refinement of results for the eight pilot countries, Phase 3 will involve working closely with interested countries and regional institutional and funding partners to enable application of the methodology on an ongoing basis in all Caribbean countries.

Key Regional Findings from the ECA Study

Current climate risk is already high, with expected losses of up to 6% of local GDPs

The damage potential under current climatic and economic conditions is already high, with annual expected losses totalling up to 6% of GDP in some countries. This economic damage is comparable in scale to the impact of a serious economic recession – but on an ongoing basis.

The expected loss from the climate risks considered varies significantly across pilot countries, ranging from 1% of GDP in Antigua and Barbuda to 6% of GDP in Jamaica. Such differences are driven by a diverse set of factors, including:

- Topography/exposure to coastal hazards
- Economic significance of particularly vulnerable sectors (e.g., residential assets, which are typically less well protected against climate hazards)
- Location (e.g., in "Hurricane Alley")

Among the hazards considered, hurricane-induced wind damage has the largest damage potential, accounting for up to 90% of the overall damage. The contribution of coastal flooding/storm surge to total damage is higher in low-lying countries. In the Cayman Islands, for example, coastal flooding/storm surge accounts for about 45% of total damage potential.

There is also a considerable difference between the risk profile for smaller and larger countries. Larger countries are more likely to be hit by a strong hurricane by virtue of the area they cover, although hurricanes have a lower relative impact. Smaller countries are hit more rarely on average, but with more devastating effects ("hit or miss").

Climate change could result in a damage increase equalling an additional 1 - 3% of GDP in the worst case scenario

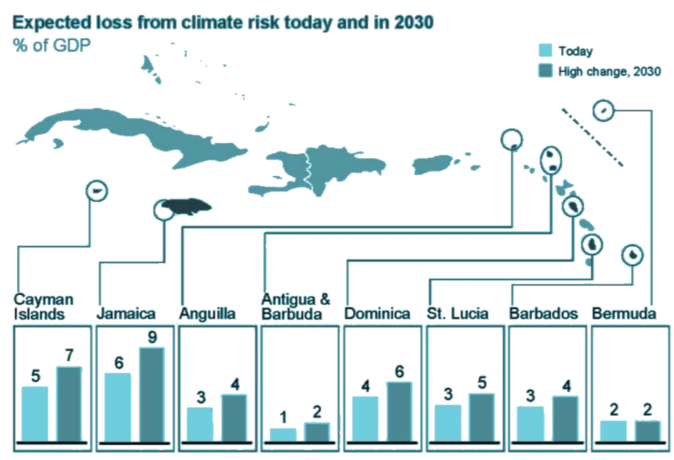
On a local scale, climate change can severely modify the risk profile of a country by impacting:

- Local sea levels
- Hurricane intensity
- Precipitation patterns
- Temperature patterns

In our high climate change scenario, sea levels may rise by up to 15mm/year (excluding local geological effects such as uplift/subsidence), and wind speeds may increase by around 5% as a consequence of the expected rise in sea surface temperature in the hurricane genesis region.

It is important to note that even small local changes may have large effects due to the non-linear correlations between climate and hazards. A 200-year event in Bermuda, for instance, might become a once-in-a-lifetime (75-year) event as a result of these seemingly

Figure 1



small changes.

Overall, expected loss as a proportion of GDP could rise to between 2% and 9% in the high climate change scenario by 2030. In absolute terms, expected loss may triple between now and 2030, with wind remaining the single largest contributor. Economic growth is typically the greatest driver of the rise in expected loss, accounting for some 60% of the increase in all countries, with the exception of Jamaica, where it accounts for around 40%.

Some countries can avoid up to 90% of the expected damage by implementing cost-effective adaptation measures

Numerous measures are available to decision makers to respond to the potentially increasing threat of climate change. These responses can be clustered into two main groups:

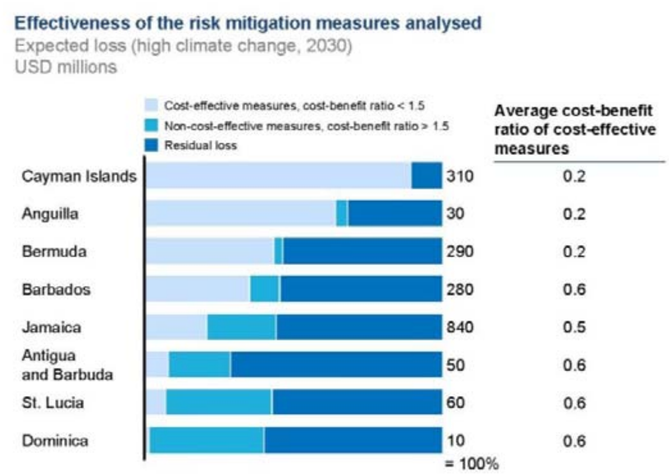
- **Risk Mitigation:** Risk mitigation responses are adaptation measures aimed at reducing the damage. They include asset-based responses (e.g., dikes, retrofitting buildings) and behavioural measures (e.g., enforcing building codes)

- **Risk Transfer:** Risk transfer solutions, such as catastrophic risk insurance, are adaptation measures aimed at limiting the financial impact for people affected by distributing the risk to other players in the market. Risk transfer solutions are particularly effective in the case of low-frequency and high-severity events. Risk transfer mechanisms are based on transferring part of the risk to a third party (e.g., an insurance/reinsurance company or the capital market), and include both traditional insurance products and alternative risk transfer instruments (e.g., NatCat bonds).

We selected 20 adaptation measures from a longer list based on their appropriateness and feasibility. For each of these adaptation measures, we quantified the benefits – that is, averted losses – as well as costs, and computed a cost-benefit ratio. This calculation accounts for cost of capital, investment costs and operating costs. Measures with a cost-benefit ratio below 1.5 were considered to be cost-effective.

Based on cost-benefit analysis, we compiled a portfolio of cost-effective adaptation measures for each country. In some countries, up to 90% of the expected loss in 2030 under the high climate change scenario can be averted cost-effectively using risk mitigation initiatives.

Figure 2



However, there are significant differences across countries.

The difference in the share of the expected loss that can be averted cost-effectively is driven by several factors. The main drivers are:

- **Value of buildings -** High-value assets justify higher investments to increase their resilience. For example, the average value of a residential building in Dominica is approximately USD 30,000, compared to a value of approximately USD 650,000 in Cayman

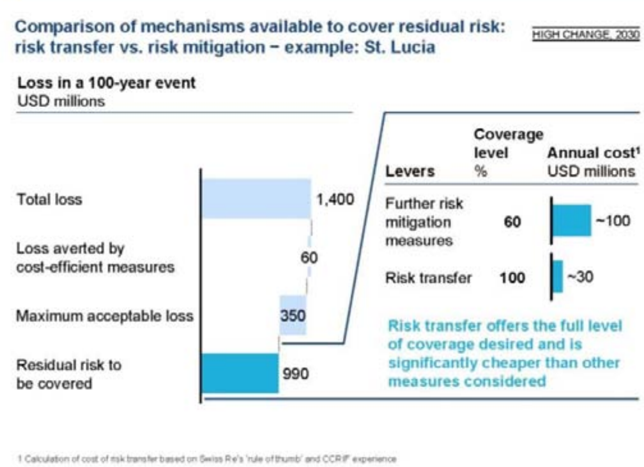
Islands. The amount of money that can be spent cost-effectively to protect a residential building in Cayman Islands is therefore proportionally larger.

- **Importance of coastal flooding/storm surge -** The risk from coastal flooding/storm surge can be mitigated more cost-effectively than wind hazard. Low-lying countries such as Cayman Islands (where coastal flooding/storm surge accounts for around 45% of the damage) can therefore increase their resilience in a more economically effective manner than a mountainous country such as Dominica (where coastal flooding/storm surge accounts for only some 15% of the potential damage).

These analyses are based on similar assumptions regarding the extent and complexity of adaptation measures for all countries. Measures could be further customised on a country-by-country basis to increase their benefits. In Dominica, for example, one could limit the windproofing of buildings to the most effective actions (e.g., reinforcing the roof), using a "design-to-cost" approach.

In many situations, risk-averse decision makers may wish to achieve a higher level of protection than a risk-neutral approach would imply. Risk aversion may be driven by, for example, the limited availability of relief capital, budget capacity, or risk appetite. Risk-averse decision makers do not base their decision on expected costs and benefits, instead thinking in terms of worst-case situations. Authorities in the Netherlands, for example, have established that dikes must be built to resist a 10,000-year event. In a risk-averse context, risk transfer solutions may be the economically most effective way to address the financial impact of low-frequency and high-severity risks. In St. Lucia, for instance, only a small share of the expected loss can be averted cost-effectively using risk mitigation measures. To address the residual risk beyond this level, it is economically more effective to purchase a risk transfer solution than to implement further risk mitigation measures.

Figure 3



Together, the results of the study illustrate the importance of a balanced portfolio of measures in each country. It is important to underline that the findings discussed above are based purely on economic considerations. However, decision makers have to consider further important elements, such as safeguarding life, and the human cost of misery. As a consequence, the results of the study do not imply that risk mitigation should not be pursued in all countries. Our findings suggest rather that the focus of an adaptation strategy in countries where only a small share of the damage can be averted cost-effectively (e.g., Dominica and St. Lucia) should rely on the following two principles:

- Using suitable risk mitigation initiatives to protect human lives
- Building on risk transfer solutions to protect economic assets

Potential Next Steps to Turn Results into Action

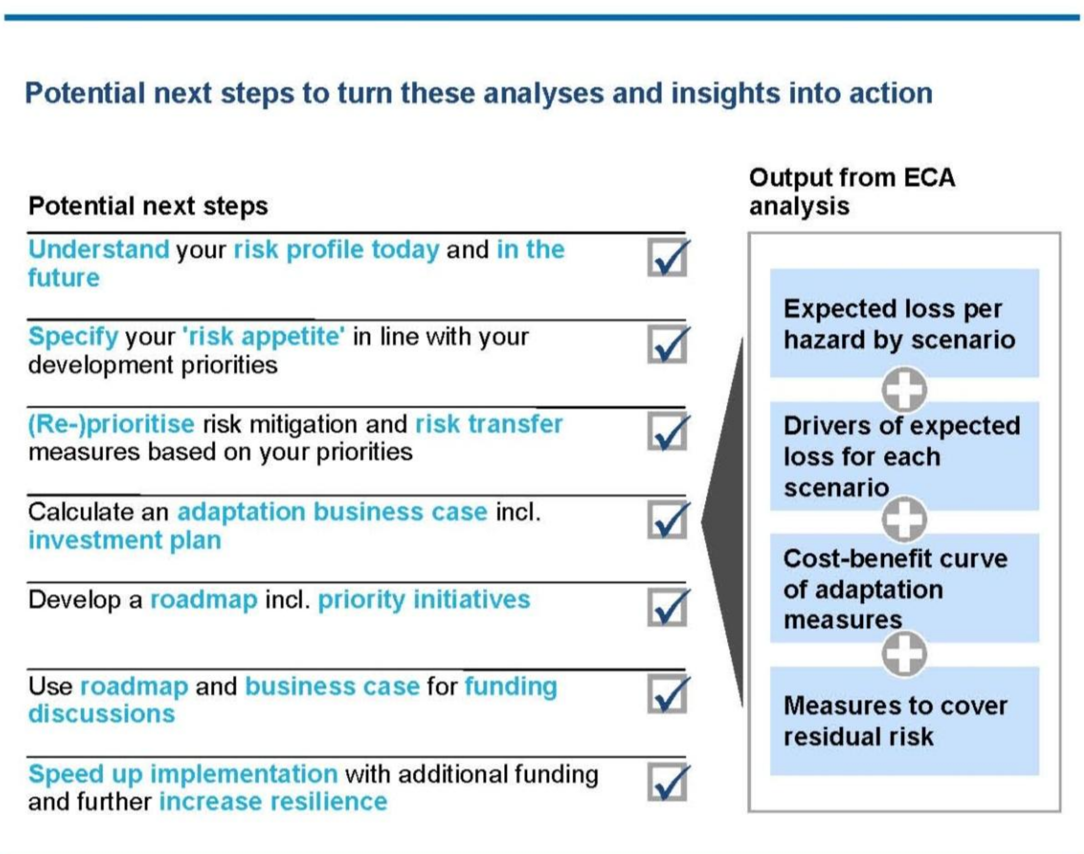
When the results have been finalised, they may be applied in several ways. A number of Caribbean countries have already started working on their National Adaptation Programmes of Action (NAPAs). The fact base provided by this study can augment the development and review of these national adaptation strategies. For example, the study prioritises areas and sectors at risk and provides clear inputs for building an economically viable portfolio of adaptation initiatives designed to increase each country's resilience.

Additionally, the results of this study can be used by countries' governments in multi-lateral and bilateral funding discussions for adaptation initiatives. Given the economic and political climate, the availability of such funds will not necessarily be permanent. Access to adaptation funding may therefore hinge on each country's ability to support effective business cases with sound quantitative data in a timely manner. This study provides a relevant toolkit to aid with this. In the short term, these preliminary results can assist the countries of the region, especially the eight pilot countries, in their preparations for the approaching COP-16 UN Climate Change Conference in Cancun, Mexico from November 29 to December 10, 2010.

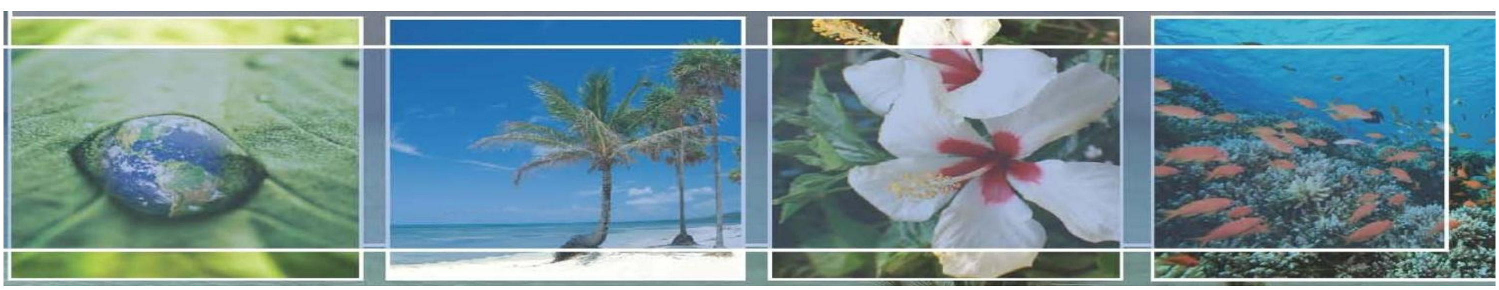
Seven next steps are required to put the final results of the ECA study into action. These steps span from understanding the results at a highly granular level to designing a cost-effective portfolio of adaptation measures, accessing funding by submitting fact-based requests, and accelerating implementation.

CCRIF is deeply committed to enhancing the adaptation fact base and the resilience of the entire region against climate hazards, and would welcome a discussion on next steps with country leaders and other stakeholders.

Figure 4



Appendices



Appendix 1

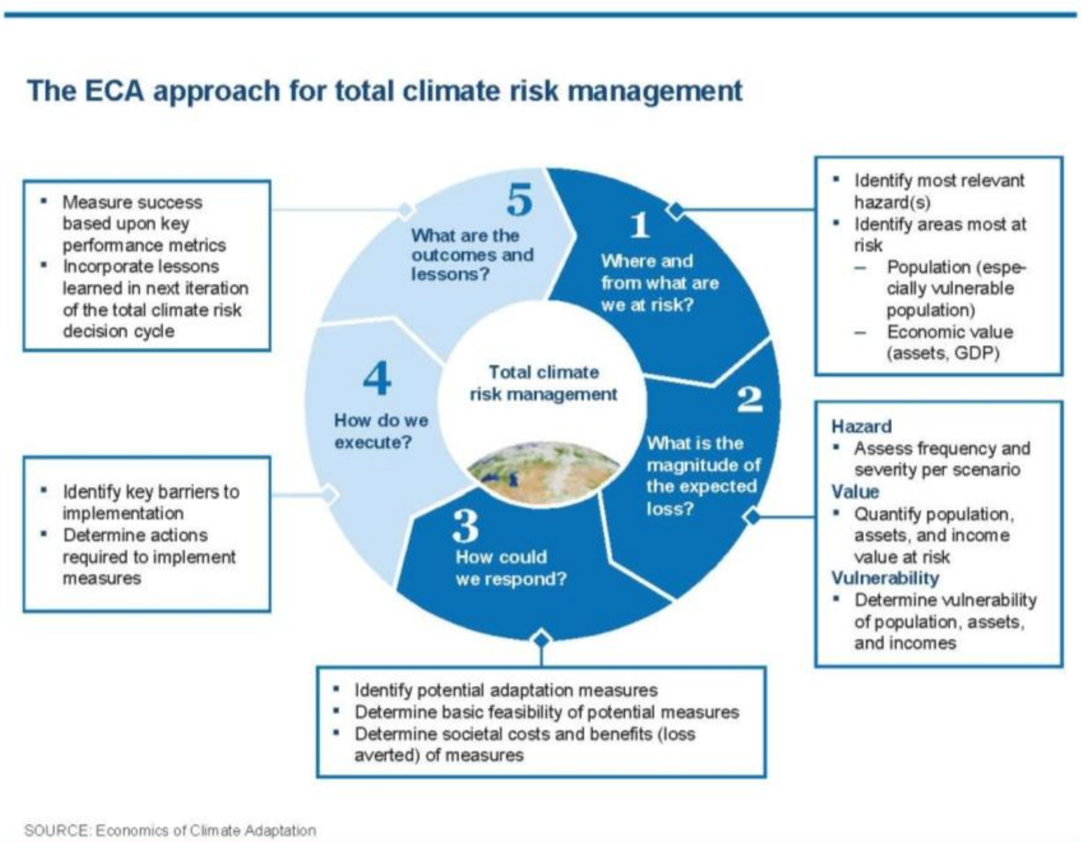
The Methodology – The Economics of Climate Adaptation Framework

This study is based on the Economics of Climate Adaptation (ECA) framework. The ECA framework was developed by the ECA Working Group for two main purposes:

- Enabling decision makers to address total climate risk both current risk and additional future risk triggered by climate change
- Enabling decision makers to integrate adaptation with economic development

The ECA framework poses five questions, each driving different sets of analyses.

Figure 5



The study focused on the first three questions.

1. Where and from what are we at risk?

In the first step, we selected the areas most at risk, and the most relevant hazards in these areas. This selection process was driven by an analysis of historical events (e.g., from disaster datasets), and also accounts for potential future changes as forecasted by climate models.

2. What is the magnitude of the expected loss?

We estimated the expected economic loss at a future date by accounting for different factors, including current climate risk (or lack of adaptation to current climate), future economic growth, and future change in climate risk.

Among the various factors, future change in climate risk is the most difficult to forecast. We therefore used scenario analysis as the main tool to help decision makers deal with uncertainty. We constructed three potential climate risk scenarios:

- Today's climate
- Moderate climate change
- High climate change

To arrive at these scenarios, we used global and regional circulation models to assess changes in precipitation and temperature, mainly based on the A2 IPCC 4th AR emission scenario[3]. We leveraged public academic research to flesh out the complex interactions between climate change and potential impact (for example, between increases in sea surface temperature and hurricane intensity). A comparison of the results for today's climate with the climate change scenarios provided an estimate of the gross costs of climate change.

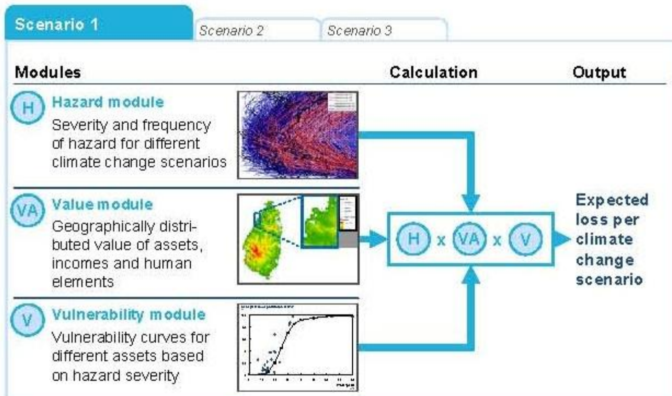
The potential loss within each country was then estimated using an approach similar to that applied for calculating insurance premiums. This approach makes use of three inputs:

- **Hazard module**: Frequency and severity scenarios were developed for the most relevant hazard(s), and a map was generated of the impact of those hazards – on public, residential, commercial or agricultural assets, for example
- **Value module**: Risks in each area were quantified in terms of population, assets and income value. Current and future hazard exposure was calculated at a very granular level using GIS data. To arrive at this output, the area's population and economic value were projected through to 2030
- **Vulnerability module**: The vulnerability to the hazard of the population, assets and incomes was determined using "vulnerability curves" that define the percentage of value damaged by hazards of differing severity for asset classes such as agriculture, residential and industrial and commercial

The analysis was based on a high-resolution hurricane model developed by Swiss Re.

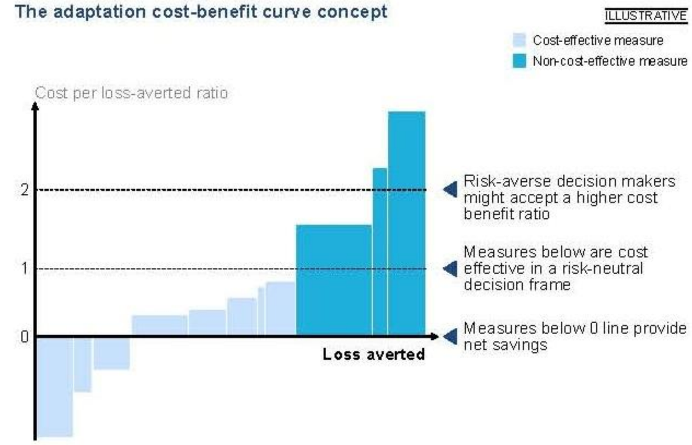
[3] Scenario A2 as presented in the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report. Main characteristics of the A2 scenario include: high population growth, medium GDP growth, high energy use, medium-high land use changes, low resource (mainly oil and gas) availability, slow pace and direction of technological change favoring regional economic development (See http://www.mapcruzin.com/climate-change-shapefiles/ccm/gisclimatechange-scenarios.htm)

Figure 6



Structure of the model used to quantify expected losses for each climate scenario

Figure 7



The adaptation cost-benefit curve concept

3. How could we respond?

We built a balanced portfolio of adaptation measures with detailed cost-benefit assessments. The cost-benefit ratio was calculated by comparing capital and operating expenditure to total economic benefit. Selected adaptation measures were assessed by calculating the net present value of the stream of costs and benefits over time, where benefits are equal to the loss averted compared to the baseline scenarios.

A more detailed description of the ECA methodology and its applications is contained in the report published by the ECA Working Group in 2009, which can be downloaded from the following URL: http://www.mckinsey.com/clientservice/Social_Sector/our_practices/Economic_Development/Knowledge_Highlights/Economics_of_climate_adaptation.aspx

Appendix 2

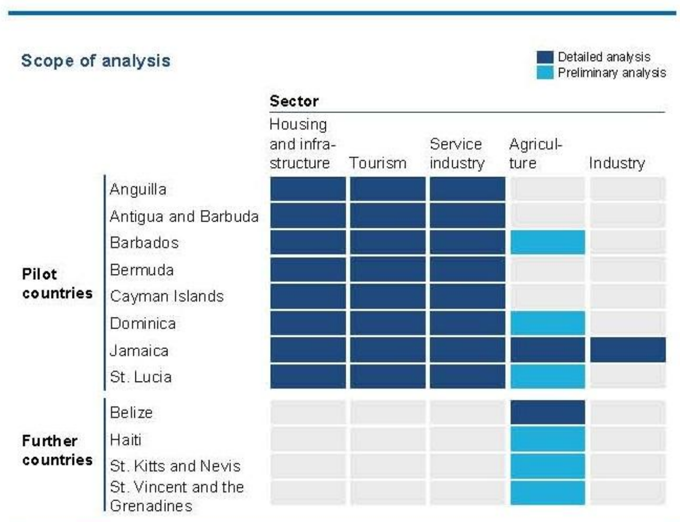
Country Results

Overview

The results presented in the following pages are based on the assessment of the impact of climate change on country-specific economic sectors. The sector selection was done in two steps. In the first step, we identified, for each country, the most relevant economic sectors in terms of both generation of economic value (GDP) and occupation. The sector selection was then refined based on data availability.

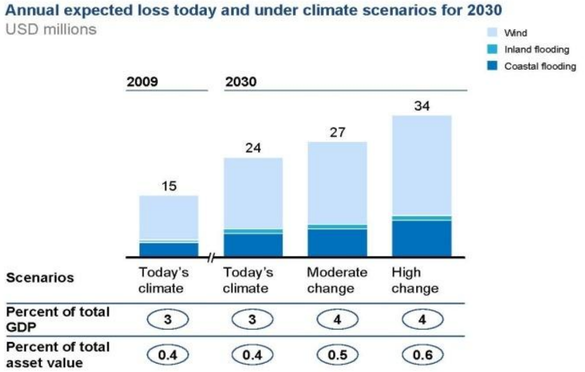
The analysis of the economic impact of climate change on the agriculture sector is subject to higher uncertainties than the other analyses (e.g. market price volatility for crops). For this reason, the results from the analysis for the agriculture sector have been handled separately. A summary of these results is provided in Appendix 3.

Figure 8

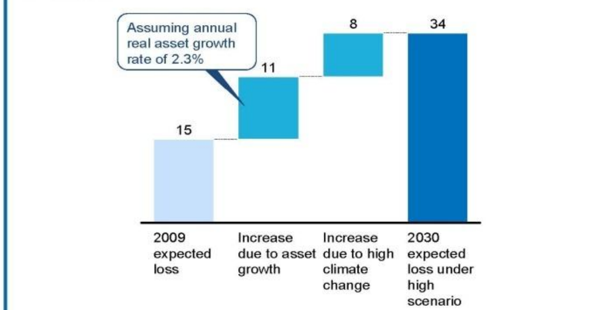


APPENDIX 2 – COUNTRY RESULTS
ANGUILLA

Annual expected loss today and under climate scenarios for 2030
USD millions

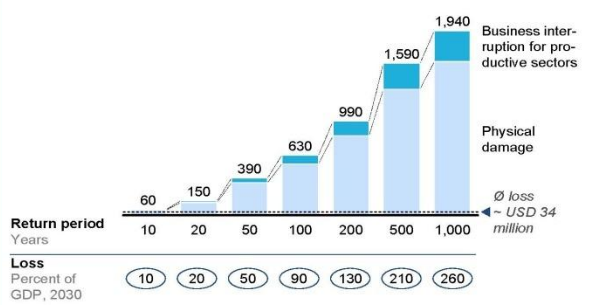


Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



Loss frequency analysis
USD millions

2030: HIGH CHANGE



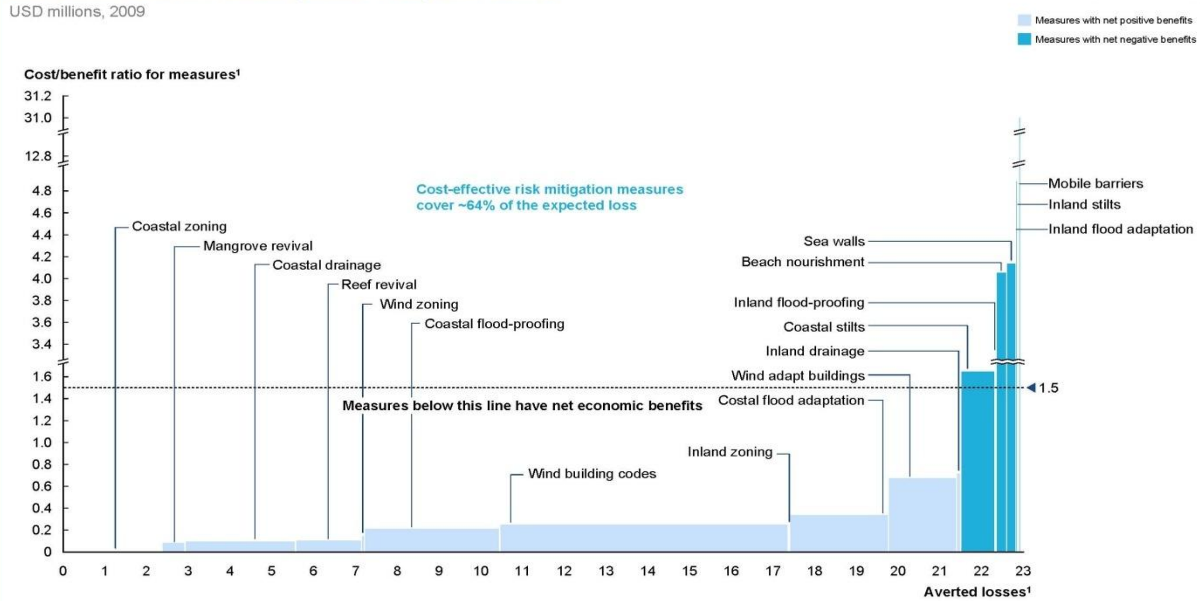
Geographical distribution of risk and assets
Percent of total asset value

2030: HIGH CHANGE

1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
USD millions, 2009

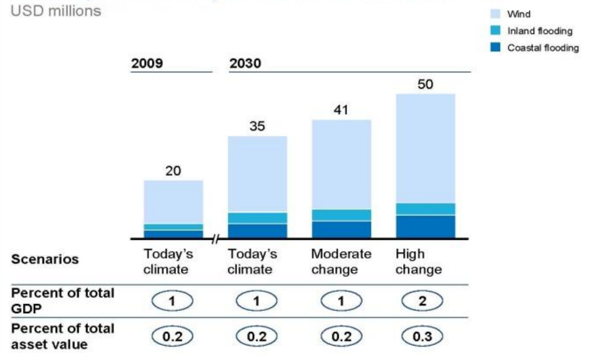
2030: HIGH CHANGE



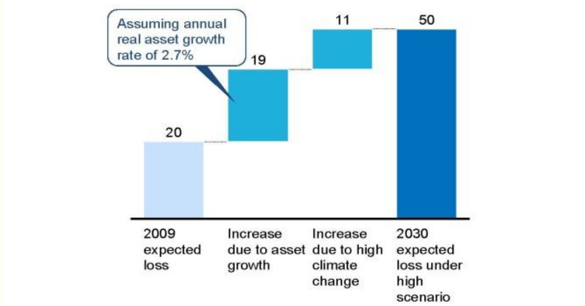
1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS
ANTIGUA AND BARBUDA

Annual expected loss today and under climate scenarios for 2030
USD millions

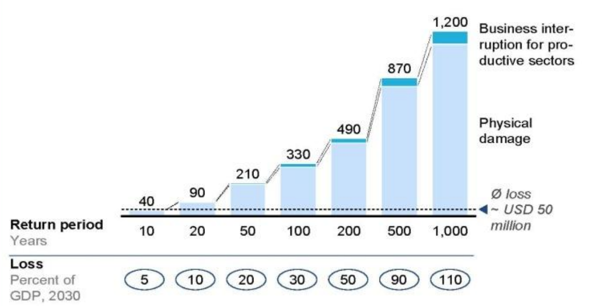


Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



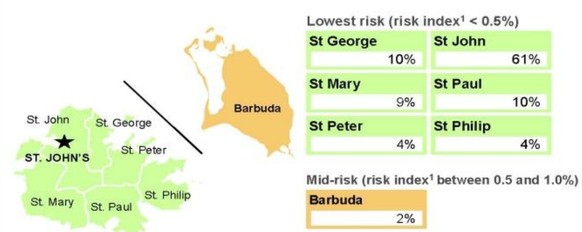
Loss frequency analysis
USD millions

2030: HIGH CHANGE



Geographical distribution of risk and assets
Percent of total asset value

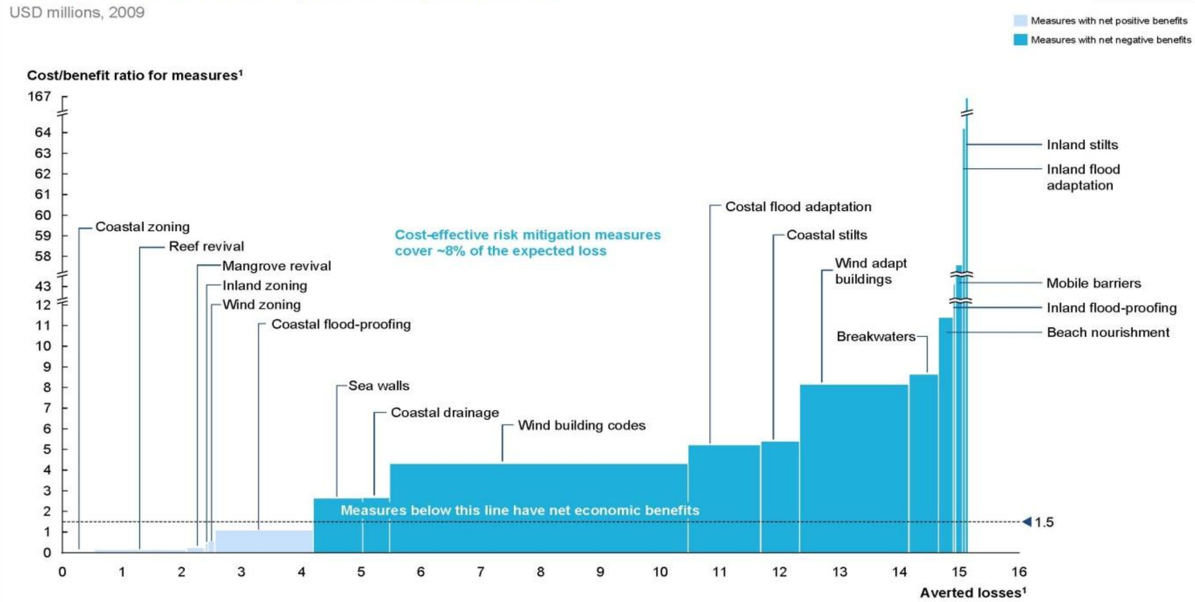
2030: HIGH CHANGE



1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
USD millions, 2009

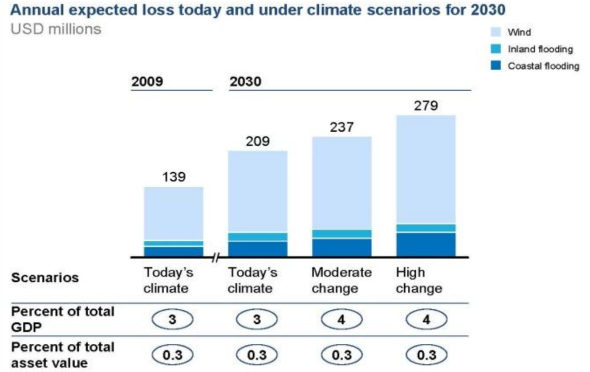
2030: HIGH CHANGE



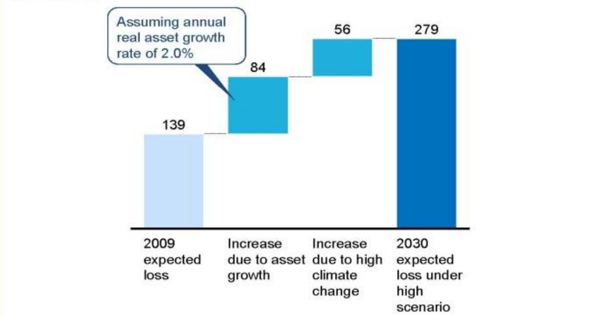
1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS
BARBADOS

Annual expected loss today and under climate scenarios for 2030
USD millions

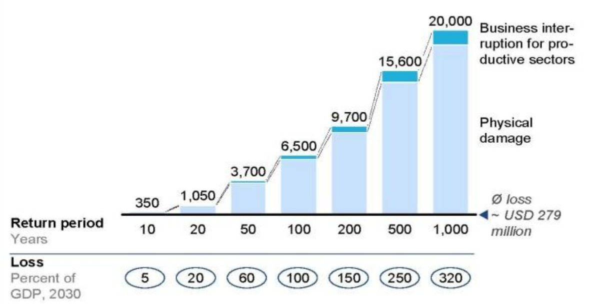


Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



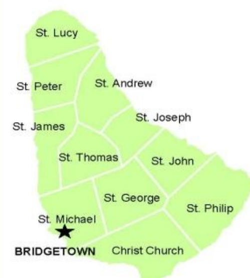
Loss frequency analysis
2030: HIGH CHANGE

USD millions



Geographical distribution of risk and assets
2030: HIGH CHANGE

Percent of total asset value



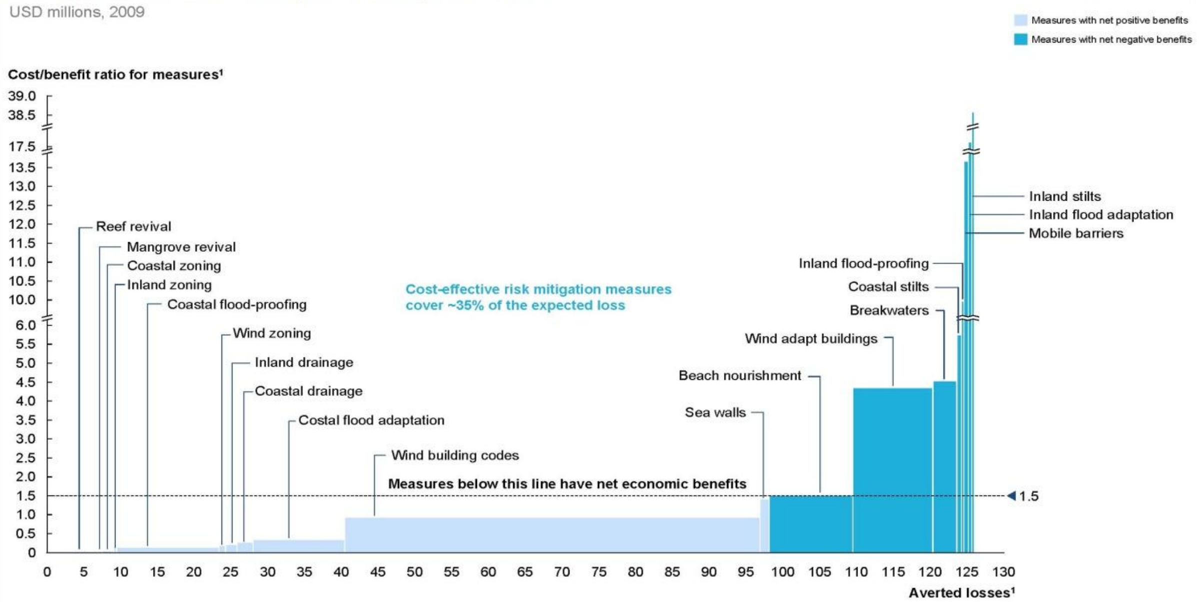
Lowest risk (risk index[1] < 0.5%)

Christ Church 23%	St. Andrew 2%
St. George 5%	St. James 14%
St. John 3%	St. Joseph 3%
St. Lucy 2%	St. Michael 29%
St. Peter 7%	St. Philip 8%
St. Thomas 4%	

1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
2030: HIGH CHANGE

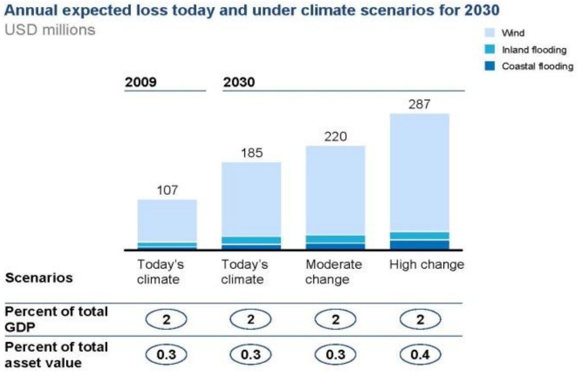
USD millions, 2009



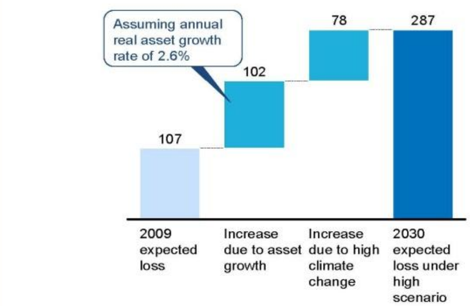
1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS
BERMUDA

Annual expected loss today and under climate scenarios for 2030
USD millions

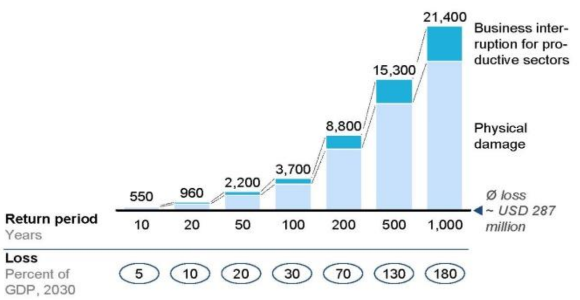


Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



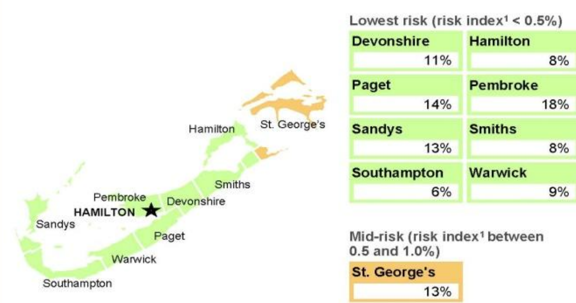
Loss frequency analysis
2030: HIGH CHANGE

USD millions



Geographical distribution of risk and assets
2030: HIGH CHANGE

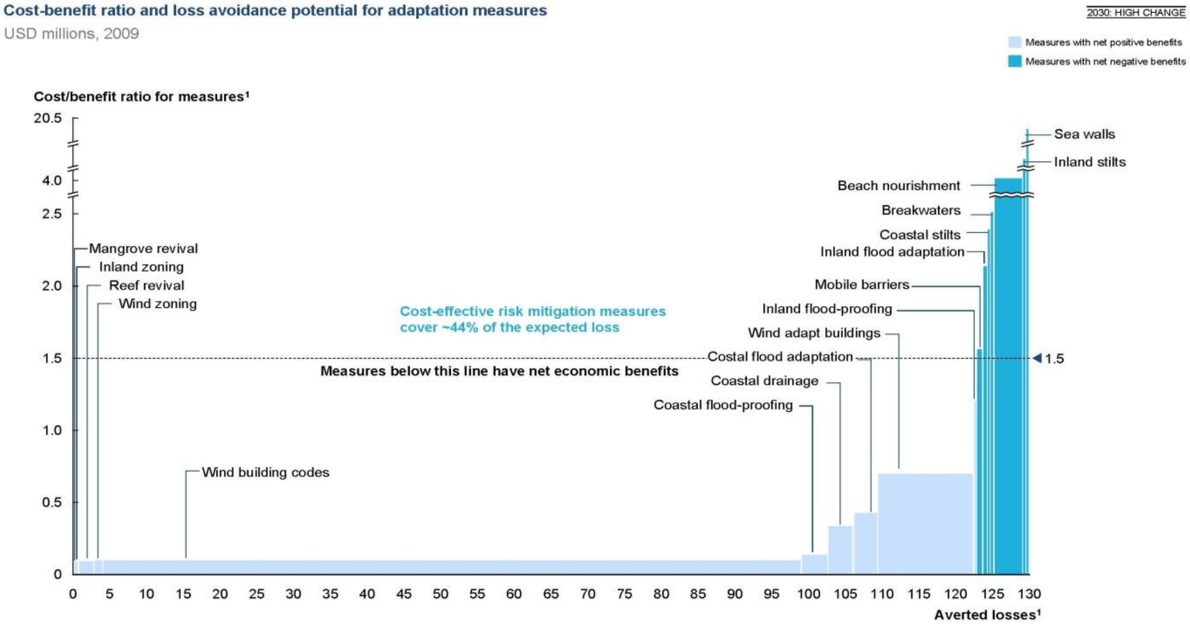
Percent of total asset value



1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
2030: HIGH CHANGE

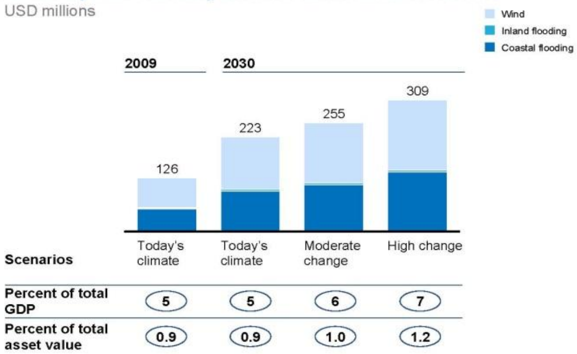
USD millions, 2009



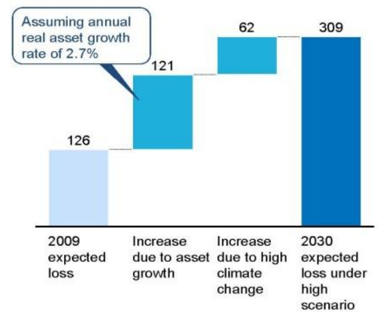
1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS
CAYMAN ISLANDS

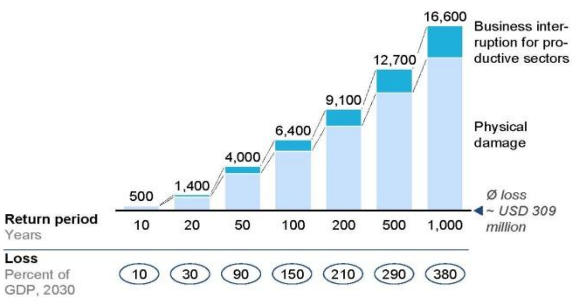
Annual expected loss today and under climate scenarios for 2030
USD millions



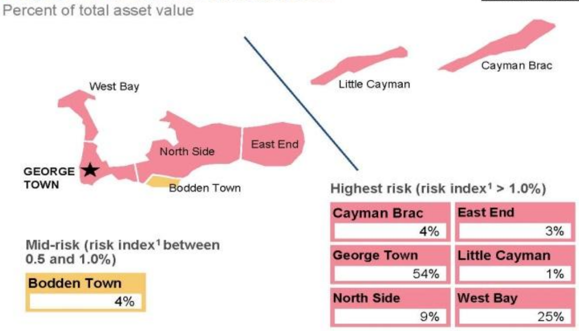
Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



Loss frequency analysis
2030: HIGH CHANGE
USD millions

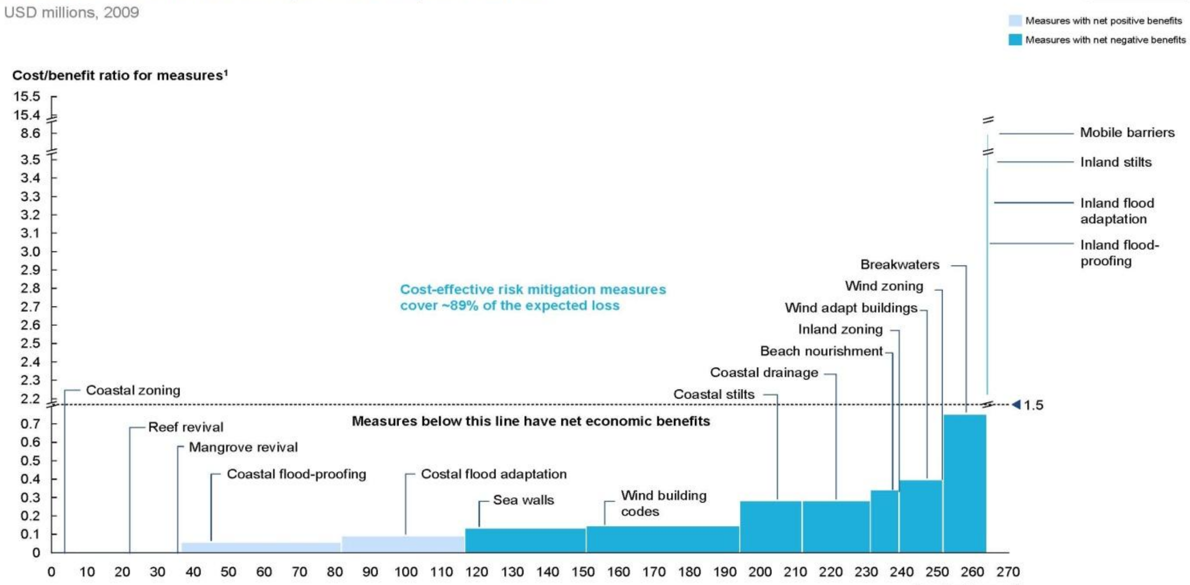


Geographical distribution of risk and assets
2030: HIGH CHANGE
Percent of total asset value



1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
2030: HIGH CHANGE
USD millions, 2009

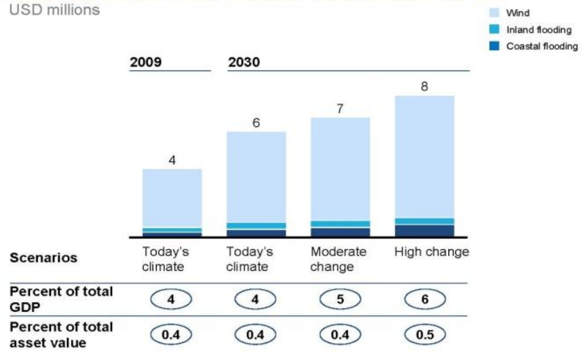


1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS DOMINICA

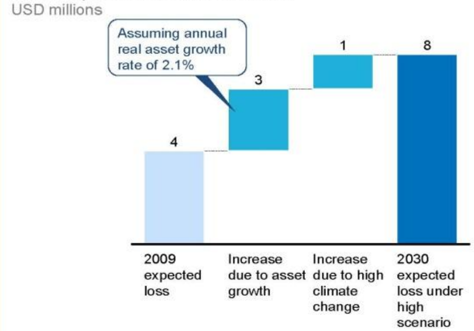
Annual expected loss today and under climate scenarios for 2030

USD millions



Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030

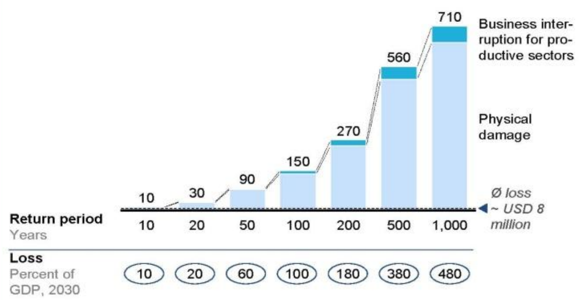
Annual expected loss in 2009 and 2030
USD millions



Loss frequency analysis

2030: HIGH CHANGE

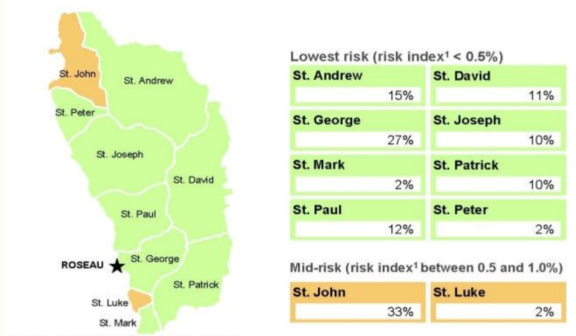
USD millions



Geographical distribution of risk and assets

2030: HIGH CHANGE

Percent of total asset value

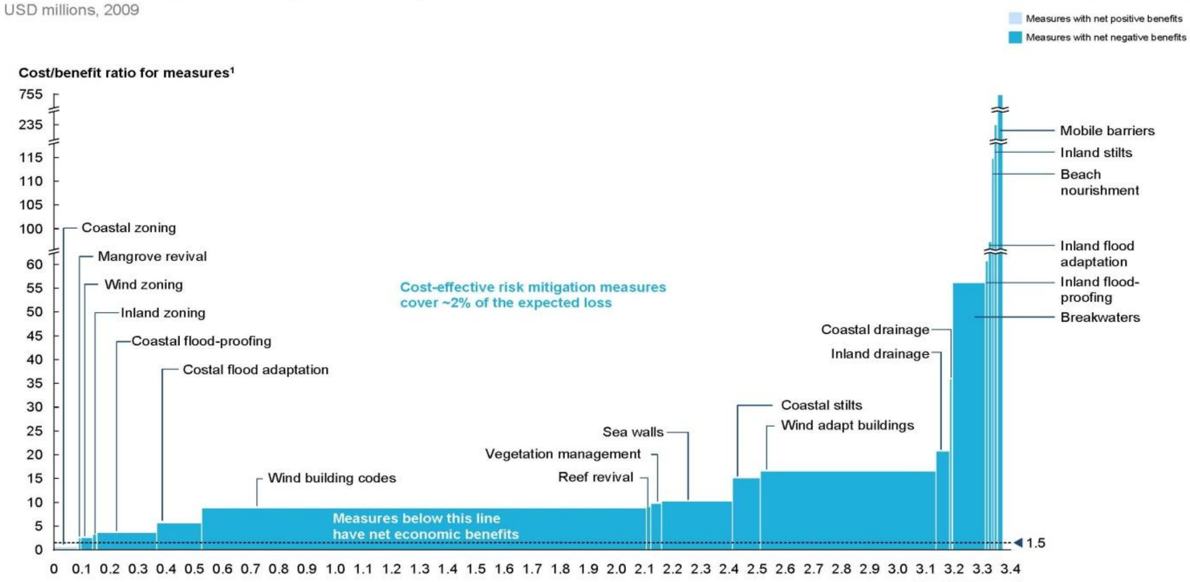


1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures

2030: HIGH CHANGE

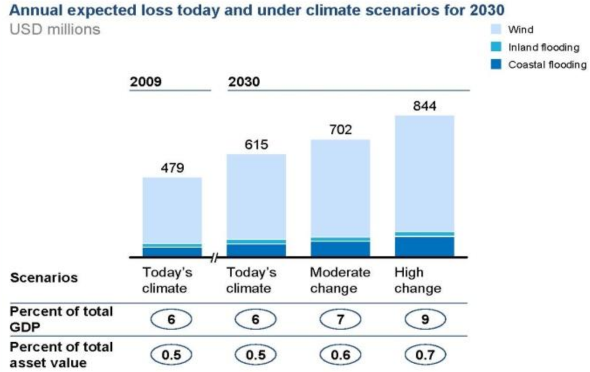
USD millions, 2009



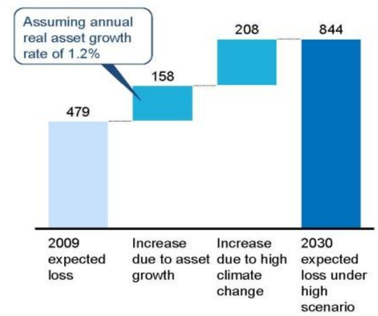
1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

APPENDIX 2 – COUNTRY RESULTS
JAMAICA

Annual expected loss today and under climate scenarios for 2030
USD millions

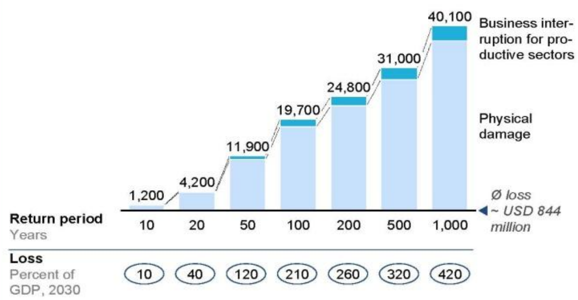


Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



Loss frequency analysis
2030: HIGH CHANGE

USD millions



Geographical distribution of risk and assets
2030: HIGH CHANGE

Percent of total asset value

Lowest risk (risk index[1] < 0.5%)

Clarendon	10%
Manchester	8%

Highest risk (risk index[1] > 1.0%)

Hanover	3%
Saint James	9%
Westmoreland	8%

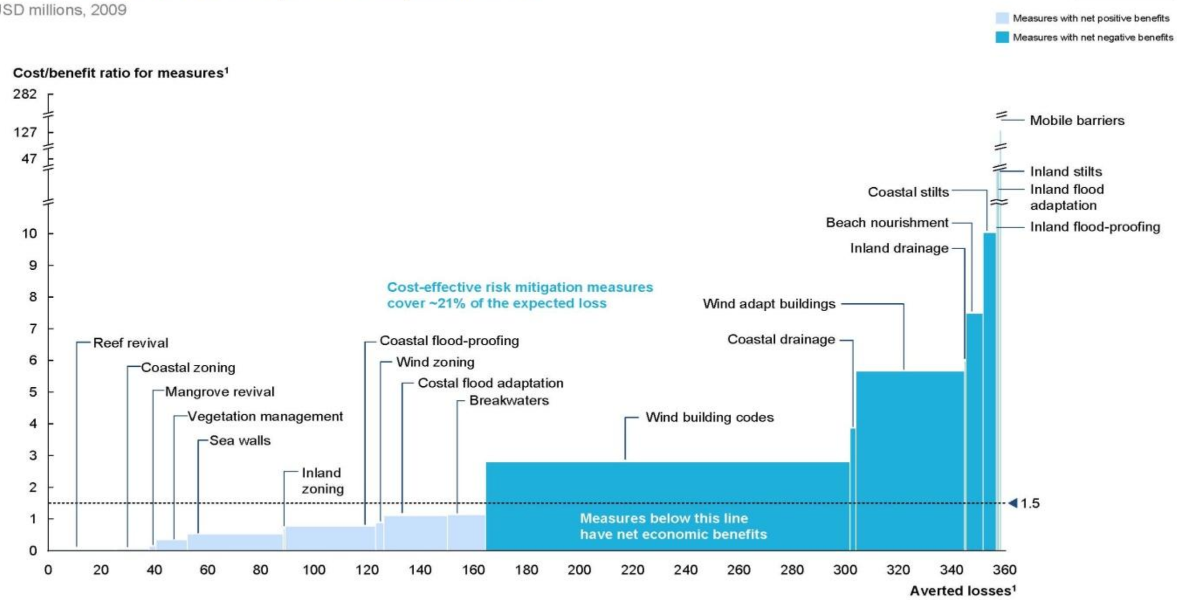
Mid-risk (risk index[1] between 0.5 and 1.0%)

Kingston	2%
Portland	3%
Saint Andrew	18%
Saint Ann	7%
Saint Catherine	13%
Saint Elizabeth	8%
Saint Mary	4%
Saint Thomas	3%
Trelawny	4%

1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
2030: HIGH CHANGE

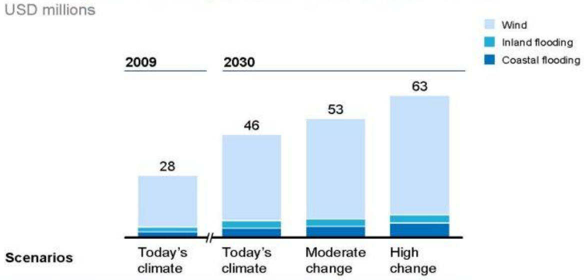
USD millions, 2009



1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

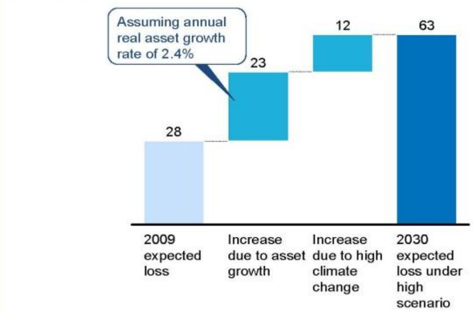
APPENDIX 2 – COUNTRY RESULTS
ST. LUCIA

Annual expected loss today and under climate scenarios for 2030
USD millions



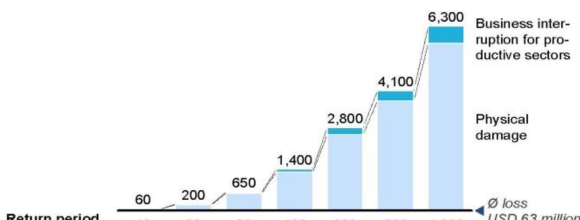
Scenarios	Today's climate (2009)	Today's climate (2030)	Moderate change	High change
Percent of total GDP	3	3	4	5
Percent of total asset value	0.1	0.3	0.4	0.4

Contribution of climate change and economic growth in asset values to the increase in expected loss to 2030
Annual expected loss in 2009 and 2030
USD millions



Loss frequency analysis
2030: HIGH CHANGE

USD millions



Return period (Years)	10	20	50	100	200	500	1,000
Loss, Percent of GDP, 2030	5	20	50	100	210	300	460

Geographical distribution of risk and assets
2030: HIGH CHANGE

Percent of total asset value

Lowest risk (risk index[1] < 0.5%)

Anse la Raye	Canaries	Castries
1%	1%	30%
Choiseul	**Gros Islet**	**Micoud**
3%	31%	12%
Soufrière		
4%		

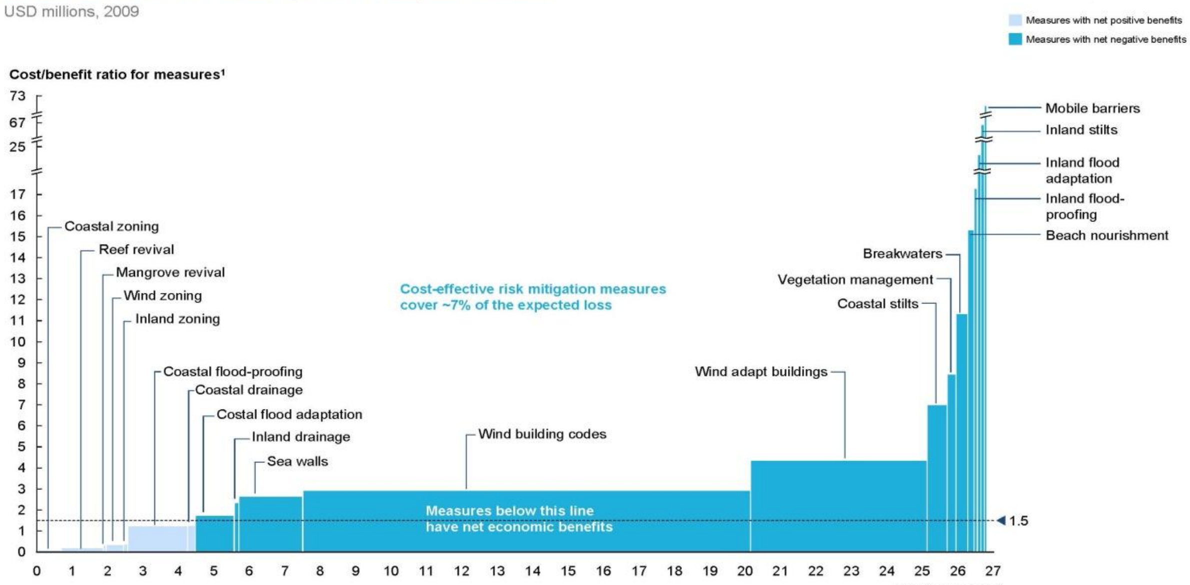
Mid-risk (risk index[1] between 0.5 and 1.0%)

Dennery	Laborie	Vieux Fort
6%	4%	8%

1 Risk-index = annual expected loss in percent of value at risk

Cost-benefit ratio and loss avoidance potential for adaptation measures
2030: HIGH CHANGE

USD millions, 2009



1 Does not account for synergies and dis-synergies between measures (e.g., building seawalls behind a breakwater)

Appendix 3

Overview of Results of Analysis of the Agriculture Sector

The assessment of the impact of climate change on the agriculture sector in the Caribbean combined an analysis of two drivers of agriculture production:

- Gradual change in climatic conditions (“climate zone shift”)
- Impact of climate change on the damage potential of extreme events

A detailed analysis was done for two countries: Belize and Jamaica. In both countries, we performed an analysis of the source of economic value and selected the economically most relevant crops. For each of the selected crops, we performed two key analytical steps:

- Calculation of impact of climate change on crop yields
- Construction of damage functions based on historical damage data and calculation of expected loss

The calculation of the impact of the climate zone shift on crop yields was based on the use of crop suitability maps, developed by the International Centre for Tropical Agriculture (CIAT). Such maps, constructed using climate scenarios and current crop yields as a key input, were applied to calculate the yield changes in each production location. In the second step, we used the damage functions to analyse the potential increase in hurricane-induced damage to plantations due to climate change.

The analysis showed that potential changes in net production volumes 2030 vs. 2009 range from -45% (sugar cane in Belize) to +10% (banana in Belize). The change in yields induced by the potential climate zone shift is the main driver of the change in production volume. Crop yields are not expected to change uniformly across countries – while some regions get significantly less suitable for specific crop types, others might not be affected as much by climate change.

The analysis also showed that the change in severity of hurricanes has the potential of increasing damage ratios for all countries and crops; however, the net effect on production appears to be significantly lower than the impact of yield change due to the climate zone shift.

Figure 9

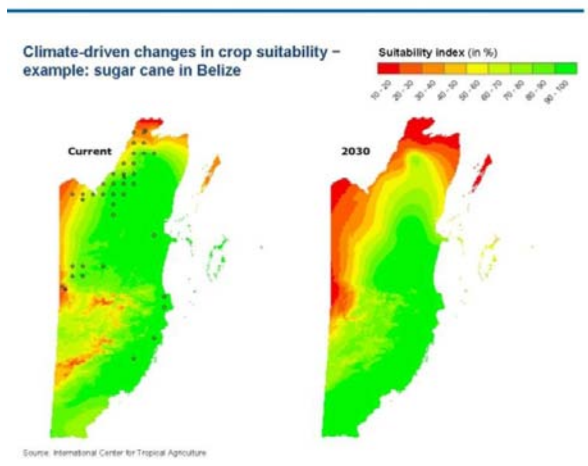


Figure 10

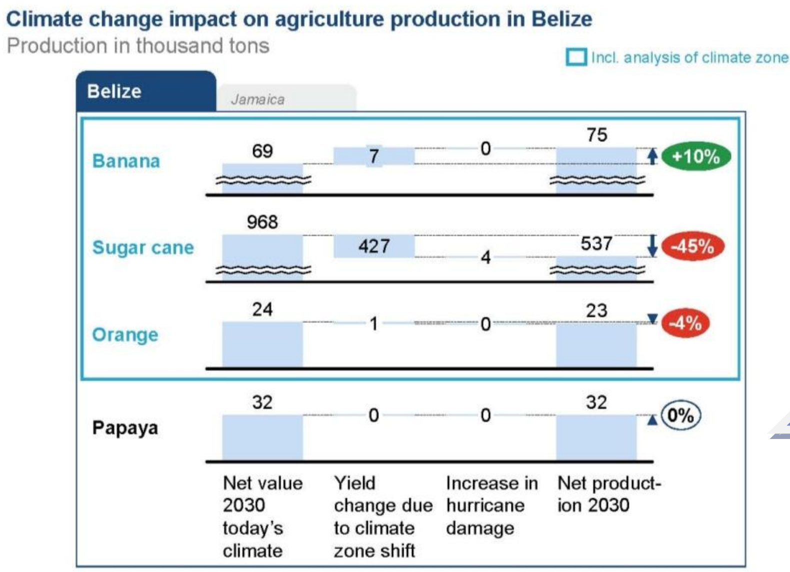
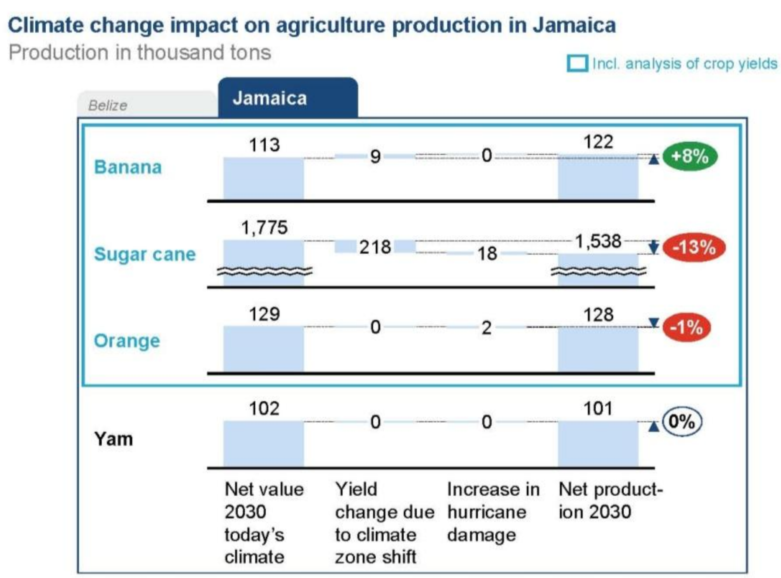


Figure 11



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CCRIF

The Caribbean Catastrophe Risk Insurance Facility

CARIBBEAN CATASTROPHE RISK INSURANCE FACILITY

The Caribbean governments' insurance fund for hurricanes and earthquakes

VISION STATEMENT

CCRIF will be a key partner with the Caribbean region in its disaster risk management strategies to support long-term sustainable development goals.

MISSION STATEMENT

Our Mission is to serve Caribbean governments and their communities in reducing the economic impact of natural catastrophes. We provide immediate liquidity through a range of affordable insurance products in a way that is financially responsible and responsive to their needs.

CCRIF, a not-for-profit company, is the first multi-risk pool in the world.

CCRIF Technical Assistance Programme

…helping Caribbean countries deepen their understanding of natural hazards and catastrophe risk, and the potential impacts of climate change on the region…

The CCRIF Technical Assistance Programme has three components as follows:

The overall aim of the technical assistance programme is to help Caribbean countries deepen their understanding of natural hazards and the potential impacts of climate change on the region; develop adaptation strategies; and build regional climate change resilience through improved risk management.

This ECA initiative falls under component two of the technical assistance programme.

Sixteen governments are currently members of CCRIF:

Anguilla, Antigua & Barbuda, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Trinidad & Tobago and Turks & Caicos Islands

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Or
Visit our website at www.ccrif.org
Email us at pr@ccrif.org