**Key messages**

- **Climate variability and change are already having severe impacts** on key sectors including agriculture and tourism.
- **These impacts are reversing economic growth**, exacerbating poverty and undermining the future prosperity of Caribbean countries.
- **CDKN research has provided locally appropriate climate change projections** that give fresh insight into the vulnerability of key sectors.
- **Adaptation investment in the agriculture sector is needed** to account for projected changes in rainfall and growing seasons, and occurrence of extreme events, especially drought.
- **Adaptation investment in the tourism sector is also needed** to build resilience to rising seas, bleached coral reefs, water scarcity and gradual temperature increase.
- **There are many potential adaptation measures** that can be applied by governments, businesses, individuals and development partners.
- **Financial support is needed** to support adaptation action as high up-front costs are a barrier to local adaptation efforts.
- **Effectively prioritising adaptation options** can maximise their value and lead to positive co-benefits for individuals, businesses and society.

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**Climate impacts on agriculture and tourism: the case for climate resilient investment in the Caribbean**

**Introduction**

For the Caribbean, climate change is not tomorrow’s problem. The threats it poses are neither distant nor abstract – they are already apparent. In recent years, hurricanes have caused major damage in countries such as Jamaica, Grenada and Cuba; severe flooding has hit Belize and Guyana; and droughts affect much of the east of the region.1 The small island state of Saint Lucia alone has faced 27 natural disasters between 1980 and 2008, with total economic damage reaching an estimated US$2.5 billion.2 The need for investment to build climate resilience in the Caribbean has never been greater.

These impacts are putting considerable strain on the finances of national governments, businesses and citizens, and threaten regional prosperity and development. The Commonwealth Expert Group on Climate Finance has said that climate change is already reversing some of the gains on poverty alleviation and economic growth that have been made in the Caribbean.3

Over the past decade, research funded by the Climate and Development Knowledge Network (CDKN) has provided fresh insight into the nature of the climate threat to the Caribbean. Researchers have developed regionally downscaled climate change projections and climate visualisation tools providing information that can be used to make informed decisions at the subregional level.4 This information has been used in conjunction with a range of other tools, and has been applied to real-life situations in Caribbean nations including Saint Lucia, Jamaica, Barbados, Belize and Cuba.

Focusing on the agriculture and tourism sectors, this document identifies some of the most pressing issues and climate vulnerabilities facing Caribbean states. It makes the case that climate resilience investment by governments, businesses and development partners is urgently needed to
sustain economic and social development, and points to some possible approaches to adaptation and resilience building.

Climate vulnerability in the Caribbean

The Caribbean is on the frontline of climate change. The Inter-American Development Bank estimated that between 2000 and 2009 the region incurred losses totalling around US$33 billion due to natural disasters, including climate-related extreme events such as hurricanes, floods and coastal inundations. The high level of exposure to hazards such as hurricanes, sea level rise, storm surge, drought and flooding is compounded by underlying environmental, social and economic conditions in Caribbean nations.

In this context, climate change can have devastating consequences for individual nations. This has been well demonstrated by past events. In 2005, for instance, Guyana was hit by a flood that cost 62% of its GDP, sending the country into an economic recession from which it is still recovering.

Recovering from such disasters can take many years, and climate change is increasing both the severity and the frequency with which they occur. Repeated shocks to economies and societies have the potential to hold back development over the long term, and cannot be considered as ‘one-off’ disruptions from which nations can expect to make a full recovery.

This has been well demonstrated in Saint Lucia’s agriculture sector, which has been hit by Hurricanes Ivan (2004), Dean (2007), Tomas (2010) and Matthew (2016). A full two years after Hurricane Tomas, government analysis of the country’s banana industry showed that the number of farmers had reduced by 550 (approximately 36%).

Using regionally downscaled climate change projections, CDKN-funded research projects – including CARIWIG, GIVRAPD and the Caribbean Research Call – have identified some of the potential risks to key sectors, including agriculture and tourism. These sectors illustrate the scale of the challenge and the need for investment.

Caribbean agriculture

Agriculture is vital to the Caribbean both from an economic standpoint and for protecting food security, especially for the poorest and most vulnerable sections of society. Primary agriculture contributed 5% of regional GDP in 2012; however, there are considerable subregional variations ranging from over 20% in Guyana to just 0.5% in Trinidad and Tobago. The sector is also a significant employer, accounting for 19% of male and 9% of female employment between 2008 and 2011.

Typically, Caribbean farms are small, often subsistence level, and use traditional farming methods that are rainfed and labour intensive. This leaves the sector vulnerable to climate change impacts on rainfall and temperature changes. CARIWIG research into the implications of future climate change on Caribbean agriculture focuses on slow-onset changes to rainfall and temperature, as well as more extreme droughts, and the resultant impact on key crops in the region.

Overall, the Caribbean can expect rainfall occurring in shorter, more intense spells, and warmer conditions. This is likely to have a significant impact on the growing season and the optimal location of many key crops. Researchers used...
CARIWIG downscaled data and the Caribbean Assessment of Regional Drought (CARI©RO) modelling tool to show that the region can expect more and longer drought events, with extreme droughts occurring one in every five years by the middle of the 21st century.22

In Belize, for example, researchers predict that declining crop yields for dry beans will make the crop unsuitable for cultivation in the country, with potential yields falling by up to 60% by the 2050s. The country’s corn crop is also expected to decrease dramatically, dropping by around 25% from 2010 levels by the 2030s.23

In Saint Lucia, reduced rainfall volume is projected to have a negative effect on rainfed agriculture. Additionally, researchers project that river flow in the Font D’Or catchment will decrease by 10% between 2011 and 2040, and by as much as 40% by the end of the century. This in turn would put pressure on agricultural production which relies on pumped, irrigated water direct from the river and on groundwater – along with demand from other sectors including energy and tourism.24

**Investing in adaptation for increased agricultural resilience**

The locally relevant climate data provided by CARIWIG have allowed researchers to identify adaptation options that are nationally and subnationally appropriate. With regard to agriculture, CDKN-supported research has identified potential measures that can be supported and applied by the state, businesses or individual growers.

- **Practise crop diversification or substitution**: CARIWIG research in Jamaica found that crops such as sweet potato, cassava and yam are good diversification alternatives. Sweet potato is comparatively drought-resistant and requires little fertiliser or soil nutrients. It is also resistant to storms as it grows underground. Climate projections indicate that sweet potato crops in the country could increase in yield by up to 33% by 2041–70.26
- **Invest in irrigation and mechanisation**: Researchers found that rainfed yields across many crop types were significantly lower than irrigated yields. Vegetable crops such as peppers can benefit greatly from irrigation, increasing yields by 50%.27 As climate change is likely to reduce the amount of available surface water,28 efficient irrigation methods such as drip-feed systems should be preferred. Some research suggests that improved mechanisation and efficiency of agricultural production have the potential to more than make up for reduced maximum potential yields driven by climate change.29 While this may be true for commercial-level farming, for many smaller farms, capital investment is needed.
- **Monitor growing areas and plan for land-use change**: Changes to average temperatures and shifts in growing seasons should be monitored closely to ensure crops are being grown in the most suitable areas.30 Research in Jamaica31 and in Trinidad and Tobago32 showed that planning is necessary to manage crop movements. For instance, while cocoa crops in Trinidad and Tobago are projected to have improved yields 500 metres above sea level, currently 98% of higher-altitude areas are forested.33 This suggests that climate change may increase the likelihood of deforestation if farmers move crops into higher altitudes in the future.
- **Improve education on sustainable farming practices**: Research in Belize34 projects an increase in the number of forest fires as droughts intensify. The researchers note that a contributing factor to these fires is *milpa* farming practices, where land is cleared by fire before being replanted. Changing farming practices, to include alley cropping, minimum-tillage ploughing, and enrichment and mechanical clearing of brush land, will be beneficial to the soil and can increase farm productivity while avoiding fire incidents.35
- **Adopt micro-insurance**: Developing micro-insurance products to protect farmers from climate-driven natural disasters and hurricanes could allow farmers to invest in more resilient infrastructure and crops after suffering a loss event.36

Investment in climate change adaptation requires capital expenditure, which can be problematic for small farmers.37 GIVRAPD research in Saint Lucia has found that while medium-scale farmers are able to invest in new technologies such as polytunnels and irrigation, for the island’s 4,000 farmers who have plots less than 1 acre in size, the level of investment that is required remains out of reach.38 Small-scale farmers will therefore need support in order to adapt to climate impacts. The value of investment in climate change
adaptation measures can have benefits that extend beyond increasing climate change resilience (see Box 1), which may create a stronger incentive for external parties such as governments and development partners to provide this support.

Caribbean tourism

Tourism is a critically important economic sector in the Caribbean, contributing substantially to GDP and jobs. In 2014 tourism’s total contribution, when supporting and dependent industries are considered, amounted to US$51.9 billion, 14.6% of GDP; and 2,231,500 jobs, 13% of employment.

The tourism industry is very exposed to climate change and its impacts. CDKN research in Belize shows that tourist infrastructure is particularly vulnerable to hurricanes and coastal inundation, with 94% of tourist accommodation facilities and 79% of tourist attractions located at lower coastal elevations.

Climate change is directly linked to damage to fragile natural habitats such as coral reefs, with increased sea temperatures, storm frequency and ocean acidification leading to coral bleaching and eventually death. Degradation of natural assets such as coral reefs was also found to be a significant threat to the tourist industry, with more than 80% of tourists participating in reef-based activities such as snorkelling and diving.

In Saint Lucia, the tourism industry is already putting pressure on the country’s water supply through high and growing demand. Changes in rainfall and increased drought incidence are projected to reduce available surface water further, and in turn to worsen existing regular water outages. This will have impacts for tourists, businesses and citizens.

Climate change also has the potential for more subtle effects on tourist behaviour that should be taken into consideration by the industry. Research from Barbados, Saint Lucia and Tobago indicates that tourists from cooler climatic zones are less able to tolerate increased temperatures. This could lead to a shift in the origin countries of tourists, with implications for marketing strategies and tourist activities.

Tourist activities and preferences may also shift as temperatures increase. Research suggests that people may seek out parks in urban areas, or avoid cities when temperatures rise too high. Beachgoers may spend more time at or near the pool or within hotel complexes. These shifts may affect the amount of tourist money that benefits the destination country.

Investing in adaptation for increased tourism resilience

The nature of the tourism sector – which is reliant on multiple interconnected industries – requires adaptive co-management and multi-stakeholder approaches. CDKN-funded research points to many possible adaptation measures for the industry, most of which are highly dependent on the local context.

Research in Belize identified 35 specific options for improving tourism sector resilience. Specific recommendations include planning regulations that restrict building to...
areas at least 2.6 metres above mean sea level and 30 metres from the high-tide mark; and a range of disaster-preparedness measures to be undertaken at the beginning of the hurricane season, including water storage, first-aid training and supplies, and securing loose fittings.

Researchers found that, crucially for effective adaptation in the tourism sector, adaptation plans “need to be presented and supported at the national level through national policy frameworks”. Implementation must involve a wide range of stakeholders, including from private sector operators. Such multi-stakeholder processes were found to be vital for successful adaptation of tourism at the local level because the sector is highly intermeshed with other sectors, including water and energy, and relies on natural ecosystems such as coral reefs. CDKN research showed how governments can foster local networks that include public and private sector institutions as well as local communities through a case study focusing on the Soufriere Marine Management Area. This longstanding protected marine reserve on Saint Lucia’s west coast has successfully managed marine conservation in the face of competing interests from a wide range of stakeholders including the tourism industry, fishermen and conservation groups.

**Conclusion**

CDKN-funded research in the Caribbean has shown that the impacts of climate variability and change on the key sectors of agriculture and tourism are, and will be, severe. Locally relevant climate change projections have given researchers a clearer picture of some of the potential changes at regional and subregional levels, with changing rainfall patterns, water scarcity and increased temperatures all expected in the region.

High capital investment costs for some adaptation measures mean that those who are less able to afford them will need support to adapt. This emphasises the importance of government in driving adaptation action. However, CDKN-funded research also shows how adaptation measures can be prioritised, focusing on low regret and no regret measures. This helps to ensure that steps taken to adapt represent good value for money.

Effective identification and prioritisation of adaptation options can also lead to a range of co-benefits that can provide additional value in a variety of ways.

The scale of the adaptation challenge for key sectors such as agriculture and tourism clearly necessitates early action to build resilience by a wide range of stakeholders. The research also emphasises the importance of supporting the development at the local level of multi-stakeholder networks that can work together to build inclusive climate change resilience.
Resources for policy-makers

Table 1 provides a directory of the useful reports and tools on which this publication is based. This may be used as a toolkit for decision-makers to build a clearer picture of some of the potential impacts of climate change for key sectors in the Caribbean, identify adaptation options, prioritise them, and integrate them into existing decision-making processes.

Table 1. Summary of research from the Caribbean

<table>
<thead>
<tr>
<th>Resource</th>
<th>Type</th>
<th>Country</th>
<th>Project</th>
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<tbody>
<tr>
<td>CARIWIG Case Study Report 2: Drought and agricultural-related forest fires in Belize</td>
<td>Report</td>
<td>Belize</td>
<td>CARIWIG</td>
<td>Uses CARiDRO to assess the relationship between agricultural forest fires and climate change via drought indices</td>
<td><a href="http://cdkn.org/resource/case-study-drought-agricultural-related-forest-fires-belize/">http://cdkn.org/resource/case-study-drought-agricultural-related-forest-fires-belize/</a></td>
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<tr>
<td>‘Climate Impacts and Resilience in Caribbean Agriculture: assessing the consequences of climate change on cocoa and tomato production in Trinidad &amp; Tobago and Jamaica (CIRCA) – Crop-Climate Suitability Modeling’</td>
<td>Presentation</td>
<td>Trinidad and Tobago, Jamaica</td>
<td>Research call: Climate impacts and resilience in Caribbean agriculture</td>
<td>Presents climate impacts on two specific crop types (cocoa and tomato production) in Trinidad and Tobago, and Jamaica</td>
<td><a href="http://cdkn.org/wp-content/uploads/2014/04/CIRCA_WP21.pdf">http://cdkn.org/wp-content/uploads/2014/04/CIRCA_WP21.pdf</a></td>
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<td>‘Climate Impacts and Resilience in Caribbean Agriculture: Assessing the consequences of climate change on cocoa and tomato production in Trinidad &amp; Tobago and Jamaica (CIRCA) – Farm Level Assessments’</td>
<td>Presentation</td>
<td>Trinidad and Tobago, Jamaica</td>
<td>Research call: Climate impacts and resilience in Caribbean agriculture</td>
<td>Presents a community-based assessment of local farmers’ knowledge, risk perceptions and vulnerability to climate variability and change in established farming communities in Jamaica and Trinidad</td>
<td><a href="http://cdkn.org/wp-content/uploads/2014/04/CIRCA-Presentation-WP3.compressed.pdf">http://cdkn.org/wp-content/uploads/2014/04/CIRCA-Presentation-WP3.compressed.pdf</a></td>
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<tr>
<td>Trinidad &amp; Tobago: Assessing the impact of climate change on cocoa and tomato</td>
<td>Policy brief</td>
<td>Trinidad and Tobago</td>
<td>Research call: Climate impacts and resilience in Caribbean agriculture</td>
<td>Highlights the impacts of climate change on Trinidad’s cocoa and tomato crops</td>
<td><a href="http://cdkn.org/resource/trinidad-tobago-assessing-impact-climate-change-cocoa-tomato">http://cdkn.org/resource/trinidad-tobago-assessing-impact-climate-change-cocoa-tomato</a></td>
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**Adaptation options – agriculture**

<p>| The adaptive capacity of Whitehouse, Jamaica to climate change | Working Paper | Jamaica | GIVRAPD | Describes a case study on the capacity of Whitehouse (Jamaica) to adapt to climate change using the Local Adaptive Capacity framework that characterises adaptive capacity based on five elements – asset base, institutions, knowledge, innovation, and flexibility in decision-making and governance – corresponding with an evolutionary perspective on adaptive capacity | <a href="http://cdkn.org/resource/working-paper-adaptive-capacity-whitehouse-jamaica-climate-change">http://cdkn.org/resource/working-paper-adaptive-capacity-whitehouse-jamaica-climate-change</a> |</p>
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<td>‘Differential climate preferences of international beach tourists’</td>
<td>Journal article</td>
<td>Barbados, Saint Lucia and Tobago</td>
<td>GIVRAPD</td>
<td>Describes a survey of 472 beach tourists comparing the climatic preferences of diverse tourism market segments on Barbados, Saint Lucia and Tobago</td>
<td>Climate Research 57: 259–269.</td>
</tr>
<tr>
<td>‘Bioclimatic comfort and the thermal perceptions and preferences of beach tourists’</td>
<td>Journal article</td>
<td>Barbados, Saint Lucia and Tobago</td>
<td>GIVRAPD</td>
<td>Provides insight into perceptions of outdoor microclimatic conditions in a coastal environment and identifies important psychological factors that differentiate tourists from everyday users of urban spaces</td>
<td>International Journal of Biometeorology 59: 37–45</td>
</tr>
<tr>
<td>‘Thermal range of coastal tourism resort microclimates’</td>
<td>Journal article</td>
<td>Barbados and Tobago</td>
<td>GIVRAPD</td>
<td>Examines the adaptive range of microclimatic conditions available in two coastal resort settings in Barbados and Tobago, with a focus on thermo-physiologically relevant climatic parameters</td>
<td>Tourism Geographies 16(3): 346–363</td>
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<td>Adaptation options – tourism</td>
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<td>Adaptation options: identification and appraisal</td>
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<td>Caribbean Climate Online Risk and Adaptation Tool (CCORAL)</td>
<td>Web tool</td>
<td>Regional</td>
<td>CCORAL</td>
<td>A decision-support tool specifically designed for decision-makers working on laws, policies, strategies, plans, programmes, projects or budgets that might be affected by climate change. These decision-makers can use the tool to see whether their work is vulnerable to climate impacts and, if so, what steps they can take to increase resilience.</td>
<td><a href="http://ccoral.caribbeanclimate.bz/">http://ccoral.caribbeanclimate.bz/</a></td>
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<tr>
<td>No and low regrets investment options for climate resilience</td>
<td>Information brief</td>
<td>Regional</td>
<td>CCORAL</td>
<td>Describes no and low regret options for resilience investments in the water sector; useful for policy-makers to understand how to make decisions in the face of uncertainty</td>
<td><a href="http://cdkn.org/resource/information-brief-no-low-regrets-investment-options-climate-resilience">http://cdkn.org/resource/information-brief-no-low-regrets-investment-options-climate-resilience</a></td>
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Endnotes

References to CDKN-funded work are in bold type.


13 Ibid.


About CDKN
The Climate and Development Knowledge Network (CDKN) aims to help decision-makers in developing countries design and deliver climate compatible development. We do this by providing demand-led research and technical assistance, and channelling the best available knowledge on climate change and development to support policy processes at the country level.

About Acclimatise
Acclimatise is a specialist consulting, communications and digital application company providing world-class expertise in climate change adaptation and risk management. Founded in 2004, our mission is to help our clients understand and adapt to climate risk, and take advantage of the emerging opportunities that climate change will bring. For more information, please visit: www.acclimatise.uk.com