Vulnerability Index to climate change in the Latin American and Caribbean Region

2014

CAF DEVELOPMENT BANK OF LATIN AMERICA

Title:
Vulnerability Index to climate change in the Latin American and Caribbean Region

Publisher: CAF
Legal Deposit: lfi74320143003766
ISBN: 978-980-7644-62-4

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This document is available at publicaciones.caf.com

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Executive summary

Climate change poses serious risks for the LAC region

The Latin America and Caribbean (LAC) region is likely to experience severe consequences as a result of climate change, although these will vary in nature and extent across the region. The LAC region is already highly exposed to multiple climate-related hazards, such as tropical cyclones, floods, droughts and heatwaves and while the region's climate is already changing, greater shifts are anticipated in the coming decades. Changes in regional temperature and precipitation regimes, including shifts in the frequency and intensity of extreme climate-related events, will affect population health, livelihoods, economies, the environment and natural resource availability across national borders. Sea level rise, already observed in recent decades, will likely lead to greater inundation, coastal erosion, saltwater intrusion and greater susceptibility to storm surge.

The consequences of these physical impacts are determined not only by a country's exposure to the variations, but also by the underlying sensitivity of a population to these impacts and the institutional capacity to implement effective adaptation. Climate change vulnerability is a multi-dimensional issue which can be influenced by a wider range of underlying factors. It is possible to lower vulnerability by reducing the sensitivity of the affected population and by improving society's capacity to adapt to the changing climate. This requires understanding of the social, economic, political and environmental context of a country and it systems, as these contribute to current levels of resilience and the potential for future adaptation.

This study aims to complement previous research by providing an improved understanding of how and why climate change vulnerability varies across the entire LAC region. A key challenge facing decision makers across public, private and civil society sectors in addressing climate change is the absence of a consistent framework to identify, understand, manage and monitor climate change vulnerability in the LAC region. This study addresses that challenge by providing up-to-date data and indices describing the relative state of climate change vulnerability across the LAC region at the national and subnational level (down to approximately 22km^2). This report has been prepared within the wider context of CAF's contributions to global climate change mitigation and adaptation through the Latin American Climate Change Programme (LACCP).

Quantifying Climate Change Vulnerability

The Climate Change Vulnerability Index (CCVI) evaluates the risk of exposure to climate change and extreme events, with the current human sensitivity to that exposure and the capacity of the country to adapt to, or take advantage of, the potential impacts of climate change.

The Climate Change Vulnerability Index (CCVI) is made up of three component indices, which in themselves constitute discrete risk indices;

— Exposure Index (50%)
— Sensitivity Index (25%)
— Adaptive Capacity Index (25%)

Risk indices offer a comparable quantified assessment of climate change risks across the LAC region. The indices are presented on a scale of 0-10, where values closer to 0 represent higher risk and values closer to 10 represent lower risk. Index values are divided into four risk categories to aid interpretation: extreme risk (0 - 2.5), high risk (>2.5 - 5), medium risk (>5 - 7.5), low risk (>7.5 - 10).

Substantial population and economic exposure to 'high' or 'extreme' climate vulnerability risks

A diverse range of circumstances contribute to the relative climate vulnerabilities and risks in the LAC region. While rural poverty and limited access to public services compound socio-economic fragilities in many vulnerable Mesoamerican countries, the weather-dependent nature of important economic sectors on Caribbean islands escalates the risks posed by high exposure and very limited resources and space. In South America, the sustainable use of the continent's rich but exposed natural resources is likely to become increasingly important in adapting to climate change.

Key findings from the analysis of climate change vulnerability in the LAC region include:

- Over 50% of the region's population is currently residing in countries with 'high' or 'extreme' climate vulnerability risks. Additionally, a significant proportion of future growth is expected to take place in vulnerable urban areas, further emphasising the importance of improving land use regulation to avoid escalating climate vulnerability risks in cities.
- Almost half of the LAC region's GDP is from countries facing 'high' or 'extreme' climate change vulnerability risks. As many of the countries with the highest adaptive capacity risks also have the lowest GDPs per capita within the region, any shocks to their economies are likely to significantly impact on prospects for building resilience, alleviating poverty and achieving stable and sustainable economic growth.
- Agriculturally dependent Mesoamerican countries and the larger Caribbean island nations with high relative exposure levels present the most extreme vulnerability risks. Haiti is assessed as the having the highest climate change vulnerable risks in the LAC region, and is likely to experience the greatest adversity from climate impacts as it has very little capacity to build resilience to gradual changes or extreme events. Guatemala has the highest vulnerability risk in Mesoamerica and is ranked immediately after Haiti in the Index.
- In South America, Paraguay and Bolivia demonstrate the highest vulnerability risks. This underscores the development challenges in these countries and their comparatively low GDPs per capita within the region.
- Capital cities in the LAC region show significant vulnerability to climate change, with 48% categorised as 'extreme risk'. Cities were also found to elevate vulnerability in many countries, often due to their exposed locations and the concentration of population and assets.
- The highest levels of vulnerability in urban areas were not concentrated in the region's megacities. The most extreme vulnerability risks at the city level were exclusively located in key urban areas within Haiti, smaller Mesoamerican countries and the Dominican Republic. Outside of the Caribbean, all of the major urban areas examined in El Salvador, Guatemala, Honduras, Nicaragua, Bolivia, Suriname and Venezuela are classed as 'high' or 'extreme risk'.

LAC region likely to be exposed to greater climate variability under climate change

Quantifying the potential impacts of climate change and climate-related extreme events provides critical insights into the vulnerability of countries. Exposure to climate change and extreme climate-related events in the LAC region varies considerably, with Caribbean and Mesoamerican countries facing the greatest exposure risks. More than half of the Caribbean nations face 'extreme' exposure risks and 75% of countries in Mesoamerica are at 'high risk'. Meanwhile, South America is the least exposed, with 25% of countries categorised as 'low risk' in the Exposure Index. Findings in this study reveal that the northern Caribbean nations of Jamaica, Dominica and Cuba to be at the highest risk.

Changes in the rainfall regime and sea level rise are the key risk drivers in the Caribbean and Mesoamerica. Decreasing rainfall over the Caribbean and Mesoamerica is likely to be accompanied by an increase in the occurrence of heavy rainfall events, affecting the frequency and intensity of both flood and drought events. A high proportion of land area of many Caribbean islands is near sea level, resulting in these countries in particular being highly susceptible to future sea level rise. Though highly uncertain, climate change may act to decrease the overall number of tropical cyclones (hurricanes) but increase the frequency of the most intense storms in the Mesoamerica and Caribbean region.

Shifting precipitation and temperature patterns over South America will affect the frequency and intensity of future floods and droughts in the region. Increases in annual precipitation coupled with a greater intensity of extreme precipitation events are projected for large swaths of southeastern South America and western Amazonia, which increases the likelihood of more frequent flooding in those areas. Meanwhile, the length of time between rainfall events in eastern-Amazonia and northeast Brazil is likely to increase, promoting conditions that may lead to more extensive droughts. The accelerating rate of glacial retreat in the tropical Andes, and the subsequent impact on dry season runoff, will likely present water resource challenges in several major cities dependent on streamflow from glacial catchments.

Poverty, inequality and high urbanisation rates are significant contributors to population sensitivity

Within the LAC region, population sensitivity to climate change is driven by a number of factors which contribute to the physical, social and livelihood circumstances present within each country. Many of the Mesoamerican countries and some of the larger Caribbean island nations generally display the highest levels of sensitivity to climate change regionally, with Haiti classed as the riskiest nation overall.

High levels of poverty and inequality are key factors driving sensitivity across the LAC region, as large numbers of people are engaged in marginal, low skilled livelihoods. The significant presence of small-holder farming and subsistence production, especially within Mesoamerica and the Caribbean, elevates sensitivity in these countries as agricultural activities are particularly susceptible to changes in climate. Education levels and health status are also closely linked with poverty, as they provide an indication of prospects for socio-economic development and resilience-building. Most of the region's countries where over 10% of GDP comes from agriculture are classified by the United Nations Development Programme as having only medium levels of human development. Health is perceived as a critical aspect of vulnerability by many LAC officials, and comparative indicators of population health status highlight particular concerns in Haiti and Bolivia.

With around three quarters of the region's population concentrated in urban areas, high urbanisation rates are elevating sensitivity for low income populations within Latin American cities. The unregulated expansion of urban areas is a feature of most municipalities and has allowed many poorer groups to locate in high risk zones, such as floodplains and landslide-prone slopes. A lack of development control has also left these areas with little or no utilities infrastructure, elevating health risks for the residents who are already vulnerable due to their socio-economic status.

High numbers of displaced persons are an additional risk driver in several South and Mesoamerican countries, most notably Colombia. These groups represent an especially vulnerable cohort within the population. The prevalence of smallholder farming across many parts of the LAC region heightens vulnerabilities associated with displacement here, as these populations often have few capital reserves or the technical capabilities needed to secure alternative livelihoods once disconnected from their land and social support networks.

Improving institutional and technical capacities, and economic resilience are key to achieving successful adaptation

As changes in the climate become ever more apparent, the ability of a country to adjust to these changes or to take advantage of opportunities they present takes on increasing importance. Structural factors such as the effectiveness of governance and the economy are significant determinants of adaptive capacity, although the link between this and financial and technical resources is moderated by other components such as natural resource availability. Haiti is classified as having the poorest adaptive capacity prospects within the region, as it struggles to reconstitute its governmental structure and operations following a repeated cycle of natural hazard occurrence and devastation. In contrast larger, more developed countries with greater technical capabilities and more diverse economies, such as Chile, Uruguay, Mexico and Brazil, have lower adaptive capacity risks.

The composition of some economies in the region makes them comparatively more exposed to the potential impacts of climate change. High levels of dependence on the agricultural sector as a source of wealth and employment is reflected in 'extreme' or 'high risk' classifications for adaptive capacity in several Mesoamerican (Nicaragua, Honduras, Belize, Guatemala and El Salvador) and South American countries (Guyana, Paraguay and Bolivia). Studies indicate that crop yields and crop viability in Mesoamerica in particular will be widely impacted by climate change, emphasising the importance of adaptation for this sub-region. In the Caribbean, heavily tourism-dependent economies on many islands are similarly exposed to climate change impacts. Sea level rise, beach erosion, changing precipitation patterns, water security concerns, increased disease ranges and a potential increase in hurricane intensity all pose significant threats to this sector.

Climate Change Vulnerability Index for the LAC region

Country	Rank	Score	Risk category
Haiti	1	0.58	extreme
Guatemala	2	0.75	extreme
El Slavador	3	0.79	extreme
Honduras	4	0.92	extreme
Dominican Republic	5	1.01	extreme
Nicaragua	6	1.19	extreme
Jamaica	7	1.50	extreme
Paraguay	8	1.58	extreme
Belize	9	2.25	extreme
Bolivia	10	2.48	extreme
Venezuela	11	3.64	high
Ecuador	12	3.76	high
Dominica	13	3.85	high
Cuba	14	3.90	high
Guyana	15	4.23	high
Colombia	16	4.30	high
Mexico	17	4.47	high
Peru	18	4.98	high
Panama	19	5.57	medium
Antigua and Barbuda	20	5.64	medium
Brazil	21	5.77	medium
Suriname	22	5.85	medium
Saint Kitts and Nevis	23	6.24	medium
Argentina	24	6.66	medium
Trinidad and Tobago	25	7.22	medium
Costa Rica	26	7.70	low
Saint Lucia	27	8.25	low
Uruguay	28	8.33	low
Bahamas	29	8.68	low
Chile	30	9.54	low
Grenada	31	9.58	low
Saint Vincent and The Grenadines	32	9.63	low
Barbados	33	9.77	low

Government capacity to implement effective adaptation is difficult to build and can be hindered by poor coordination between actors in many LAC countries. This, in turn, is hampered by low levels of technical capacity, which is linked to the availability of resources to invest in education and research. The perception of corruption in many LAC countries also threatens adaptive capacity, both in terms of government effectiveness and in influencing how external donors direct funds. In addition, external funding for climate change adaptation in the LAC region has been difficult to secure, with support for mitigation projects in the past 10 years over seven times the amount spent on adaptation. This has been largely focused in larger, more developed countries, with small island states receiving only 10% of climate finance approved for the wider region despite their acute need to adapt.

Reducing climate vulnerabilities in the LAC region requires a collaborative approach

Understanding the specific components affecting vulnerability within each country allows resilience-building efforts to target particular drivers of risk to effectively increase capacities to address climate change impacts. Within this context, it is important to recognise that the challenges presented by climate change are global issues that require a comprehensive approach to tackle. Countries will need to work in collaboration with each other and external partners to leverage national, regional and international technical and financial resources to reduce vulnerability to climate change across the region.

Climate Change Vulnerability Index 2014, LAC region

1— Introduction

1.1 Project context

The Latin America and Caribbean (LAC) region is likely to experience severe consequences as a result of climate change. The LAC region is already highly exposed to multiple natural hazards, such as tropical cyclones, floods, droughts and heatwaves. For example, in September 2013, Hurricane Ingrid and Tropical Storm Manuel almost simultaneously struck Mexico's Atlantic and Pacific coasts, displacing thousands and causing an estimated US$5.7bn in economic losses.[1] In January 2011, 900 people were killed and thousands made homeless following landslides and flash flooding in Brazil. In 2013, drought in Bolivia affected over 340,000 people, almost 200,000 hectares of crops and killed over 440,000 head of cattle.[2]

The region's climate is already changing, but greater shifts are anticipated. According to the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5), a number of significant changes have already been observed. These observations include positive minimum temperature trends, glacial retreat in the Tropical Andes, and reductions in precipitation over the Caribbean.[3] By the end of the 21st century, temperatures are likely to be higher over Mesoamerica, the Caribbean and South America. Some areas will become wetter, such as parts of southeastern and northwestern South America. Others are likely to get drier, such as northern areas in South America as well as southern parts of the Caribbean. Sea level rise (SLR), already observed in recent decades in the Caribbean and along the Atlantic coast of South America, will likely lead to greater inundation, coastal erosion, saltwater intrusion and a greater susceptibility to storm surge.

The economic damages caused by climate change will be significant, undermining efforts to maintain and improve the quality of life experienced by millions. Each of the 611 million people residing in the LAC region will be impacted by climate change, including the 152 million living in poverty[4] and 69% living in extreme poverty.[5] While steady growth has helped lift millions into the middle class over the past decade, economic damage caused by climate change could stop others from achieving this status. Numerous studies have highlighted the potential economic impacts of climate change on the region. For example, a 2009 study of the impacts and costs of SLR in the Caribbean estimated that annual costs for 2080 would amount to between US$13.5 and US$19.4bn per annum, equivalent to 1.6% to 2% of GDP for CARICOM members in 2080.[6] A 2013 study led by the Inter-American Development Bank (IADB) found that a 2°C increase from pre-industrial levels could cost US$100bn annually by 2050.[7] A 2011 study of the economic impacts of climate change on Brazil found that by 2050, the average annual loss for each citizen could reach US$874.[8] Despite the extent of these potential costs, Latin America is only responsible for approximately 12.5% of global greenhouse gas emissions.[9]

However, the impacts of climate change will not be uniformly experienced across the LAC region due to varying levels of vulnerability. The magnitude and severity of climate change impacts are contingent on the unique climatic, topographic, socio-economic and political factors which define particular locations. For example, parts of Mesoamerica are seriously affected by droughts, cyclones, and the El Nino-Southern Oscillation (ENSO) phenomenon. Due to the importance of agriculture to the national economies of Mesoamerican countries, climate change impacts are likely to be amplified. In comparison, sea level rise combined with saltwater intrusion and coral bleaching pose severe risks to many small, low-lying Caribbean countries.

This study aims to complement previous research by providing an improved understanding of how and why climate change vulnerability varies across the entire LAC region. Substantial steps have been taken to understand and respond to the threat posed by climate change in the LAC region. In addition to international research, such as the studies which contribute to the global IPCC assessment reports, a number of regional climate change assessments have focused on the LAC region. Several of these initiatives have been led by development financial institutions such as the World Bank and the IDB. However, a key challenge facing decision makers across public, private and civil society sectors in addressing climate change is the absence of a consistent framework to identify, understand, manage and monitor climate change vulnerability in the LAC region.

1.1.1 Study objectives

This report has been prepared for the Development Bank of Latin America (CAF) to assist in its contributions to global climate change mitigation and adaptation through the Latin American Climate Change Programme (LACCP). Strategically, this study informs the LACCP workstream on climate change adaptation. This workstream is defined as "bolstering and supporting duly planned adaptation processes at policy, planning, programme and project levels, allowing for sustainable development to be achieved in countries in the LAC Region from an innovative outlook."[10]

The LACCP Adaptation Programme is built around five action lines. These are:

1 Bolstering access to the flow of financial resources available for adaptation purposes.

2 Strengthening the climate change adaptation-driven institutional capacity of the public and private sectors in place in countries in the region.

3 Fostering specific adaptation measures *in situ*, in response to the more pressing needs of the Latin American and Caribbean countries.

4 Buttressing knowledge generation and management in matters concerning adaptation to climate change.

5 Carrying out actions which are focused on both strengthening CAF's own skills, and incorporating climate-oriented considerations into the set of operations being supported by the institution.

Within the wider context of the LACCP Adaptation Programme, there are two main objectives of this report:

6 To provide a mechanism that helps CAF to embed climate change vulnerability within corporate decision making and the implementation of the organisation's own operations; and

7 Enhance awareness of the current state of climate change vulnerability across countries in the LAC region, thereby facilitating opportunities to increase resilience to climate change over the long-term.

The key contribution made by this study is in the provision of up-to-date data and indices describing the relative state of climate change vulnerability across the LAC region at the national and subnational level (down to approximately $22km^2$). In addition to visualising climate change vulnerability graphically through the use of maps, additional datasets (such as those on human development, gross domestic product, poverty, etc.) have been incorporated to provide a clearer understanding of vulnerability.

Focus box

Countries in the LAC region

The LAC region is comprised of 33 sovereign states located across the three sub-regions of South America, Mesoamerica and the Caribbean. The 33 sovereign countries in the LAC region contain over 600 million people, approximately 8% of world population. This study has focused on these 33 countries, excluding overseas territories of countries such as the UK.

The following countries are considered in this study:

Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago (collectively defined as the Caribbean).

Belize, Costa Rica El Salvador, Guatemala, Honduras, Mexico and Nicaragua(collectively defined as Central America and also called Mesoamerica when Mexico is included).

Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela (collectively defined as South America).

Map 1.
LAC Regions

- Caribbean Country
- Mesoamerican Country
- South American Country

Data source: Maplecroft, 2014

1.2 Conceptual framework

1.2.1 Conceptual framework for climate change vulnerability

Climate change impacts are determined by a combination of physical exposure to hydro-meteorological variations, the underlying circumstances of a population and the degree to which a country's governance system is able to implement effective adaptation. According to the Intergovernmental Panel on Climate Change (IPCC), vulnerability to climate change is "a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity".11 Therefore, vulnerability to potential climate change is dependent on:

- The level of **exposure** to the hazard;
- The degree of **sensitivity** within the system; and
- The ability of the system to **adapt** to change.

Understanding vulnerability as a composite of multiple factors highlights the importance of preparing for physical exposure to climate change and addressing the drivers of sensitivity and low adaptive capacity. It is possible to lower vulnerability to climate change by reducing the sensitivity of the affected population and by improving the capacity of society to adapt. This requires awareness of the wider social, economic, political and environmental context of a country and it systems, which will shape the levels of resilience present and the potential for achieving improvements.

Focus box

Climate change vulnerability – key terms

Climate change vulnerability is an important concept because it can be used to assess the potential nature, extent and severity of climate change impacts across different locations, thus informing adaptation efforts. The following terms are used extensively throughout this report and have been defined by the IPCC:[12]

- **Vulnerability**: the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

- **Exposure**: The nature and degree to which a system is exposed to significant climatic variations.

- **Sensitivity**: the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli.

- **Adaptive capacity**: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. It has also been defined as the whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures.

- **Adaptation**: Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

For the purposes of this study, climate change vulnerability is defined as a function of exposure, sensitivity and adaptive capacity:

Vulnerability = (exposure + sensitivity) – adaptive capacity

1.3 Methodology

1.3.1 Constructing the climate change vulnerability index

The Climate Change Vulnerability Index (CCVI) evaluates the vulnerability of human populations to extreme climate related events and changes in major climate parameters over the next 30 years. The Climate Change Vulnerability Index combines the risk of exposure to climate change and extreme events, with the current human sensitivity to that exposure and the capacity of the country to adapt to, or take advantage of, the potential impacts of climate change.

The Climate Change Vulnerability Index (CCVI) is made up of three component indices, which in themselves constitute discrete risk indices;

— Exposure Index (50%)
— Sensitivity Index (25%)
— Adaptive Capacity Index (25%)

The Exposure Index evaluates the risk of a region being impacted by extreme climate related events (drought, wildfires, tropical cyclones and storms, storm surge, severe local storms, precipitation induced landslides, flooding and sea-level rise), as well as the risk posed by the projected changes in baseline climate parameters (air temperature, precipitation and specific humidity).

While the Exposure Index is unable to predict the exact location of future extreme events, by combining state-of-the-art future climate model data with information on past extreme events, the user is able to identify broad patterns of potential changes along with hotspots for extreme events.

The Sensitivity Index examines the current relative human sensitivity to exposure to extreme climate related events (drought, tropical storms and cyclones, wildfires, precipitation induced landslides, severe local storms, storm surge, flooding and sea-level rise) and predicted climate change. Sensitivity is a measure of the population's susceptibility to the impacts of climate change, which is a function of their existing physical, social and livelihood circumstances. Utilising a combination of sub-national and national data, the index examines aspects of sensitivity related to health, poverty, knowledge, infrastructure, conflict, agriculture, population and resource pressure.

The characteristics of a population dictate the degree to which the impact of climate change is felt by that population. Within this report, the Sensitivity Index focusses on the human population and its interaction with natural resources, rather than the sensitivity of ecosystems themselves. Ecosystem stress and destruction driven by climate shifts intensifies the sensitivity of human populations as they may be forced to exploit alternative food, water and livelihood options.

The Adaptive Capacity Index evaluates the ability or potential of a country's institutions, economy and society to adjust to, or to take advantage of, existing or anticipated stresses resulting from climatic change. Key factors that influence a country's adaptive capacity are: the strength of the economy; the effectiveness and stability of the government; the level of knowledge transfer and communication to the populace; the ability of a country to develop innovative technologies or practices; available natural resources; and the level of dependence on agriculture, or other vulnerable activities, to support the economy.

The concept of vulnerability reflects a balance between a potential threat and the capacity of a system to mitigate that threat. In the context of the CCVI, the Exposure Index represents the threat. Meanwhile, the threat of climate change may be mitigated by reducing a population's sensitivity to the impacts, or by implementing measures to reduce the potential impacts themselves. The ability of the human population to reduce the impacts of climate change is jointly captured by the Sensitivity Index and the Adaptive Capacity Index. As such, within the CCVI, equal weightings are apportioned to the Exposure index (50%) and jointly the Sensitivity Index (25%) and Adaptive Capacity Index (25%).

Calculating risk indices for the LAC region

The risk indices utilised in this report offer an evidence-led and comparable quantitative assessment of climate change vulnerability risk across the 33 Latin American and Caribbean countries. They are developed using qualitative and quantitative primary data from a range of respected international sources, in combination with expert research.

The risk indices are calculated at either a national or sub-national level. At the national level, national indicators are used to calculate a single risk value for each country. Where relevant and suitable data are available, sub-national level maps have been created with a high spatial resolution (typically about $22km^2$) covering the entire LAC region, with the risk index calculated for each grid cell. These results are then used as a basis to calculate the national scores for a country.

Interpreting risk indices

The indices are presented on a scale of 0-10, where values closer to 0 represent higher risk and values closer to 10 represent lower risk. Index values are divided into four risk categories to aid interpretation: extreme risk (0 - 2.5), high risk (>2.5 - 5), medium risk (>5 - 7.5), low risk (>7.5 - 10). Countries are also assigned a rank, based on their relative position in the index, where the country ranked 1 represents the highest risk.

Limitations

The risk indices utilised in this report are constructed using data obtained from third parties. Although the quality of the primary data cannot be guaranteed, only on data from reputable sources are used. Primary datasets are also subjected to thorough inspection and assessed for inconsistencies during the research process. Maplecroft's risk indices included in this report are generated using the most up-to-date information available at the time of publication. While the methodologies for the indices are designed to be as 'forward looking' as possible, in certain instances, the scores and rankings may not reflect the change in risk level resulting from a recent major geopolitical event.

When selecting sources of primary data, we aim to achieve comparability across as many countries as possible. However, in a limited number of cases, data for a specific country and year are not available in the primary dataset. In these cases, values are substituted either with equivalent data from alternative reputable sources, or data from a previous year to allow the analysis of key affected countries alongside their peers and to provide a more complete comparative context. For a country to be included in the index there must be available data for at least 70% of indicators.

The Exposure Index does not distinguish between predicted increases and decreases to baseline climate parameters, but rather measures the degree of change as representative of the necessity for that system (human or natural) to cope with a potential alteration of the current state. The extent of certain extreme climate-related events, such as flooding, can be particularly localised risks; two locations in close proximity to one another can be exposed to very different risks. Therefore, indicators of extreme climate-related events provide a generalised overview of risk in a locality and recognise that particular locations in the locale may well have markedly different exposures.

Although the focus of this report has centred on the sensitivity of human populations and systems, climate change will likely have significant impacts on a range of ecosystems in a variety of different ways. Consideration of certain impacts is beyond the scope of this report – for example the migratory response of species to shifting patterns of temperature and rainfall. However, aspects of the human interaction with ecosystems are captured within the Sensitivity Index – for example, by considering the gross forest cover loss. Human impacts on natural resources such as this can also be considered in conjunction with the impacts of climate change. For example, recently logged areas may be more susceptible to erosion if climate change increases the likelihood of heavy rainfall events.

While adaptive capacity can be examined at the national, community or individual level, the Adaptive Capacity Index focuses on macro-level, structural factors such as governance and the economy. This is so as to avoid overlap with the community and individual focus of the Sensitivity Index. By delineating these two dimensions of vulnerability, their utility within the Climate Change Vulnerability Index is increased.

As demonstrated by the IPCC's Fifth Assessment Report, not only is the underlying climate change science still being developed, but our understanding behind impacts and adaptation is also evolving. As a result, a simple weighting of the sub-indices within the CCVI is considered appropriate in this report. However, readers should be aware that any adjustments to the configuration of the CCVI may yield slightly different results.

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2— Exposure to climate change in the LAC region

2.1 Overview

Exposure to climate change and extreme climate-related events in the LAC region varies considerably due to the range of climate regimes in the region. Countries facing the greatest exposure are located in the Caribbean and Mesoamerica, with the northern Caribbean nations of Jamaica, Dominica and Cuba at highest risk.

Shifting temporal and spatial patterns of rainfall are key drivers of risk for the Caribbean and Mesoamerica. The projected drying trend in the Caribbean and Mesoamerica is likely to be accompanied by an increase in the frequency of heavy rainfall events, affecting the frequency and intensity of both flood and drought events. Sea level rise is also a factor in the high exposure risks found in the Caribbean, where a high proportion of the land area of many islands is at, or close to, sea level. Mesoamerica and Caribbean nations are also subject to tropical cyclones, which are the most costly climate-related hazard in the region. Though highly uncertain, climate change may act to decrease the overall frequency of tropical cyclones but increase the frequency of the most intense storms.

The El Niño-Southern Oscillation (ENSO) is main driver of current interannual climate variability in the LAC region, contributing to the substantial spatial and temporal variation in extreme climate-related events. El Niño is typically associated with drier than normal conditions in Mesoamerica and the Caribbean, and La Niña with wetter conditions. In South America, El Niños have been associated will drought conditions in northeast Brazil, Venezuela and Colombia, while prompting flooding along the west coast of the continent. Although ENSO will remain the dominant mode of interannual variability in the future, the increased moisture availability in the atmosphere associated with climate change will likely result in the intensification of related rainfall.

Flooding is the most prevalent climate-related hazard in South America and is a key driver of exposure risk. The increase in precipitation totals and, more critically, the intensity of extreme precipitation events projected for large swaths of southeastern South America and western Amazonia increases the likelihood of more frequent flooding in those areas. Meanwhile, the increasing period between rainfall events predicted over eastern-Amazonia and northeast Brazil promotes conditions that may led to more extensive droughts. The accelerating glacial retreat in the tropical Andes in recent decades is expected to continue as temperatures in the region rise. Subsequent impacts on dry season runoff are likely to have significant implications for water resource management in several South American countries, particularly in Peru and Bolivia where key cities are heavily dependent on streamflow from glacial catchments.

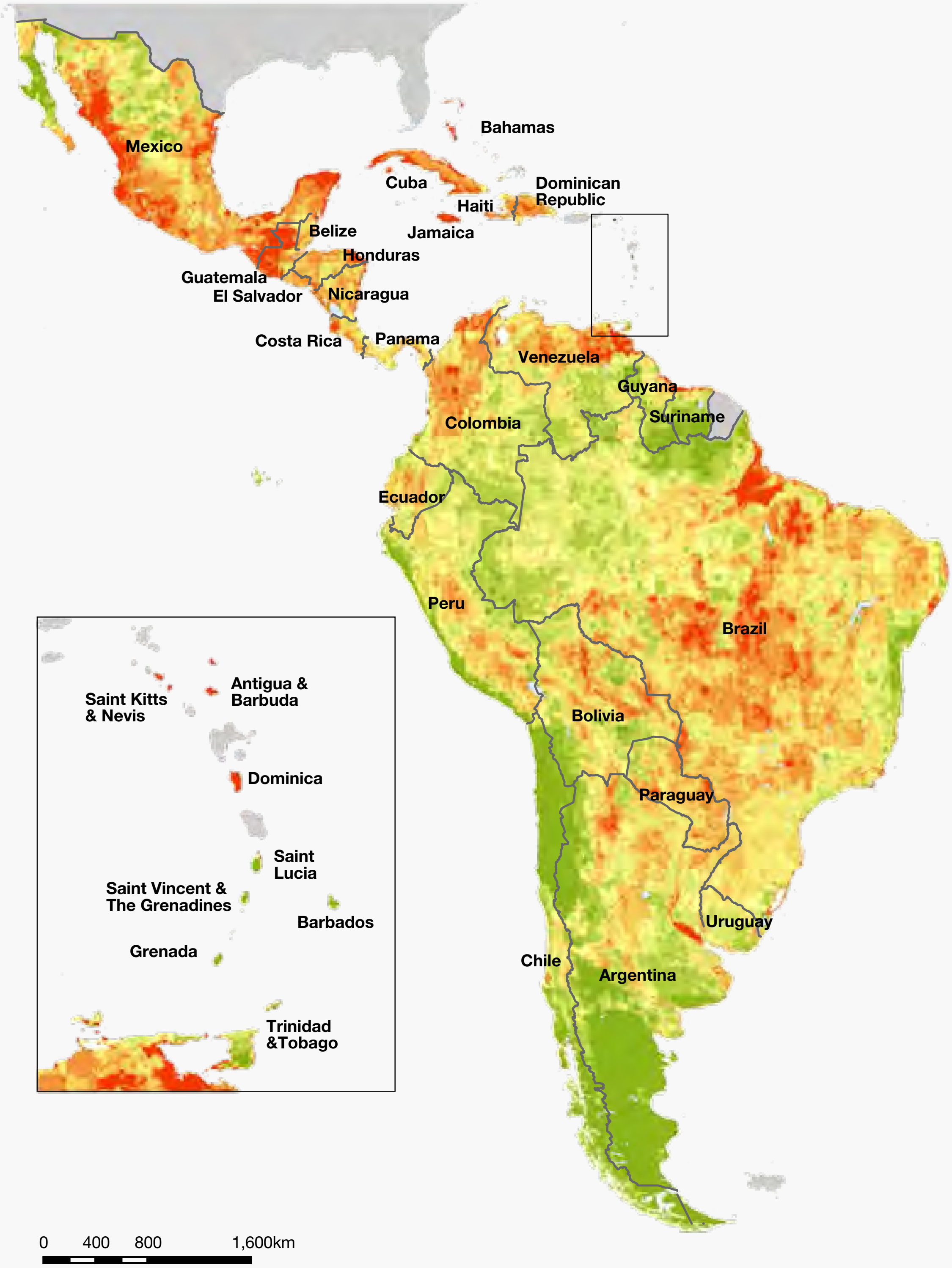
Map 2.
Exposure Index 2014, LAC region

Climate Change Exposure Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014



2.2 Introduction

2.2.1 Assessing exposure to the climate change in Latin America and the Caribbean

Future climate change will alter large scale atmosphere-ocean circulations that will impact temperature and precipitation regimes around the world. It has been widely acknowledged that global temperatures are likely to increase by between 1.5 and 4°C during the course of the 21st century, while sea-level rise is likely to be in the range 0.3-0.8 metres. [1] Global climate change will affect precipitation patterns, temperature extremes, and the intensity and frequency of extreme climate-related events such as tropical cyclones, floods and droughts. Ocean warming and expansion, coupled with the increased mass loss from glaciers and ice sheets will drive future sea level rise. Meanwhile, the increasing uptake of carbon dioxide (CO_2) by the ocean will result in increasing acidification, with a decrease in surface ocean pH of 0.06 to 0.32 projected by 2100.[2]

By the mid-21st century climate change has the potential to cause damage to property, infrastructure and human populations, as well as adversely impact the natural environment and ecosystem integrity. The relationship between rising global temperatures and the localised response of the interannual variability of regional climates is highly complex. Rising mean temperatures over the coming decades will prompt a disproportional response in extreme climate-related events such as severe storms, floods, droughts and tropical cyclones. Significant shifts in climate are likely to occur in many parts of the LAC region by the mid-21st century. Results of a recent study identify the year by which a statistically significant change in the climate will be detectable (i.e. a signal greater than current natural variability). According to this study, many parts of the LAC region will be amongst the earliest globally to measurably demonstrate the impacts of climate change; significant shifts are expected to occur in almost all countries in this region by 2050, and in some Caribbean nations by 2030.[3]

Climate change will impact key modes of climate variability in the LAC region, which will affect regional temperature and precipitation patterns to varying degrees. Future temperature and precipitation changes will not be evenly distributed across the globe, with some locations projected to experience greater shifts than others. The degree to which changes in global scale atmosphere and ocean circulation patterns affect regional modes of climate variability will, in part, determine the extent of regional climate change. Significant changes in the mean, variability and extremes of seasonal temperature and precipitation are projected for the Amazon, with some areas considered to be among those which will undergo some of the greatest shifts in climate by 2050 globally.[4] Meanwhile the change in the magnitude of mean, variability and extremes of seasonal temperature and precipitation in southern parts of South America are projected to be amongst the lowest globally.[5] However, these areas may still be vulnerable to climate change, as even small shifts in climate can have significant impacts on human and natural systems.

A critical component of assessing a nation's vulnerability to climate changes is to first quantify the degree to which that nation is exposed the potential impacts of climate change and climate-related extreme events. The Maplecroft Exposure Index evaluates the current risk of a region being impacted by extreme climate-related events (drought, wildfires, tropical cyclones and storms, storm surge, severe local storms, precipitation induced landslides, flooding and sea-level rise), as well as the risk posed by the projected changes in baseline climate parameters (air temperature, precipitation and specific humidity). Whilst the Exposure Index is unable to predict the exact location of future extreme events, by combining state-of-the-art future climate model data with information on past extreme events, broad patterns of potential changes along with hotspots for extreme events are identified.

2.2.2 The climate of Latin America and the Caribbean

The LAC region displays a diverse range of regional climates, with substantial temporal and spatial contrasts in temperature and precipitation regimes. A high proportion of this region is located in the tropics, with the climate dominated by seasonal shifts in the Inter-tropical Convergence Zone (ITCZ) and South Atlantic Convergence Zone (SACZ). Sub-tropical regions both north and south of the equator are subject to summer monsoonal circulations which dictate the precipitation patterns of Mexico, parts of Mesoamerica, and tropical and sub-tropical areas east of the Andes in South America. These climate systems give rise to a high spatial variability in precipitation; the LAC region is home to the driest desert in the world in northern Chile, hosts the greatest number of tropical glaciers globally and one of the wettest and most humid places on earth in Amazonia.

Climate over the Caribbean islands is characterised by wet and dry seasons, with the driest part of the year typically occurring in the northern hemisphere winter. The onset of the wet season begins in April-May, with the Caribbean Low Level Jet intensifying in July-August causing a slight reduction in rainfall at that time of year. Tropical cyclones can produce extreme rainfall events during the wet season in this region and are associated with considerable damage to property and livelihoods. The wet season draws to a close around November, when the decline in convective activity reduces rainfall to a minimum in the dry season months of November to February.

A strong east-west gradient in tropical climate in South America is caused by the tropical Andes. The cold and dry conditions on the western side of the Andes contrast significantly with wet and humid conditions to the east over the Amazon basin. Easterly winds drive moisture towards the mountains during the southern hemisphere summer, resulting in the distinct wet season (November-April in Peru, December-March in Bolivia and northern Chile). Interannual variations are strongly influenced by the El Niño-Southern Oscillation (ENSO), with the warmer than average waters of the coast of Peru and Ecuador associated with El Niño promoting heavy rainfall in normally very dry coastal regions. Further inland, El Niño enhances westerly flow aloft, preventing moisture transport from the Amazon and reducing the precipitation over the tropical Andes.

2.3 Results

The Caribbean nations of Jamaica (1), Dominica (2), and Cuba (3) are among those most exposed to the potential of impacts of climate change in the LAC region. The high ratio of coastline to land area exhibited by these nations exacerbates their susceptibility to sea level rise – a factor further compounded by the low-lying nature of many of the Caribbean islands. Tropical Cyclones (or hurricanes) and associated storm surges are also major drivers of exposure risk for many of the more northern Caribbean nations. Guatemala (4) is the only non-Caribbean nation in the 'extreme risk' category of the Exposure Index, demonstrating the substantial exposure faced by the majority of the Caribbean region. However, the southern islands of Saint Lucia (30), Barbados (31), Saint Vincent and the Grenadines (33) and Grenada (32), all appear as 'low risk', while Trinidad and Tobago (24) is classified as 'medium risk'.

South American countries are some of least exposed to climate change and extreme climate-related events in the LAC region. While the majority of South American countries exhibit some sub-national areas of 'extreme risk' and 'high risk', Paraguay (16) is the highest ranked in the Exposure Index and features as 'high risk'. Drought, flooding and severe storms are key drivers of risk in this region, along with some of the greatest increases in temperature projected for the LAC region. The northern nations of Venezuela (17), Colombia (20) and Ecuador (21) are amongst the highest risk in South America. Chile (29) is the lowest risk South American country in the Exposure Index, despite exhibiting several 'high risk' areas in central region.

Aside from Guatemala, all Mesoamerican countries feature as 'high risk', although each is exposed to a slightly different combination of climate-related events. The more central countries of Honduras (10) and El Salvador (9) along with Guatemala are the highest risk countries in this region, and face significant risks from flooding, drought and landslides alongside significant projected temperature and precipitation changes.

Table 1.
Exposure Index for the LAC region

Country	Rank	Score	Risk category
Jamaica	1	0.84	extreme
Dominica	2	1.24	extreme
Cuba	3	1.39	extreme
Guatemala	4	1.66	extreme
Haiti	5	2.14	extreme
Dominican Republic	6	2.28	extreme
Saint Kitts and Nevis	7	2.36	extreme
Bahamas	8	2.50	extreme
El Salvador	9	2.68	high
Honduras	10	2.73	high
Antigua and Barbuda	11	3.16	high
Mexico	12	3.35	high
Belize	13	3.56	high
Costa Rica	14	3.70	high
Nicaragua	15	3.81	high
Paraguay	16	4.30	high
Venezuela	17	5.07	medium
Brazil	18	5.11	medium
Panama	19	5.26	medium
Colombia	20	5.41	medium
Ecuador	21	5.82	medium
Bolivia	22	6.00	medium
Peru	23	6.69	medium
Trinidad and Tobago	24	7.02	medium
Uruguay	25	7.27	low
Argentina	26	7.32	low
Guyana	27	7.58	low
Suriname	28	7.99	low
Chile	29	8.57	low
Saint Lucia	30	8.70	low
Barbados	31	9.07	low
Grenada	32	9.79	low
Saint Vincent and The Grenadines	33	9.85	low

2.4 Key risks profile

2.4.1 Current extreme climate related hazards in the LAC region

The LAC region hosts several different climate zones, which exhibit diverse patterns of precipitation and temperature, along with significant variation in the frequency and intensity of climate-related extreme events such as flooding, droughts and tropical cyclones. Flooding is the most common natural hazard is this region and in Mesoamerica and the Caribbean is typically associated with the tropical cyclone season. Meanwhile, ENSO is a dominant factor in both the patterns of flooding and drought in South America. Flood risk is compounded by steep terrain in many areas of the Andes, where flash flooding is a common feature. Defined wet and dry seasons in many countries in this region result in seasonal droughts, which may be exacerbated by ENSO. During El Niño conditions dryer than normal conditions prevail in northeast Brazil, Mesoamerica, Colombia and Venezuela. During these dry periods wildfires are also a risk. Given their tropical climates, rainfall in the Caribbean and Mesoamerica is largely governed by convective processes. Tropical cyclones pose a significant risk to both Mesoamerica and the Caribbean, with the former region lying in both the North Atlantic and eastern North Pacific storm track.

Over the last three decades the number of climate-related disasters, along with their economic and humanitarian impacts, has varied greatly across the LAC region. Between 1980 and 2013, the LAC region experienced over one thousand climate-related disasters[6], equivalent to 18.5% of the global total in that period.[7] In that period climate-related disasters affected 127 million people and resulted in 81,825 fatalities and economic losses in excess of US$129 billion (at 2014 values).[8] The frequency and nature of climate-related disasters varies across the LAC region, and is both dependent on the inherent exposure to the hazard as well as the socio-economic resilience of the impacted regions to that particular hazard. Between 1980 and 2013, Mexico experienced the greatest number of climate-related disasters (124) and associated economic losses (US$34 billion), while the greatest numbers of fatalities were reported in Venezuela (30,534). The economic impact from climate-related disasters varies considerably from country to country, but also between sub-regions of LAC; while average annual economic losses amount to 0.04% of GDP in South America, that figure is 17 times greater for the Caribbean at 0.7%.

The distribution of economic and humanitarian impacts of climate-related hazards is uneven. As demonstrated in *Figure 1*, while 44% of climate-related disasters occur in South America, only 33% of economic losses occur in this region. However, the humanitarian impacts of climate-related disasters have been highest in South America in the 1980-2013 period. Of all the people affected by climate-related disasters in the LAC region between 1980 and 2013, 63% were in South America, 55%of related fatalities also occurred in this sub-region. These figures somewhat reflect the relatively high population in South America compared with both Mesoamerica and the Caribbean. To take this into account, *Table 2* shows the average number of people affected by climate disasters in each country on an annual basis, relative to the total population. On average 23 people per 1,000 are affected by climate-related disasters each year in the Caribbean, while that figure drops to 7 for Mesoamerica and 8 for South America.

Similarly, *Table 2* also shows that the relative economic impact of climate-related disasters tends to be greater in Caribbean nations. The average annual economic losses in Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis and Saint Lucia all exceed more than 2% of national GDP. Mexico, despite experiencing the greatest number of climate-related disasters in the LAC region between 1980-2013, suffered a much lower relative economic impact; the annual average loss is 0.11% of GDP, which is comparable to other major economies of the region. Despite the larger economies of Brazil, Mexico, Argentina, and Colombia suffering the greatest absolute economic losses, the number of fatalities relative to the total population is much lower in these countries than the smaller economies of Honduras, Haiti and Nicaragua.

Table 2.

Overview of the number of climate-related disasters in LAC region, and their economic and humanitarian impacts between 1980 and 2013

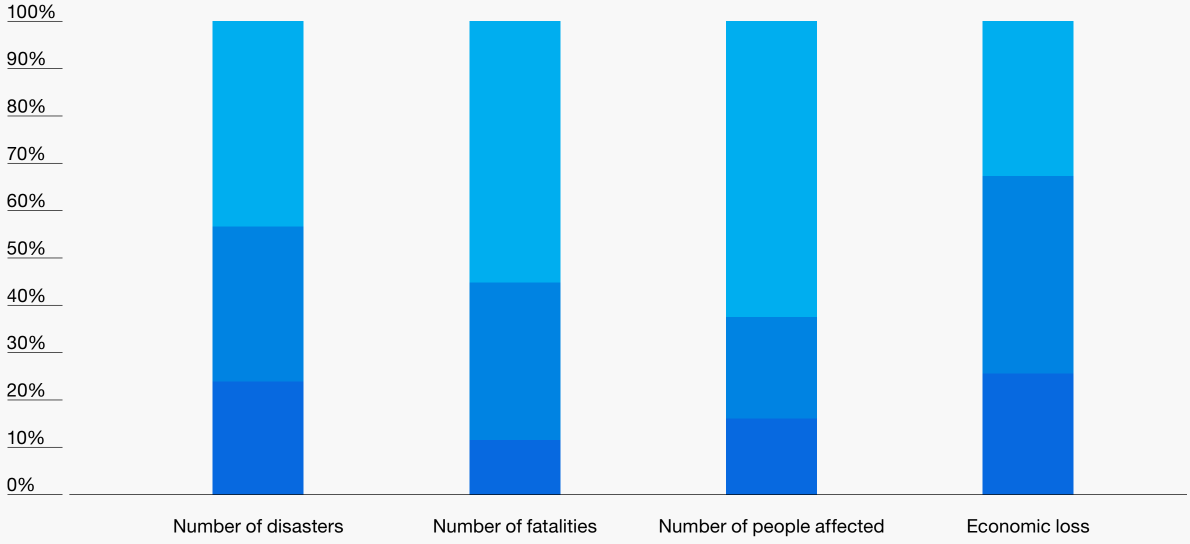
Country	Number of disasters (1980-2013)	Total economic loss (1980-2013) (US$1000)	Annual average loss (as % of GDP)	Total number of fatalities (1980-2013)	Number of people affected (1980-2013)	Annual average number of people affected (per 1,000 population)
Antigua and Barbuda	9	847808	2.870	8	117800	54.55
Argentina	39	8002259	0.067	312	6519328	6.55
Bahamas	14	3415216	1.701	20	30500	3.37
Barbados	7	217737	0.194	1	2500	0.37
Belize	10	737264.4	1.907	64	210000	26.36
Bolivia	45	4717683	0.666	1049	6340204	24.76
Brazil	106	13066850	0.022	3982	43453726	9.04
Chile	30	2317934	0.034	653	1110352	2.63
Colombia	78	3726513	0.040	4091	9342337	8.06
Costa Rica	32	1138972	0.097	196	1234612	10.56
Cuba	49	14044197	0.856	190	12888801	47.67
Dominica	9	365220	2.943	9	18929	10.95
Dominican Rep	39	3734074	0.258	1358	1342128	5.38
Ecuador	30	1983881	0.095	1066	915104	2.42
El Salvador	29	3378546	0.572	1031	1003600	6.60
Grenada	6	1125220	5.704	40	62860	24.73
Guatemala	40	3604904	0.284	2623	4800010	12.93
Guyana	7	812376	1.124	44	1016974	52.99
Haiti	61	1964353	0.959	7361	3769392	15.22
Honduras	39	6507194	1.425	15539	3456558	17.79
Jamaica	24	4127869	1.111	157	2062346	30.87
Mexico	124	34816774	0.114	3490	13487531	4.59
Nicaragua	40	3265089	1.222	4075	2740625	18.78
Panama	29	368307	0.037	145	250887	2.71
Paraguay	20	40913.8	0.006	29	2421990	14.84
Peru	66	2842736	0.054	3631	7467837	10.24
St Kitts and Nevis	6	1024694	5.567	6	12880	9.90
St Lucia	13	2277132	7.378	87	73775	16.86
St Vincent and The Grenadines	9	105036	0.597	7	28105	10.71
Suriname	2	0	0.000	5	31548	2.44
Trinidad and Tobago	7	1445.74	0.000	8	2760	0.09
Uruguay	7	403350	0.032	14	152900	1.87
Venezuela	30	4824776	0.058	30534	659561	0.90

Source: CRED, 2014.[9]

Figure 1.
Proportional distribution of economic and humanitarian impacts of climate-related disasters between 1980 and 2013, in different LAC sub-regions

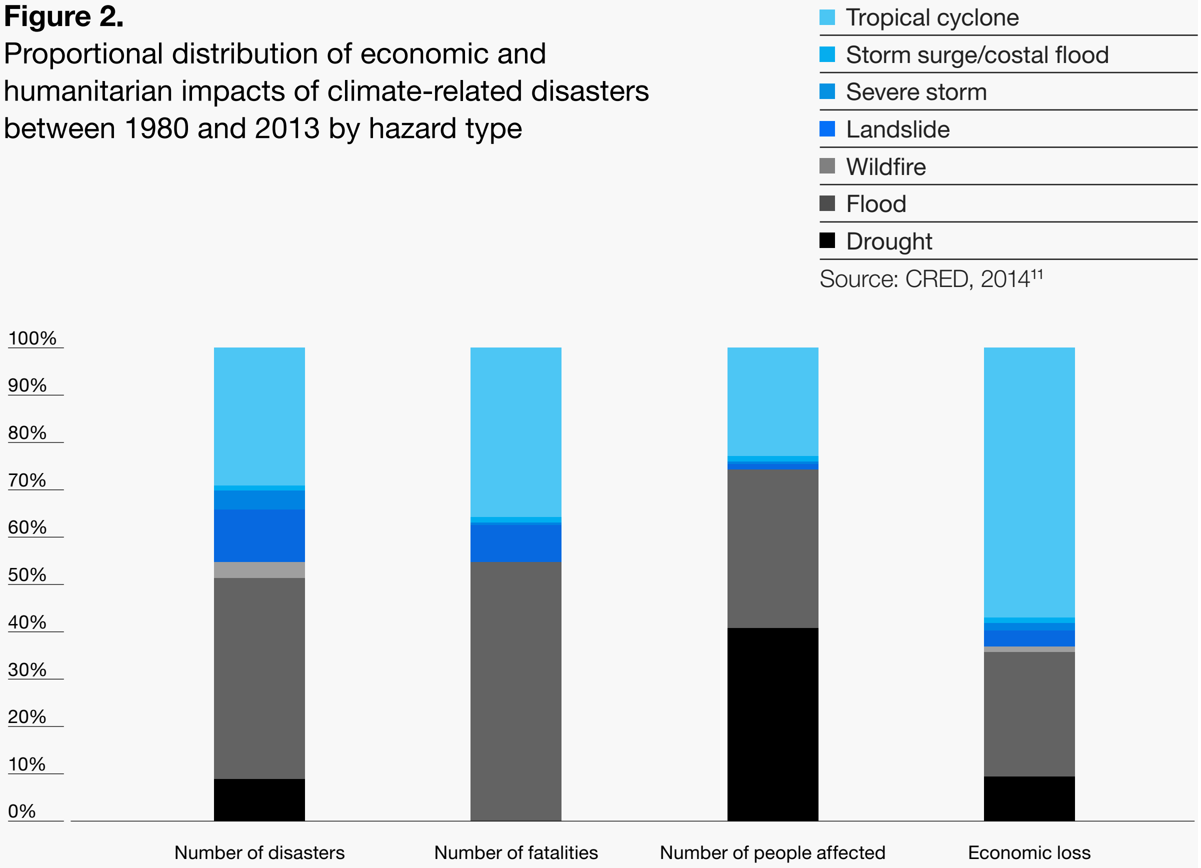
- South American
- Mesoamerican
- Caribbean

Source: CRED, 2014[10]



The nature of risk in the different sub-regions of LAC varies as a function of the exposure to different types of climate-related hazard. As shown in Figure 1, tropical cyclones, landslides, droughts and flooding are the most prevalent climate-related disasters in the LAC region, both in terms of humanitarian and economic impacts. Almost a quarter of all disasters in the LAC region between 1980 and 2013 were flood disasters in South America, which comprise more than half of that region's climate-related disasters. While floods still comprise a high proportion of disasters in Mesoamerica and the Caribbean (38% and 24% respectively), tropical cyclone is the dominant hazard type in these regions; tropical cyclones represent 64% of climate-related disasters in the Caribbean and 40% in Mesoamerica. Flooding and tropical cyclones also represent the most deadly climate-related hazards, with a combined 90% of fatalities reported in the 1980-2013 period associated with these types of hazards.

Figure 2.
Proportional distribution of economic and humanitarian impacts of climate-related disasters between 1980 and 2013 by hazard type



Source: CRED, 2014[11]

The LAC region has been subject to a number of climate-related disasters in the last three decades that have been associated with natural climate variability. Variations in temperature and precipitation patterns associated with ENSO are likely to have contributed to a number of drought and flood events. For example, the intense El Niño of 1997/1998 contributed to drought conditions in Colombia, which affected over 100,000 people and resulted in shortages of municipal water supplies, reduced agricultural output, energy shortages and forest fires. The same El Niño brought heavy rain in Ecuador, Peru and Bolivia and caused extensive flooding that destroyed thousands of homes and livelihoods.

Mesoamerica and the Caribbean lie in the storm track of both North Atlantic and eastern North Pacific tropical cyclones which is reflected by the propensity of disasters related to this hazard in those regions. Between 1980 and 2013 the Caribbean suffered 162 disasters related to tropical cyclones, while the Mesoamerica's 136 tropical cyclone disasters were associated with both North Atlantic and North Pacific systems. Among the most active North Atlantic hurricane season on record, 2005 saw Hurricanes Wilma, Stan and Emily severely impact Mesoamerica, while Hurricane Dennis affected over 2 million people in Cuba and resulted in economic losses in excess of US$2 billion.[12] Hurricane Stan, which made landfall in Guatemala resulted in over 1500 deaths, and affected nearly 0.5 million people, as torrential rainfall sparked flooding and landslides in many parts of the country.[13]

Drought is one of the most prevalent climate-related hazards to impact countries in the LAC region. Since 1980 droughts have affected more people in the region than any other climate-related disaster. Of the 33 countries in the LAC region, more (26) have experienced a drought than any other climate-related disaster in the 1980-2013 period. The combination of drought conditions and a reliance on hydropower can have substantial economic implications. During the Brazilian drought of 2000-2001, when hydropower contributed 90% of the country's electricity, the government enforced energy quotas to reduce consumption. This subsequently impacted operational capacity in many of Brazil industrial sectors and is estimated to have reduced the country's GDP by 1.5%.[14] Growing population, agricultural activities and hydropower demands have resulted in attention being focussed on water availability in many countries. Managing drought risk requires an understanding of the current climate variability as well as the potential impacts of future climate change, and is often hampered by a lack of reliable and long-term records of climate data in this region.

2.4.2 Climate change impacts in the LAC region

Sea level rise poses a significant risk to several LAC nations

Scientific consensus suggests that the rate of sea level rise (SLR) will increase during the 21st century regardless of which emissions scenario is considered. Ocean warming and mass loss from glaciers and sea ice will drive the upward trend in global sea level, with predictions in the range of 0.32 to 0.63m for RCP4.5, but up to 0.98m under RCP8.5, by the end of the century. However, there will be regional variations in the global rise, with projections under RCP4.5 suggesting increases between 0.5-0.6m for the Caribbean and along the Atlantic coast of Mesoamerica and South America as far south as central Brazil. Meanwhile, sea level rise in the eastern pacific is likely to be slightly lower at 0.4-0.5m by 2100. [15]

Rising sea levels are likely to have significant impacts in low lying coastal regions, affecting infrastructure, agriculture, tourism, water supplies and local ecosystems. SLR not only poses the direct threat of inundation, but exacerbates the risks posed by storm surges and high energy waves. Even small increases in sea level can increase the severity of the impact of storm surges to a much greater degree.[16] Saltwater intrusion associated with sea level rise also presents significant threats, and can further exacerbate the effects of drought on freshwater shortages. Degraded ecosystems as a result of SLR, temperature increase and increasing ocean acidity will have detrimental impacts on sectors reliant upon them, as well damaging natural defences to coastal flooding. While coral reefs are considered to be a critical component of the ecosystem, and particular important for fisheries, reefs also provide a natural defence system against storm surges.

Case study

Sea level rise presents a severe economic threat to Jamaica

Jamaica is highly exposed to the projected impacts of sea level rise (SLR) and ocean acidification. A large proportion of the country's infrastructure, industrial activity and population are located close to the coast. Key sectors such as tourism and fishing are dependent on a healthy marine environment. IPCC predictions of Caribbean mean SLR vary between 0.13m and 0.56m for 2100 relative to 1980-1999 reference period.[17] However, separate research has predicted SLR of up to 1.45m for the Caribbean, suggesting that the information from the IPCC is too conservative.[18]

A 2005 study estimated that it would cost US$426 million to protect Jamaica's coast from a one-metre SLR, equivalent to 19% of the country's GDP at the time.[19] More recent studies have highlighted the economic importance of Jamaica's marine infrastructure. For example, joint research undertaken by Caribbean and US-based organisations found that the loss of coral reefs - as a result of human activities and climate change (warming seas and ocean acidification) – could result in US$23 million in lost tourism revenue and undermine the livelihoods of 15,000 to 20,000 fishermen.[20]

As yet, current estimates of the full potential economic costs of sea level rise and ocean acidification to the Jamaican economy are not available. These costs would help demonstrate pressing challenges such as: the annual loss of 100 million cubic meters of groundwater (10% of local supply) due to sea water intrusion; the retreat of beaches at approximately 100 times the rate of SLR; the potential displacement of the large proportion of the population (25%) located close to the coast; and the impact of increased coastal flooding on port facilities, transport networks and tourist centres.[21]

The risks facing Jamaica as a result of sea level rise and ocean acidification are shared across many Caribbean island nations. Therefore urgent investments to help protect critical economic and environmental assets are likely to help safeguard against future economic losses.

Historic changes in sea level in the LAC region vary considerably, with the short term trend heavily influenced by ENSO and the Pacific Decadal Oscillation. Many of the western Caribbean nations have seen little to no change in local sea level over the period 1993-2012, while a decrease of up to 4mm per year has been measured along the Pacific coastline of Mesoamerican countries and northern South America. [22] In the 20 year period 1993-2012 the greatest sea level change in the LAC region has been experienced by in the South Atlantic; a 2-4mm per year increase has been observed from Colombia to central Brazil. SLR in some areas in the South Atlantic offshore of Uruguay and Argentina has been among the greatest globally with satellite measurements suggesting increases in excess of 20cm since 1993.[23] Indeed Buenos Aires, Argentina, and Montevideo, Uruguay, have witnessed significant increases in sea level exceeding 10cm over the last century.[24]

ENSO is a major factor in short-term (years) trends in sea level rise, while the Pacific Decadal Oscillation (PDO) exhibits influence on decadal trends. El Niño's anomalously warm waters in the eastern Pacific result in thermal expansion and subsequently sea level along the Pacific coastline of the Central and South America is elevated during these events. Conversely during La Niña, sea levels are observed to drop slightly. The 20-30-year variability of the PDO influences ocean temperatures in the Pacific, with the negative phase associated with cooler than normal water in the central and eastern Pacific, which promotes lower than average sea levels along the Pacific coast of Central and South America. The current negative phase, which commenced around 2000 correlates with the recent observed decrease in sea levels along the Pacific coasts of Central and South America. It is therefore important to consider that any future climate change driven sea level rise in the LAC region will be superimposed upon the natural variability.

Many of the Caribbean nations are highly sensitive to sea level rise due to their relief and relative length of coastline compared with land area. Of the countries with the greatest proportion of land below 5m in elevation in the region, nine of the top 10 (see Table 3) are found in the Caribbean - Belize being the exception. Countries with a greater proportion of land at low elevations are more susceptible to changes in sea level, while those with large populations in those zones may face significant impacts from future sea level rise.

Table 3.
Top 10 countries with the greatest proportion of land area under 5 metres elevation in the LAC region and proportion of population living in that area

Countries	Land area below 5 m (%)	Population living below 5m (%)
Bahamas	72.0	46.5
Antigua and Barbuda	32.4	32.3
Saint Vincent and The Grenadines	22.0	22.0
Grenada	21.7	21.7
Saint Kitts and Nevis	19.0	22.1
Barbados	15.7	15.7
Cuba	12.7	10.0
Belize	9.5	15.8
Dominica	9.4	10.4
Saint Lucia	8.0	8.0

Source: World Bank, 2014

While the correlation between the population living below 5m and the proportional of land area below 5m, shown in Table 3, is strong, the primary outliers in the LAC region are in South America: 68% of Suriname's population and 31% of Guyana's population live below 5m, despite only 3.45% and 2.7% of the land areas of those respective countries lying below this elevation. The majority of Suriname's population live in coastal zones that are susceptible to SLR. In recent years Suriname has experienced coastal erosion and coastal inundation that has caused damage to infrastructure, agriculture and ecosystems. Meanwhile, many parts of Guyana's capital, Georgetown, lie below sea level which has contributed to a significant number of flood events in the city's history. The January 2005 flood - which was caused by heavy rainfall and resulted in an economic losses equivalent to 59% of the GDP - may have been exacerbated by recent SLR which effectively caused water to backup upstream.[25]

There is a degree of variability in the geology of the Caribbean nations than also contributes to their vulnerability to SLR. The islands of The Bahamas, the Grenadines and Barbuda, which are mostly low lying and comprised of coral reefs, are threatened by erosion and retreat of mangroves and the potential intrusion of saltwater into the shallow groundwater lens. Meanwhile, the volcanic islands of Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Dominica have narrower coastal zones, with SLR contributing to beach erosion and localised landslides. Haiti, Barbados, Jamaica and Trinidad and Tobago have more varied coastlines, with combinations of wide coastal plains and steep, volcanic cliffs, and therefore the threat of sea level rise is more localised.

On almost every Caribbean Island critical economic activity and infrastructure, such as tourist resorts, roads and international airports, are located in coastal regions susceptible to SLR. Many of the communities, infrastructure and facilities in the Caribbean nations are located within 1.5km of the shoreline.[26] A recent study further highlighted the vulnerability of the tourism industry, a critical component of the economy of these nations, demonstrating that a 1m rise in sea level would result in more than 5% of the major resorts in each of Antigua and Barbuda, Barbados, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, The Bahamas and Trinidad and Tobago being inundated - Saint Kitts and Nevis (64%) and Haiti (46%) were found to be most at risk.[27]

Future tropical cyclones track and intensity changes are highly uncertain

Potential changes in the track, intensity and/or frequency of tropical storms and cyclones have significant implications for many Caribbean and Mesoamerican nations. While the tropical cyclones may bring destructive winds and heavy rainfall that can spark flooding and landslides, rainfall during the tropical storm season is a critical component of renewing water resources in many areas. For example, approximately half the annual rainfall in Baja California Sur, Mexico, is associated with tropical cyclones.[28] Many of the Caribbean nations are particularly exposed to tropical cyclones, with those north of Saint Lucia lying closer to the main North Atlantic hurricane track. Haiti, Dominican Republic, Cuba and Jamaica are at higher risk of being impacted by tropical cyclones, each having been affected by one tropical cyclone a year since 1980 on average.

Future projections of the temporal and spatial variability of tropical cyclones, and their intensity in the tropical Atlantic and Eastern North Pacific, suggest an overall decrease in the frequency of tropical cyclones, but an increase in their intensity. Evidence suggests that the combination of increasing wind shear over the tropical Atlantic Ocean and East Pacific and increasing sea surface temperatures will combine to have the effect of lowering the annual frequency of tropical cyclones in this region but increasing their intensity.[29] Greater confidence may be placed in North Atlantic tropical cyclone projections, with a significant increase in the frequency of the most intense tropical cyclones (categories 4 and 5) of up to 200% by the end of the 21st Century simulated by some models.[30] As in the North Atlantic, the total annual frequency of tropical cyclones forming in the Eastern North Pacific is projected to decrease by approximately 10-15%.[31]

Tropical cyclones are dependent on the sea surface temperatures, which are expected to continue to rise throughout the 21st century. While global sea surface temperatures have risen by almost 0.4˚C since 1980, sea surface temperatures in the wider Caribbean have risen by 0.7˚C since 1985.[32,33] Warming of up to 1.5˚C has been experienced in some locations of the Caribbean Sea, with regions north of Venezuela exhibiting the greatest temperature increase.[34] Warming rates have been slightly less in the main tropical cyclone path, varying between 1˚C around Dominica and 0.5˚C around Cuba. [35] Atlantic sea surface temperatures along the Mesoamerican coast have risen at more moderate rates since 1985, with values typically between 0.5 and 0.7˚C.[36]

Tropical cyclones typically require a minimum sea surface temperature of 26˚C in order to form or sustain development.[37] Therefore, the observed increase in sea surface temperatures in the Caribbean region over the last three decades acts to extend the period of the year during which tropical cyclones may form, but also the geographic extent in which they may form. Future projections suggest sea surface temperatures will continue to rise at similar rates, with upper estimates suggesting increases of up to 2˚C in the Caribbean Sea by the end of the 21st century.[38] Upward trends such as this will promote tropical cyclone development, but must be factored against future changes in other components affecting tropical cyclone development in this region. Another component of tropical cyclone development is the wind conditions in the upper reaches of the troposphere (typically around 15km in the tropics). Wind shear (the variation in wind speed with height) acts to pull apart developing systems and inhibits tropical cyclone formation and intensification. Evidence suggests that wind shear over the tropical Atlantic and East Pacific may increase during the 21st Century.[39] The increase in wind shear over these regions is a common feature of many future climate simulations; however the impact of increased wind shear on future tropical cyclone frequency and intensity has not been quantified.

The changing temperature regime of the LAC region

Despite regional variations in historic temperature trends, the LAC region has undergone significant warming in the last 30 years. Since the early 1980s, with the exception of coastal parts of Peru and Chile the whole LAC region has undergone a warming of 0.3˚C to 1.5˚C, with the greatest increases in temperature having occurred over northern parts of South America.[40] A localised cooling of roughly 1˚C has been observed in coastal regions stretching from central Peru to central Chile over the past 30-50 years.[41,42] This is linked to the increased coastal upwelling bringing cooler water to the surface along the coastline, linked to an intensification of the trade winds in the region.

Future climate projections suggest a broad pattern of warming across the LAC region of 1-2˚C by mid-21st century, with slower rates of warming predicted over Argentina, Uruguay and Chile.[43] A large degree of spatial correlation exists in the projected temperatures increases in Mesoamerica and the Caribbean, which suggests temperature increases will be greater in summer than winter, and higher over Mesoamerica than the Caribbean. While a winter (December-February) warming of 1-1.5˚C is simulated for most of this region by mid-21st century, parts of northern Mexico may experience a warming of up to 2˚C.[44] Modelled increases in future temperatures tend to be slightly greater in summer (June-August) than winter in this region, especially Mexico, where projected summer temperatures increase by 1.5-2˚C in most areas by mid-21st century.[45]

December to February temperature increases of 1.5-2˚C are projected for the Amazon and northeast Brazil regions by mid-21st century. Greater increases are simulated for the June-August period, with central parts of the Amazon predicted to experience increases in the range 2-3˚C in the same timeframe. For a high emissions pathway, climate models suggest the temperature increase from the equator to as far south as Paraguay may be as much as 5˚C by the end of the century, which would have significant negative impacts on important ecosystems in this region.[46] Temperatures over southern South America are expected to increase more in the South American summer (December-February) than winter (June-August). Projections indicate that temperatures may rise by up to 1.5˚C by mid-21st century over most of southern South America in the months December to February, while the Andes could experience a 1.5-2˚C rise.[47]

Across the LAC region the frequency of high extreme temperatures is projected to increase, while the frequency of low extreme temperatures is projected to decrease. This is consistent with observed trends in recent decades which show an increase in hot days and warm nights and decreases in cold nights and cool days in Mesoamerica, northern South America, northeast Brazil, and southeastern South America.[48] An observed warming over the La Plata basin in the southeast of South America has manifest in an increasing trend in the number of warm nights (up to 6% more frequent) and minimum temperatures over the last 40 years.[49] Meanwhile, the Caribbean region demonstrates the greatest projected increase in "hot days", while greatest increase in the incidence of "warm nights" is estimated to be in tropical South America. Changes in extreme temperatures in the LAC region will likely be more significant for some sectors than changes in mean temperatures. Increases in the frequency of higher extreme temperatures can lead to longer lasting heatwaves, which can have negative impacts on human health, while increases in the frequency of lower extreme temperatures can decrease growing season length and negatively impact the agricultural sector.

Rising temperatures will continue to promote glacial retreat with subsequent impacts on water supply

The IPCC reports that Andean inter-tropical glaciers are very likely to disappear in the coming decades, which will negatively impact water availability in many South American countries. A warming of approximately 0.1˚C per decade has occurred over much of South America since 1960, contributing to the intensifying rate of glacial retreat.[50] The warming trend is expected to continue, as is the glacial retreat, affecting water supply in many countries, including Bolivia, Peru, Colombia and Ecuador. Pressure on water resources in these countries is already high, with high demand for domestic consumption, agriculture and hydropower. Therefore any future changes in the hydrological cycle in these areas will have significant implications for these countries.

Glacial retreat in the last three decades in the tropical Andes is occurring at the fastest rate since the Little Ice Age maximum in the late 1600s.[51] Given their location in the tropics, melting occurs year round at the lower parts of the glacier and results in a high sensitivity to changes in temperature. Eight glaciers disappeared in the 20th century in Colombia, while the remaining glacial surface area has been estimated at 47km^2 in 2007, with a loss rate of 3.0km^2 per year.[52] Peru's Cordillera Blanca, the world's most densely glacier-covered mountain range, has seen a decrease in glacier coverage exceeding 10% since 1970.[53] Meanwhile the Chacaltaya glacier in Bolivia's Cordillera Real disappeared completely in 2009, with a 48% decline in surface area in glaciers in the mountain range overall estimated between 1975 and 2006.[54]

In addition to global increases in temperature, the greater frequency of El Niño in recent decades has contributed to rapid glacial retreat. El Niño promotes the intensification of the westerly flow aloft over the Andes, which prevents the advection of moisture from the Amazon basin and results in anomalously low precipitation in the tropical Andes.[55] In conjunction, higher temperatures than normal are experienced during El Niño. While precipitation trends are difficult to identify in the tropical Andes, a slight increase has been shown in the second half of the 20th century in Ecuador and northern/central Peru, while southern Peru and Bolivia a decreasing trend is suggested.[56] However, the contribution to glacial melt by the rise in temperature in this region far outweighs changes related to long-term trends in precipitation.

The ongoing glacial retreat will be increasingly problematic for populations dependent upon water sources from glacial catchments, especially in Peru and Bolivia. Glaciers play a critical role as buffers against seasonal precipitation variations, stored wet season snowfall as ice, and providing a dry season baseflow downstream. Many arid regions to the west of the Andes are fed by glacier meltwater, which is especially important as these locations are subject to substantial seasonal variations in precipitation with the dry season (between May/June and September/October) typically bearing little or rain. Therefore, the supply of water from glacial catchments is particularly important at this time of year. For instance La Paz, Bolivia, typically receives less than 20mm or rainfall per month between May and August and relies on the Antizana and Cotopaxi glacier catchments for 30% of its water supply.[57] As glaciers retreat, crops have been replanted at higher elevations in order that they may be irrigated by glacial water, but the yields have suffered due to the poorer soil qualities at these higher elevations.

Future glacial retreat will modify runoff behaviour in the tropical Andes, reducing the dry season water supply downstream and concentrating the runoff in the wet season. These combined impacts will increase the seasonality of water supply and will likely increase the risk of flooding in the wet season and droughts in the dry season in these areas. Growing water demand for domestic and agricultural use, hydropower production and mining operations combined with a changing seasonality of streamflow will likely combine to increase pressure on water resources. Many glaciers in the tropical Andes are already undergoing decreases in their volume resulting in recent observations of increased runoff during the dry season in several watersheds.[58] In these situations growing populations that are reliant on the recent increased dry season water supply face an unsustainable situation; as the glacial volume decreases, dry season runoff will also decrease, potentially leaving communities facing water deficits.

The direct impact of retreating glaciers on water supply is dependent on the location of the community relative to the glacier. The contribution to streamflow of glacial melt decreases with increasing distance from the glacier itself. As a result, glacial retreat may have greater impacts on countries such as Bolivia and Peru, whose dry season rainfall is minimal, than Ecuador or Colombia, whose rainfall is more evenly distributed throughout the year,

Decreasing trend in Mesoamerica and Caribbean rainfall set to continue

The decline in rainfall in Mesoamerica and the Caribbean in recent decades is likely to continue in the future. The majority of rainfall in most countries in Mesoamerica and the Caribbean occurs between April and September, and therefore relative changes in rainfall in these months may have significant impacts. In recent decades the overall drying trend is most evident in the summer months between June and August, with summer rainfall in the some parts of the eastern Caribbean and Mesoamerica estimated to have decreased by as much as 30% since the mid-20th century.[59] This observed drying trend is likely to continue in future, with decreases in rainfall projected for both the April-September (wet season) and October-March (dry season) periods. Projections of rainfall suggest decreases in October-March rainfall of up to 10% by mid-21st century for Mesoamerica and southern parts of the Caribbean. Meanwhile, projections for northern parts of the Caribbean, including Jamaica, Cuba and The Bahamas, suggest an increase in October-March rainfall of up to 10% in the same timeframe.

Wet season rainfall in the Mesoamerica and the Caribbean is expected to continue to decrease over the course of the 21st century. All countries in this region are projected to receive up to 10% less rainfall in the April-September period by mid-21st century, while many Caribbean nations south of Cuba face decreases of up to 20%.[60] Annual rainfall in the Caribbean exhibits a peak in May and a secondary maximum in September-October. The reduced rainfall in July-August is associated with the peak in the intensity of the Caribbean Low-Level Jet.[61] Under future climate simulations the strength of the Caribbean Low-Level Jet is shown to increase between May and November, and is likely one of the drivers behind the projected reduction in rainfall in the Caribbean at this time of the year.[62]

The sea surface temperature threshold for convection (26.5˚C) is a critical factor than governs the start of the wet season for the Caribbean islands. Historically, this threshold is crossed around March-April in the central Caribbean, but not until May-June around the Bahamas. The greatest sea surface temperature warming in the Caribbean is likely to occur in March-June and be focussed in the northeast of the region.[63] This increase in sea surface temperatures earlier in the year may result in an earlier onset of the wet season for the nations such as the Bahamas and Cuba.

Parts of Mesoamerica and Mexico in particular are heavily reliant on the rainfall associated with the North American monsoon system (NAMS). The NAMS strongly influences warm season rainfall in this region, with some evidence suggesting an increase in intensity and decrease in frequency of events over the last 40 years.[64] Greater variability in the monsoon system will affect precipitation extremes and subsequent increase the flood and drought risk in those areas. While there is much uncertainty surrounding the impact of climate change on the NAMS, climate models simulations suggest a slight decrease in monsoonal rainfall.[65] However, no robust findings regarding changes in the timing of the monsoon have been identified.[66]

Greater variability in South American precipitation impacts flooding and droughts

Interannual variability of rainfall in northern parts of South America is strongly linked to ENSO. A decreasing trend in rainfall has been identified for the Amazon basin as a whole since 1950, with the decrease in rainfall in the 1975-1998 period strongly linked to the more frequent and intense El Niño events experienced in that period.[67] These trends emphasise the decadal variability in rainfall in this region and its strong link to ENSO. Therefore any future changes in ENSO variability will have significant impacts on the future variability of rainfall in the Amazon basin. Elsewhere, droughts in northeast Brazil are often associated with El Niño (for example the droughts of 1983, 1987 and 1998). However it is important to note that not all El Niño events result in drought, and in fact the 2013 drought occurred in a period when ENSO was in a near neutral phase.

Variability in extreme precipitation has increased in parts of South America over the last 60 years, with future variability likely to affect flood and drought risk. Two extreme climate-related events occurred simultaneously in 2012, with the heavy rainfall and flooding in Amazonia and drought in northeast Brazil both considered among the most severe in the last 50 years. The impacts of these events highlight the importance of considering not just changes in the mean climate, but also changes in the extremes. Warm season precipitation is associated with the South American monsoon system (SAMS), the onset of which follows a northwest path, typically beginning in the highlands of Brazil in October and propagating northwards, and affecting most South American countries located in the 0-20˚S latitude band. Since 1950 the SAMS has demonstrated a greater amplitude, including and earlier onset and later demise.[68] Extreme precipitation and the number of consecutive dry days have shown increases in the period 1969 to 2009.[69]

Climate model simulations show robust increases in the frequency and intensity of extreme rainfall events and the number of dry days associated with the SAMS.[70] An increase in the intensity of extreme precipitation events is also projected for a large swath of southeastern South America and western Amazonia, which will likely increase the risk of flooding in these areas. In contrast, heavier rainfall events are projected to be become less frequent in northern South America and eastern parts of the Amazon basin and northeast Brazil, with the increasing period between rainfall events predicted over eastern-Amazonia and northeast Brazil likely to promote more frequent drought conditions.[71]

Changes in the future annual precipitation in South America shows significant spatial variation. Northwestern parts of South America, including Ecuador, Colombia and southeastern areas including southern Brazil, Uruguay and Argentina are expected to see increases in annual precipitation. Meanwhile, Chile, southwestern Argentina and northeastern South America, including parts of Brazil, Venezuela, Guyana and Suriname are expected to become drier. Future projections of October-March precipitation suggest a drying trend through the 21st century across much of the South America north of 20˚S. Reductions of up to 20% by mid-21st century in October-March rainfall are projected for parts of Venezuela, while Colombia, Guyana and Suriname expected to see a decrease of up to 10% in that timeframe. [72] However, the majority of rainfall in South America north of the equator falls between April and September, when a more extensive drying pattern is projected, with reductions of up to 10% projected in South American countries bordering the Caribbean Sea. Given that rainfall in tropical South America (from the equator to roughly 20-25˚S) exhibits a minimum in May-September, and much of the Amazon and northeast Brazil are projected to experience a 10% decrease of April-September rainfall by mid-21st century, dry season droughts may become more prevalent in these areas. [73]

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3— Sensitivity to climate change in the LAC region

3.1 Overview

Within the LAC region, population sensitivity to climate change is driven by a number of factors which contribute to the physical, social and livelihood circumstances present within each country. Many of the Mesoamerican countries and some of the larger Caribbean island nations generally display the highest levels of sensitivity to climate change regionally, with Haiti classed as the riskiest nation overall.

High levels of poverty and inequality are key factors driving sensitivity across the LAC region, as large numbers of people are engaged in marginal, low skilled livelihoods. The significant presence of small-holder farming and subsistence production, especially within Mesoamerica and the Caribbean, elevates sensitivity in these countries as agricultural activities are particularly susceptible to changes in climate. Education levels and health status are also closely linked with poverty, as they provide an indication of prospects for socio-economic development and resilience-building. Most of the region's countries where over 10% of GDP comes from agriculture are classified by the United Nations Development Programme as having only medium levels of human development. Low literacy rates are a concern in Haiti and many Mesoamerican countries, along with high primary school drop-out rates, whereas poor quality education has been highlighted as a challenge in the Caribbean. Health is perceived as a critical aspect of vulnerability by many LAC officials, and comparative indicators of population health status highlight particular concerns in Haiti and Bolivia.

With around three quarters of the region's population concentrated in urban areas, high urbanisation rates are elevating sensitivity for low income populations within Latin American cities. The unregulated expansion of urban areas is a feature of most municipalities and has allowed many poorer groups to locate in high risk zones, such as floodplains and landslide-prone slopes. A lack of development control has also left these areas with little or no utilities infrastructure, elevating health risks for the occupants who are already vulnerable due to their socio-economic status.

High numbers of displaced persons are an additional risk driver in several South and Mesoamerican countries, most notably Colombia. These groups represent an especially vulnerable cohort within the population. The prevalence of smallholder farming across many parts of the LAC region heightens vulnerabilities associated with displacement here, as these populations often have few capital reserves or the technical capabilities needed to secure alternative livelihoods once disconnected from their land and social support networks.

Map 3.
Sensitivity Index 2014, LAC region

Climate Change Sensitivity Index 2014
Low risk — Extreme risk
No data
Data source: Maplecroft, 2014

3.2 Introduction

Population sensitivity is a complex and multi-dimensional issue

Sensitivity is a measure of the population's susceptibility to the impacts of climate change, which is a function of their existing physical, social and livelihood circumstances. The Sensitivity Index examines the current relative human sensitivity to exposure to extreme climate related events (drought, tropical storms and cyclones, wildfires, precipitation induced landslides, severe local storms, storm surge, flooding and sea-level rise) and predicted climate change. Utilising a combination of sub-national and national data, the index examines aspects of sensitivity related to health, poverty, knowledge, infrastructure, displacement, agriculture, population pressures and resource pressures.

The degree of impact experienced as a result of climate change is significantly influenced by the characteristics of the population. Sensitivity is therefore an essential component in understanding overall vulnerability. The strengths and weaknesses present in the current physical, social and livelihood circumstances of a population determine the likelihood that, and degree to which, these changes will affect the human systems in place. In combination with physical exposure to climate risks and the adaptive capacity conferred by structural factors such as governance and the economy, the sensitivity of the population indicates the overall vulnerability to climate change.

The diversity of the countries within the LAC region results in differences in the factors underlying sensitivity to climate change in various regions and environments. Circumstances range from rural populations with little access to services engaged in vulnerable, marginal livelihoods in Mesoamerica, to the unregulated expansion of densely populated, low income urban areas in hazardous slope-side locations in many Latin American cities. Sensitivity also varies for different cohorts within a population – for example, the old and marginalised or displaced members of society are often groups which experience particularly severe impacts from hydro meteorological changes, due to their typically poorer health status and lower financial resources. The profile of risks driving population sensitivity is therefore unique to each country. The underlying drivers of sensitivity cannot be viewed in isolation from each other as sensitivity is a function of cumulative circumstances. For example, countries with high rates of poverty, high levels of agriculture-based livelihoods and low adult literacy rates face different prospects and challenges for capacity building and socio-economic development in the face of climate change than countries with high population densities but good access to sanitation and low levels of water stress.

Decreasing sensitivity builds resilience and increases the likelihood that people will be able to successfully respond to the changes in climate predicted. Sensitivity is very closely linked with adaptive capacity: decreasing a population's sensitivity by addressing the component factors which confer vulnerability to climate change is often a function of the ability of wider macro and institutional capabilities within a country. However, capacity-building can also be community led. By taking a pro-active role with regard to the potential impacts of climate change through, for example, improvements to health behaviours, increased education and awareness, and livelihood diversification, populations have the ability to decrease their sensitivity, and by so doing, mitigate both short- and long-term impacts from predicted climate change.

3.3 Results

Extreme population sensitivity concentrated in the Caribbean and Mesoamerica

Caribbean and Mesoamerican nations dominate the top ten positions and exhibit the greatest relative levels of population sensitivity. This is illustrated in *Table 4: Sensitivity Index for the LAC region*, which presents the national-level rankings, scores and risk categories for this dimension of vulnerability. **Haiti** (1st) is classified as having the highest sensitivity to climate change within the LAC region (where lower scores equate to greater risks). This reflects its history of social unrest, the repeated impacts to the economy, infrastructure and livelihoods from natural hazards, environmental degradation and high levels of poverty., All of these factors have combined to leave little chance for the population to build capacity and secure improved status in health, wellbeing, education levels and livelihoods assets which characterise resilience.

Other Caribbean island nations appear in the top ten rankings for the Sensitivity Index, including the **Dominican Republic** (2nd) and **Jamaica** (6th), which are both classified as 'extreme risk', and **Cuba** (8th) and **Barbados** (9th), which are both classified as 'high risk'. It is notable that, which the exception of Barbados, it is the larger islands which exhibit higher population sensitivity relative to the smaller nations within this sub-region. **El Salvador**, **Guatemala**, **Nicaragua**, and **Honduras** occupy the 3rd, 4th, 5th and 7th positions respectively, emphasising vulnerable conditions within the populations in much of Mesoamerica. Despite appearing outside of the top ten, **Costa Rica** (14th) and **Panama** (17th) are also classified as 'high risk' for sensitivity to climate change. **Ecuador** (10th) is assessed as the highest risk South American country for sensitivity to climate change.

Table 4.
Sensitivity Index for the LAC region

Country	Rank	Score	Category
Haiti	1	0.22	extreme
Dominican Republic	2	0.76	extreme
El Slavador	3	0.93	extreme
Guatemala	4	1.38	extreme
Nicaragua	5	2.01	extreme
Jamaica	6	2.11	extreme
Honduras	7	2.43	extreme
Cuba	8	3.15	high
Barbados	9	3.30	high
Ecuador	10	3.47	high
Colombia	11	3.72	high
Paraguay	12	3.90	high
Greneda	13	4.12	high
Costa Rica	14	4.22	high
Peru	15	4.50	high
Bolivia	16	4.58	high
Panama	17	4.61	high
Saint Vincent and The Grenadines	18	4.69	high
Mexico	19	5.32	medium
Saint Lucia	20	5.45	medium
Trinidad and Tobago	21	5.75	medium
Venezuela	22	6.25	medium
Brazil	23	6.32	medium
Guyana	24	7.17	medium
Argentina	25	7.22	medium
Belize	26	7.81	low
Antigua and Barbuda	27	7.98	low
Chile	28	8.04	low
Dominica	29	8.50	low
Uruguay	30	8.61	low
Saint Kitts and Nevis	31	8.68	low
Suriname	32	8.89	low
Bahamas	33	8.89	low

Many smaller Caribbean countries, along with smaller South American states such as **Guyana** (24th) and **Suriname** (32nd) are classified as 'medium' or 'low' risk countries for sensitivity to climate change, which is partially a function of their lower populations relative to other countries in the region. The comparatively less advanced South American nations – **Colombia** (11th), **Paraguay** (12th), **Peru** (15th) and **Bolivia** (16th) – are all classified as 'high risk' for population sensitivity, whereas the comparatively more developed nations of **Brazil** (23rd), **Argentina** (25th), **Chile** (28th) and **Uruguay** (30th) are 'medium' or 'low' risk.

The following section highlights some of the key factors driving population sensitivity within the LAC region. This is not an exhaustive review, but aims to demonstrate how sensitivity risks are derived from multiple components of societal and physical circumstances and which may bear consideration as distinct issues in their own right.

3.4 Key drivers of sensitivity

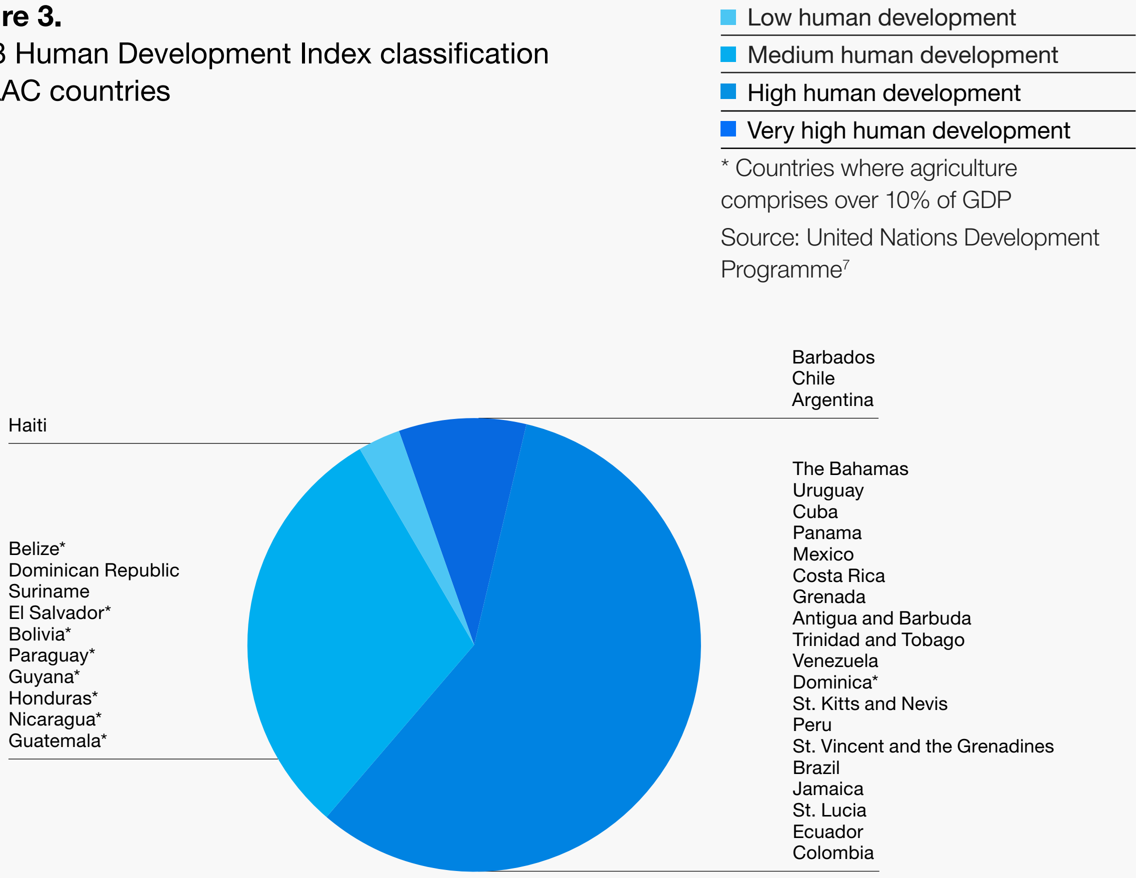
3.4.1 Poverty, inequality and livelihoods

Poverty, inequality and sensitive livelihoods are prevalent climate risk drivers in many parts of the region

Poorer members of society have fewer resources to adapt to the implications of a changing climate and are likely to have less access to information to build capacity. Low-income households are often engaged in marginal livelihoods which are most exposed to the impacts of climate change, such as agriculture and fishing. With little capital to insulate from external shocks, this status presents a perpetuating cycle from which it is very difficult to improve socio-economic prospects. Those with higher incomes and more substantial assets are generally more likely to be more resilient to the effects of climate change due to the extent and nature of the resources which they are able to employ.[1] In addition, higher income households generally tend to be located in relatively less hazardous areas, particularly within urban zones, and are more likely to reside in dwellings with higher structural integrity which are better able to withstand high winds and intense precipitation.

Poverty is a critical development issue for the LAC region and a substantial driver of increased sensitivity to

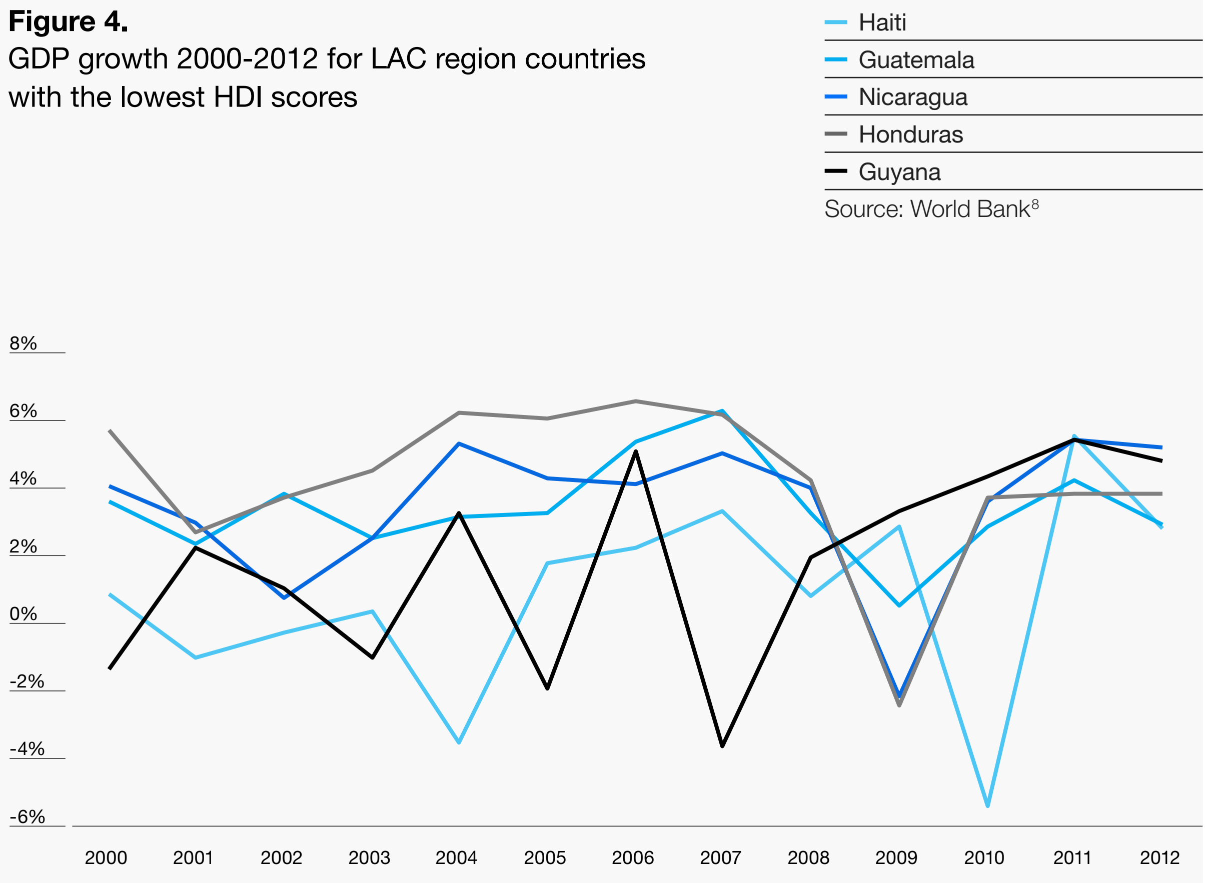
Figure 3.
2013 Human Development Index classification for LAC countries



climate change. In 2012, 11.3% of the LAC population, around 66 million people, were living in extreme poverty.[2] Poverty in the LAC region is linked with a diverse range of factors including marginal livelihoods, income inequality, social segregation, land rights issues and low government capacity to address the problem. Perversely, growth in the agricultural sector for the region as a whole has not driven a significant reduction in rural poverty,[3] which is partially due to the region's high inequality which is especially pronounced in rural areas.[4] Urban poverty in the region is characterised by unemployment, as these populations are typically more integrated with the market economy, and resultant sensitivity to price fluctuations. Pronounced social exclusion within cities also limits access to educational opportunities and jobs for low income groups.[5]

Poverty is linked with the low overall levels of human development in much of the region, which in turn is connected to the presence of agricultural economies. The United Nations Development Programme's (UNDP) Human Development Index (HDI) is a statistical measure of overall social and economic progress at the national level, encapsulating elements of health, education and income.[6] Haiti, classified as the highest risk country in the Sensitivity Index, is the only LAC nation classified as exhibiting low human development, but it is notable that all of the countries where agriculture comprises 10% or more of GDP are classified as having only medium human development, with the exception of Dominica which is high (See *Figure 3: 2013 Human Development Index Classification for LAC Countries*).

Figure 4.
GDP growth 2000-2012 for LAC region countries with the lowest HDI scores



Source: World Bank[8]

Prospects are poor for achieving socio-economic improvement in the volatile economic environments of countries with low HDI scores. *Figure 4: GDP growth 2000-2012 for LAC countries with the lowest HDI scores* demonstrates the volatility of economic progress in these countries. The figure reveals a stark absence of sustained, positive growth and every country with the exception of Guatemala has experienced at least one year of negative GDP growth since 2000. It is of note that the countries with the five lowest HDI scores are also classified as the top 5 riskiest countries in the Adaptive Capacity Index, indicating the strength of the influence of institutional and macro-level factors on socio-economic development. This emphasises the importance of building capacities within communities to reduce their reliance on governments to help them cope with the consequences of climate change.

Although Latin America as a region has experienced a reduction in poverty and inequality in the past decade, this is emerging as an uneven trend and levels remain high in many areas. A 2011 World Bank report asserts that income inequality reduction in Latin America is largely a result of the expansion of the middle class in more developed South American countries and the share of income for the extreme poor within Latin America has not changed significantly.[9] In comparison with developed nations, inequality in Latin America remains high. The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) report that the rate of poverty reduction is decreasing across the region and poverty levels in many countries, such as Costa Rica, the Dominican Republic and El Salvador, remain broadly stable.[10]

The latest figures available for Honduras and El Salvador indicate that in 2009, 29.8% and 16.9% of their populations respectively lived on less than US$2 per day.[11] The most recent data available for Guatemala (2006) indicates a rate of 26.3% and 31.7% for Nicaragua (2005).[12] Costa Rica is the notable exception for this region, with only 5.97% of the population living on less than US$2 per day in 2009.[13] Chile and Uruguay are classed as the only 'high income' countries in the LAC region in the World Bank's 2014 World Development Report,[14] and of the South American nations, these two countries and Argentina stand out as exceptions to the generally high levels of poverty exhibited elsewhere across the continent.[15]

High levels of poverty in Caribbean nations a persistent and complex problem

Poverty has been a significant issue for many small island economies in the Caribbean for many years, and seems likely to persist despite efforts to address this. The root causes of poverty in the Caribbean are complex and include poor human capacity development, unsuitable development policies, low levels of economic growth, low wages and an associated low skills base.[16] This situation is compounded by high levels of unemployment[17] and significant rural populations on many islands with poor access to services and education.[18] Other nation-specific issues, such as natural hazard impacts in Haiti, the Dominican Republic, Dominica and St. Kitts and Nevis, and political unrest in Haiti, also contribute to perpetuating poverty.

The persistence of this issue is revealed in assessments of progress towards the Millennium Development Goals (MDGs). Antigua and Barbuda's 2009 report on progress indicated that efforts to halve the proportion of the population living below the poverty line by 2015 were unlikely to succeed.[19] A similar report for Grenada in 2013 also concluded that the country was not on track to achieve this goal.[20] Saint Lucia's 2008 MDG report indicates that national poverty levels rose between 1995 and 2005 despite the implementation of programmes to address this problem.[21]

Obtaining current and comparable data on poverty incidence and the economic situation of the populations in Caribbean island nations is difficult, compounding challenges in establishing sensitivity. Most figures on poverty available in ECLAC and Caribbean Community and Common Market (CARICOM) reports date from at least 10 years ago and are often based on information from the 1990's (see *Table 5: Available data on national poverty rates for Caribbean nations*). The absence of accurate information on socio-economic circumstances across the sub-region exacerbates sensitivity to climate change for these nations, in part because it undermines policy formulation and prevents the compilation of a consistent picture of population status.

Table 5.
Available data on national poverty rates for Caribbean nations

Caribbean countries	National poverty rate (year of data)
Haiti	75% (2001)[b]
Dominica	39% (2002)[b]
St. Vincent and the Grenadines	37.5% (1996)[b]
Grenada	37.7% (unknown)[a]
St. Kitts and Nevis	St Kitts, 27%; Nevis 15.9% (unknown)[a]
St. Lucia	28.8% (unknown)[a]
Antigua and Barbuda	18.4% (unknown)[a]
Jamaica	14.5% (unknown)[a]
Trinidad and Tobago	16.7% (unknown)[a]
Barbados	13.9% (1997)[b]
The Bahamas	9% (2001)[b]
Dominican Republic	44.9% (2002)[b]

Sources: [a]Girvan, 2011 citing CARICOM, 2010[22]; [b]United Nations Economic Commission for Latin America and the Caribbean (ECLAC), 2007[23]

Poverty in the Caribbean also demonstrates a substantial gender bias which plays a significant role in perpetuating low development circumstances and has implications for efforts to address this risk driver. The UNDP's 2012 Caribbean Human Development Report highlights how poverty in the region is exacerbated by gender inequality, with women experiencing a significant proportion of poverty and unemployment, which in turn is driving the intergenerational transmission of low socio-economic status in these states.[24] In Jamaica for example, 14.6% of women are unemployed, compared to 8.6% of men.[25] Significant proportions of Caribbean women, particularly in families with female heads or in rural areas, have few employment options[26] and thus little prospect of improving their status.

Prominent agricultural sector for both incomes and subsistence exposes many to climate change impacts

Agricultural livelihoods are very important for the region but typically provide only low incomes and are particularly exposed to the effects of climate change. There are around 15 million smallholder farms in the LAC region, of which around 10 million are estimated to be subsistence enterprises which rely on non-farm sources of income to maintain their livelihoods.[27] In Mesoamerican and Caribbean countries, the prevalence of smallholder farming livelihoods is intrinsically linked to drivers of poverty such as rural isolation, lack of access to services, low education levels and poor access to credit, inputs and markets.[28] Without skills to improve employment options or capital to enhance productivity, opportunities for subsistence farmers and agricultural workers remain restricted.[29] The widespread use of traditional farming methods with limited use of inputs means that productivity for many crops is relatively low.

On many islands in the Caribbean agriculture employs between 20-30% of the workforce,[30] but crops are largely rainfed and therefore very susceptible to changes in precipitation patterns.[31] For example, agriculture comprises over 15% of Dominica's GDP but the sector is primarily composed of smallholders each farming under 10 hectares of land with minimal technological inputs.[32] In 2010, banana production on Dominica dropped by 43% from the previous year following severe drought in the region.[33]

Climate-related extreme events are likely to adversely affect production, with severe consequences for smallholders with marginal profit boundaries under normal conditions. Although some studies indicate productivity for some crops in the LAC region may improve with climate change,[34] the exposure of large parts of the LAC region to tropical cyclones (hurricanes) and other climate-related events such as drought increases the sensitivity of agricultural livelihoods. Past events have demonstrated the extent of the impacts which can be experienced.

- In September 2007, Hurricane Felix made landfall on the eastern coast of Nicaragua, significantly damaging maize, paddy crops and banana, coconut and mango trees in the area. In some locations, replanting of crops was prevented due to ongoing flooding.[35]
- In August 2007, Hurricane Dean caused up to 100% losses of both food and cash crops in Jamaica, Saint Lucia and Dominica. The Food and Agriculture Organization of the United Nations (FAO) assessed that over 90% of Dominica's banana crop was destroyed, and destruction of between 30-75% of Jamaica's crops left the country reliant on emergency food assistance and substantial quantities of imported food to meet demand.[36]
- Flooding across Bolivia's lowlands at the end of 2006 and the beginning of 2007 combined with dry and cold weather in the highlands resulted in an 11% decline in tuber and cereal production (0.7 million tonnes), and included 100% crop losses in some eastern and northern departments. Livestock farmers were also negatively affected with heavy stock losses in flooded areas.[37]
- After Hurricane Mitch swept across Mesoamerica in 1998, crop losses in Honduras alone were estimated at 58% of maize for domestic consumption and 85% and 60% of the banana and sugarcane export crops respectively. Timescales for the recovery of the agricultural sector were significantly affected by the loss of topsoil during the rains and landslides which were triggered within the slopes of coffee plantations.[38]
- Drought across the Caribbean in later 2009 and early 2010 reduced agricultural production in St. Vincent and the Grenadines by 20%, and 30% of the tomato crop was lost on Antigua and Barbuda.

3.4.2 Education

Low levels of literacy in Haiti and Mesoamerica likely to hamper resilience-building

Low education levels play a key role in perpetuating the cycle of poverty and, with respect to climate change impacts, have significant implications for efforts at capacity-building. Haiti, Belize, Guatemala, Nicaragua, El Salvador, and Honduras all have adult literacy rates below 85% in the population over 15 years of age, and in Haiti this is just 48.7%.[39] Although rates for Cuba, Barbados, Antigua and Barbuda, and Guyana are above 99%, in many other LAC countries literacy is below 95% (2011 figures).[40] This compares with rates of 99% in Canada, France, Australia and Germany.[41] An inability to read severely restricts employment prospects and skills development, and thus the potential for increased income and livelihood diversification which are important capacities for adapting to climate change.

Low literacy rates limit abilities to access information about a wide range of risk issues, from health and finances to disaster risk reduction actions. In addition, low literacy reduces the methods by which stakeholder and community engagement can occur to transfer knowledge on these risk issues, and in turn is likely to require more labour-intensive, face-to-face participation efforts. These are typically more costly initiatives, with greater funding implications.

Quality of schooling driving educational concerns for Caribbean nations

The provision of access to good quality schooling for the children of low income households has been identified by the World Bank as a priority factor for sustaining inequality reduction in the LAC region.[42] The opportunity to develop skills and access premium labour markets increases prospects for escaping the cycle of poverty. However, while education enrolment rates are high, for example in many Caribbean countries, often the quality of the schooling does not provide students with the necessary education to achieve socio-economic mobility.[43] The quality of education in the Caribbean is largely considered inadequate and is translating to high rates of unemployment amongst school leavers.[44] Problems stem from a lack of qualified teachers, as well as poor accountability within educational systems.[45]

Rural communities and the poor particularly at risk for lower educational prospects

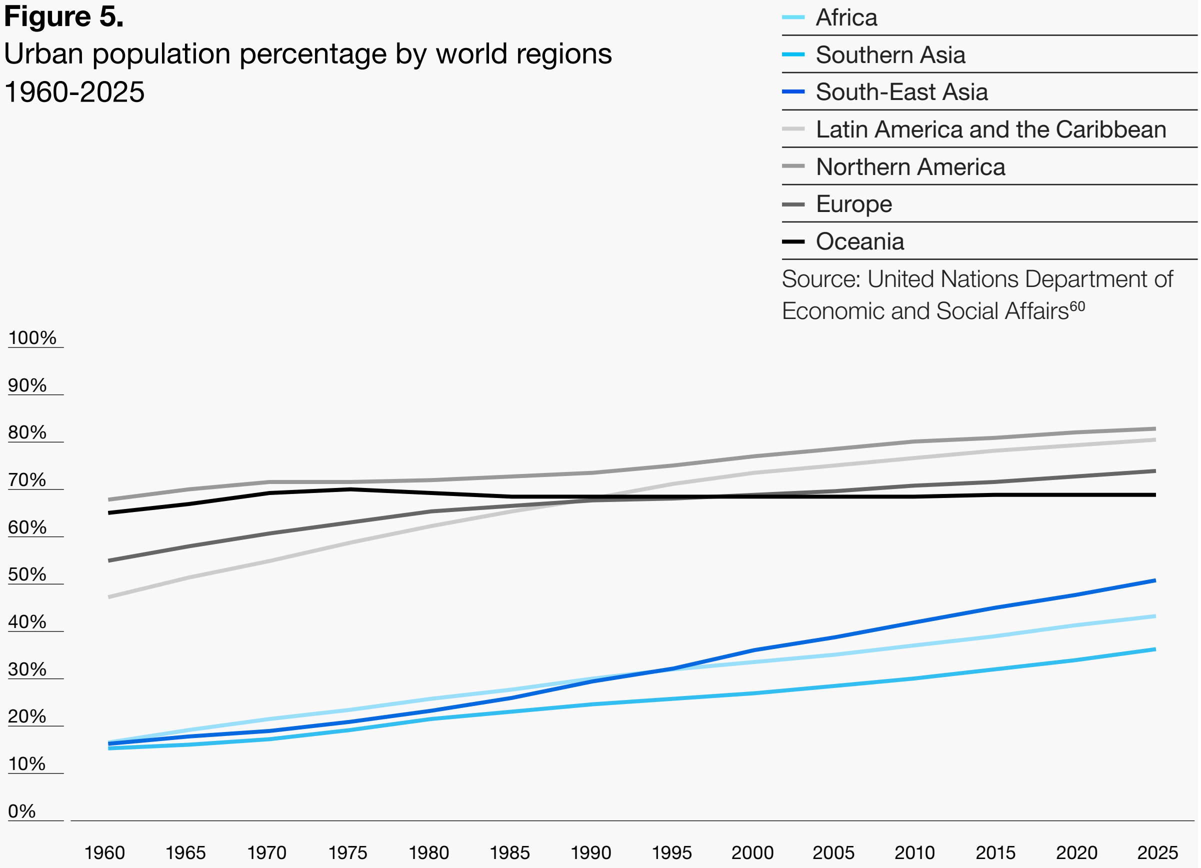
The low secondary completion rates achieved in many rural communities in the LAC region have been attributed to socio-economic status and disparities in the provision of educational opportunities. UN statistics reveal that although secondary education completion rates are slowly increasing amongst rural populations in Latin America, these remain below 80% in the 20-24 years age demographic even for more developed countries such as Chile, Argentina and Brazil.[46] Rates are particularly low for Mesoamerican countries, and are below 60% for Panama, Costa Rica, Mexico, Honduras, Nicaragua and Guatemala (data is not available for many Caribbean countries).[47] The World Bank has placed an emphasis on the need to standardise education provision in the LAC region so that rural areas and households of lower socio-economic status are not disadvantaged, as can occur at present.[48] UNESCO has identified that the inequality which is still present within many LAC countries exacerbates schooling issues by implicitly segregating institutions and cohorts of children based on socio-economic status.[49]

Improvements in early years enrolment and primary school retention key areas for focus

The importance of early years schooling in educational attainment has been highlighted by several international institutions, but enrolment is linked with prosperity, compounding risks for the poor. A recent World Bank report identified that Caribbean countries need to focus on improving early years, pre-school education and enrolment.[50] UNESCO data indicates that this is also true for many Mesoamerican countries, where 2010 enrolment rates for pre-primary education were lower than 60% in countries including Guatemala, Honduras, Nicaragua and Belize.[51] This contrasts with much higher pre-primary enrolment rates in nations such as Barbados (95%), Uruguay (78%) and Argentina (73%).[52] UNESCO has linked this difference to economic resource potential, where countries with higher GDP per capita tend to have higher levels of pre-school enrolment.[53] This situation exacerbates the sensitivity of the rural poor, who are already disadvantaged by their socio-economic status.

In conjunction with this, early-school leaving can be the result of poverty, which drives children into the workforce and reduces their ability to develop skills and build personal capacity to adapt to climate change. This appears to be a particular problem in Mesoamerica, where 2010 primary school drop-out rates in Honduras, Guatemala, Nicaragua and Costa Rica were 28%, 23%, 14% and 13% respectively, in comparison with the regional average of just 8%.[54] Although the rates have reduced since 2000, this indicates significant proportions of the population in these countries are without a complete primary education, which can impact on earnings potential and economic development prospects more widely.

Figure 5.
Urban population percentage by world regions 1960-2025



Source: United Nations Department of Economic and Social Affairs[60]

3.4.3 Urban development

Rapid and unregulated urbanisation commonplace, concentrating risks and enhancing sensitivities

The impacts of climate change are strongly linked with development, with rapid urbanisation in many parts of the world concentrating risks in these locations.[55] With such expansion often taking place in an unregulated manner in developing countries, densely populated areas with clustered economic assets can be located in highly exposed geographies and on dangerous topography (see *Section 2: Exposure to climate change in the LAC region*). Compounding this risk, with little strategic planning or land use control informing this growth, such urbanisation is often accompanied by inadequate infrastructure for basic services such as water, sanitation and electricity. This heightens risks to health, livelihoods and wellbeing. Many small and medium sized cities in Mesoamerica in particular are known to suffer from infrastructure problems, which are compounded by low institutional capacity to effect change.[56]

A very high proportion of the LAC region's population live in urban areas, exposing large numbers of people to climate-related risks that can be exacerbated by rapid growth and high population density. Globally, the LAC region is second only to North America for its proportional urban population, which comprised 78.8% in 2010.[57] UNDESA estimates that by 2025, 82.5% of the LAC population will live in urban areas (see *Figure 5: Urban population percentage by world regions 1960-2025*).[58] In Latin America, it is the mid-sized and smaller cities which are currently experiencing the greatest growth.[59] South and Mesoamerica are home to a number of the world's megacities, with populations in excess of 10 million people. Multiple other cities with populations in excess of 5 million are also present.

Table 6.
Largest cities in the LAC region

Cities	Population in 2011
Mexico City, Mexico	20,446,000
Sao Paulo, Brazil	19,649,000*
Buenos Aires, Argentina	13,528,000
Rio de Janeiro, Brazil	11,867,000*
Lima, Peru	9,130,000
Bogota, Colombia	8,743,000
Belo Horizonte, Brazil	5,407,000*

*figure for 2010

Source: United Nations Department of Economic and Social Affairs[61]

High urban populations and the rapid and unregulated expansion of metropolitan areas are now features of most Latin American cities. Much of this expansion has taken place in hazardous areas, for example on flood plains, slopes prone to landslides and areas exposed to storm surges[62] – for example, in Rio de Janeiro it is estimated that 1.1million people live in the favelas on the slopes of the Tijuca mountains.[63] These areas are typically occupied by low income groups with few alternative options, escalating the vulnerability of these populations which are already socio-economically sensitive to climate impacts.

Where urbanisation takes place on flood plains or hillside slopes (which are stripped of vegetation to accommodate development) flood and landslide risks are increased for these areas and in adjacent zones. Denuded and developed slopes decrease ground stability and increase surface water run off rates. With deficient infrastructure and a lack of regulation, drainage systems are inadequate or non-existent in many of these locations, and building stock quality is also typically substandard. In these circumstances, urban flood and structural collapse risks rapidly increase.
In the past 20 years, highly disruptive flood events in multiple cities across the continent have been blamed on rapid and unregulated urbanisation.

- After the Argentinian city of Santa Fe had increasingly encroached into the Rio Salado floodplain, floods in 2003, 2006 and 2007 repeatedly inundated exposed areas, forming a shallow lake across one third of the city and forcing the evacuation of tens of thousands of residents on each occasion. [64]
- In December 1999, heavy rainfall triggered unprecedented flooding and mudslides in Caracas and coastal areas to the north in Vargas State. Communities on the north coast located on hazardous alluvial fans and mountain gorges fell victim to flash flooding and debris flows as the steep mountainous topography channelled water, mud and boulders towards these settlements.[65] In Caracas, floods and landslides destroyed homes in poorer neighbourhoods located on the slopes of the surrounding mountains. The overall death toll was estimated at 30,000, 80,000 homes were damaged or destroyed and over 600,000 persons were directly affected.[66]
- In April 2010, days of heavy rainfall triggered landslides in hillside favelas across Rio de Janeiro. Around 4,000 families were left homeless and the death toll was estimated at 250. The greatest loss of life was at the hillside Morro de Bumba favela on the eastern edge of Rio de Janiero, constructed on a landfill site which collapsed in a substantial landslide that destroyed 60 homes and a church.

The high incidence of unplanned development and the expansion of densely populated favelas also raises health risks for urban dwellers. Standing water from floods and the poorly drained surfaces of informally constructed urban areas increase water-borne and mosquito-vectored health risks for the low income residents of favelas. After the 2003 floods in Santa Fe, 180 cases of leptospirosis were recorded, a disease which is transmitted through water contaminated with rat urine. [67] Following Hurricanes Noel and Olga in 2007, 2,355 cases of leptospirosis were reported in the Dominican Republic.[68] A lack of electricity infrastructure in these areas also increases population exposure to heat waves and cold weather, which can have health consequences for vulnerable groups. In Buenos Aires, it is estimated that 10% of deaths in summer months are associated with the heat.[69]

- Examples exist of cross-sector initiatives to reduce risks for low-income settlers in Latin American cities, but significant challenges are present and hazards persist in many areas. While such schemes were not directly motivated by a wish to reduce climate change sensitivity, they nevertheless represent programmes which target a driver of vulnerability and have brought about improved climate resilience as a result. Notable examples include the household relocation programme in Manizales, Colombia, where local government, universities, NGOs and community members worked in collaboration to move households from dangerous sites at risk from landslides to nearby new homes funded by the city government. Between 1990 and 1992, the number of dwellings located in high risk zones was reduced by 63%.[70] In the coastal city of Ilo, Peru, a long term participatory initiative sustained by consecutive mayors improved water, electricity and sanitation provision, waste collection and the availability of public open space, as well as sustainable growth planning which has prevented the settlement of low income groups in risk-prone locations.[71]
- In situ slum upgrading programmes have also been carried out with varying degrees of success across Latin America. Examples include the PROFAVELA programme in Belo Horizonte, Brazil; the El Mezquital project in Guatemala City; and the PRIMED programme in Medellin, Colombia.[72] However, attempts to relocate citizens displaced by the 1999 Caracas floods to the country's interior regions were met with a reluctance to move and problems of integration.[73] Poor enforcement of land use controls and building regulations has allowed re-settlement in the affected areas, exposing residents to similar dangers in future.[74]

3.4.4 Population health

Climate change impacts on health perceived as a key concern for the LAC region

The general health of a population provides an important gauge for climate change sensitivity as it has a bearing on many dimensions of social and economic wellbeing. A generally healthy population is more capable of proactively addressing climate risks, from preparing for extreme weather events to earning capital to fund livelihood diversification. As changing temperatures and humidity create scope for species range shifts for diseases, a population with a healthy baseline and healthy living conditions can better withstand these threats.

The impacts of climate change on health are perceived as particularly critical by officials in the LAC region. A 2009 European Commission (EC) report on climate change in Latin America obtained questionnaire responses from the governments of 18 LAC countries on climate change issues – 13 of the responses indicated that health was regarded as a main aspect of social vulnerability.[75] Nevertheless, in 19 out of the 33 countries in region, over 15% of the population still does not have access to improved sanitation.[76]

Haiti and Bolivia consistently fall within the lowest quartile for the region for multiple population health indicators. The health profile for populations is revealed by indicators such as maternal mortality rate, life expectancy, undernourishment, and access to water and sanitation. It is evident that several countries perform poorly across many of these aspects in comparison with others in the region (see *Table 7: Health indicators matrix*), indicating generally lower levels of health within these populations. In comparison with other countries in the region, Haiti's performance indicates ongoing impacts to health and healthcare as a result of the 2010 earthquake and subsequent natural disasters. According to the NGO World Vision, Haiti also has the highest child death rate for the region, with 76 of every 1000 live births dying before the age of five, compared with the regional average of 13.[77]

Table 7.
Health indicators matrix

■ Country falls within the lowest quartile for this health indicator (where the eight worst-performing nations in the region are considered the lowest quartile)

	Maternal mortality ratio*	Life expectancy at birth	Prevalence of undernourishment in the population	Population with access to improved water supplies	Population with access to improved sanitation
Bolivia	■	■	■	■	■
Dominican Republic	■		■	■	
Ecuador	■		■		
El Salvador		■		■	■
Grenada			■		
Guatemala	■	■	■		
Guyana	■	■			
Haiti	■	■	■	■	■
Honduras				■	
Jamaica	■				
Nicaragua			■	■	■
Panama					■
Paraguay			■	■	■
Peru				■	■
St. Kitts and Nevis		■			
St. Lucia					■
Suriname	■	■			
Trinidad and Tobago		■			

* No data available for St. Kitts and Nevis; Dominica; Antigua and Barbuda.

Sources: UNICEF[78]; World Health Organization[79]; Food and Agriculture Organization of the United Nations[80]; World Bank[81]

Country falls within the lowest quartile for this health indicator within the region (where the eight worst-performing nations in the region are considered the lowest quartile)

Other countries which present consistently concerning statistics across these dimensions of health in comparison with other regional countries include Bolivia, Nicaragua, Guatemala, El Salvador, the Dominican Republic and Paraguay. The poor health circumstances in these countries are reflected in the Sensitivity Index which classifies all of them as 'extreme' or 'high risk'. In contrast, countries such as Uruguay and Chile present a considerably different profile across these indicators, performing within the upper quartile for the region for these indicators, suggesting a far more robust situation with respect to the health of their populations. Both Chile and Uruguay are classified as 'low risk' countries in the Sensitivity Index.

Case study

Lack of access to water and sanitation increases sensitivity to climate change in Paraguay

Limited access to sanitation, wastewater facilities and clean water in Paraguay present serious public health concerns, particularly in poor urban and rural communities. Lower levels of health increase overall sensitivity to climate change impacts, while an increase in extreme weather events has the potential to expose higher numbers of people to health risks by increasing risks of water borne and diarrheal diseases. Improved water management and sanitation services contribute to poverty reduction efforts. These actions are recognised by the World Health Organisation as necessary conditions for enabling economic growth.[82]

Paraguay is one of the poorest countries in the LAC region, suffering from extremely low rates of water and sanitation services in rural areas and sewerage coverage in urban centres. Just 66% of the rural population has accessed to an improved water source, compared to 99% of urban populations. Additionally, only 41% of the rural population has access to improved sanitation facilities, compared to 90% in urban areas (however only 15% of urban residents have access to a network sewerage connection[83]).

The inadequate provision of these services has an adverse impact on health in Paraguay. For example, according to the World Health Organisation (WHO), Paraguay is one of only two countries in the Region of the Americas to have reported 'non-imported' cases of cholera – a water-borne disease that can occur where water supplies and sanitation are inadequate – between 2003 and 2012 (the other was Brazil).[84] Additionally, diarrhoea was identified as the cause of 12% of under-fives deaths in Paraguay in 2008, one of the most predominant causes outside the 'neonatal' category.[85]

Climate change can also undermine the realisation of the internationally-recognised human right to water and sanitation, which are foundations for public health and socio-economic development. Increasing access to basic infrastructure services such as clean water and sanitation could help to improve the population's health status in Paraguay, reducing sensitivity to climate change and contributing to securing long-term economic growth.

Dengue fever may already be displaying species range shift in the LAC region

The changing climate is also an independent driver of health risks as disease vector ranges spread and exposure unfamiliar populations to new threats. Increasing dengue fever rates in the LAC region have been partially attributed to climate change, which has expanded the geographic range for the mosquito vectors of this viral disease, in combination with increasing population density and international trade and travel.[86] According to the Pan American Health Organization (PAHO), incidence rates of the disease increased by over 100% for the period 2005-2007 compared with 1995-1997 levels in El Salvador, Costa Rica, Jamaica, Haiti, Grenada, Barbados, St. Vincent and the Grenadines, St. Lucia, Dominica, Antigua and Barbuda, St. Kitts and Nevis, The Bahamas, Guyana, Suriname and Bolivia. [87] With no cases reported in the1995-1997 period, the disease also appeared in Chile, Argentina, Paraguay and Uruguay by 2005-2007,[88] demonstrating a move southwards from its traditional tropical latitudes.

3.4.5 Conflict and displacement

High numbers of vulnerable displaced populations increases the challenge of building climate resilience

Displaced persons are particularly vulnerable to a number of adversities, including the impacts of climate change. Positioned within unfamiliar environments, away from their livelihoods and lacking social support networks, challenges for displaced persons are often compounded by their low income status and the circumstances which forced their relocation. The prevalence of smallholder farming across many parts of the LAC region heightens displacement risks here, as these groups often have little capital reserves or technical capacity to turn to alternative livelihoods once disconnected from their land, markets and natural resource supplies.[89] Displacement can also affect access to education and healthcare, further advancing underlying drivers of population sensitivity to changes in the climate. Colombia has the world's highest displaced population, with the Internal Displacement Monitoring Centre (IDMC) estimating there are around 4.9 million displaced persons in the country,[90] most of whom are low income farmers, indigenous persons and Afro-Colombians.[91]

Displacement across the LAC region has occurred for a variety of reasons and across differing time periods, presenting a range of profiles for these groups which have a bearing on efforts to address sensitivity. Several Latin American countries have comparatively high numbers of internally displaced persons (IDPs). In Colombia, displacement has been occurring for decades. This has been largely as a result of internal armed conflict between militia groups who have used violence to force people from their homes and appropriate land (see Case study: Conflict and displacement as a driver of climate change sensitivity in Colombia).[92] Much of the displacement in Mexico is attributed to criminal violence linked with cartels. A significant proportion of displacement in Haiti is due to the impact of natural hazards. In both Peru and Guatemala, displacement has been a protracted result of long-term internal armed conflicts, with indigenous populations disproportionately affected.[93]

Case study

Conflict and displacement as a driver of climate change sensitivity in Colombia

Colombia has one of the world's highest rates of internally displaced people (IDP) as a result of decades of civil conflict, increasing the sensitivity of these populations to the impacts of climate change.

Forced internal displacement remains a serious concern in Colombia despite government efforts to negotiate a peaceful resolution to the conflict with the Revolutionary Armed Forces of Colombia (FARC) and to improve its wider response to the problem. According to the UN Refugee Agency (UNHCR), insecurity and violence continues to plague many regions, including both urban and rural areas. [94] According to official government figures, over 4.7 million people have been internally displaced since 2000,[95] although the true figure may be substantially higher.

Climate change can result in serious consequences for IDPs. Once displaced, individuals often endure the loss of livelihoods and subsequent poverty and economic exclusion. The vast majority of IDPs in Colombia move to urban areas,[96] where they tend to live in marginalised neighbourhoods that are highly exposed to natural hazard risks, such as earthquakes, flooding and landslides. Bogota, for example, is home to a large number of IDPs and is prone to earthquakes, floods, landslides and wild fires. Poor urban communities housing IDPs are also likely to be overcrowded and lacking in appropriate water, sanitation and health facilities, thereby increase risks to wellbeing. IDPs can also drive environmental degradation, thereby exacerbating their own vulnerability to climate impacts. For example, high rates of deforestation in and around informal settlements in Colombia can increase slope instability, soil erosion and the frequency of flash flooding and precipitation-induced landslides.

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4— Capacity to adapt to climate change in the LAC region

4.1 Overview

As changes in the climate become ever more apparent, the ability of a country to adjust to these changes or to take advantage of opportunities they present takes on increasing importance. Structural factors such as the effectiveness of governance and the economy are significant determinants of adaptive capacity, although the link between financial and technical resources and adaptive capacity is moderated by other components such as natural resource availability and the adequacy of infrastructure. Haiti is classified as having the poorest adaptive capacity prospects within the region, as it struggles to reconstitute its governmental structure and operations following the 2010 earthquake. In contrast larger, more developed countries with greater technical capabilities and more diverse economies, such as Chile, Uruguay, Mexico and Brazil, are classified as low risk.

The composition of some economies in the region makes them comparatively more exposed to the potential impacts of climate change. High levels of dependence on the agricultural sector as a source of wealth and employment is reflected in ‘extreme’ or ‘high risk’ classifications for adaptive capacity in several Mesoamerican (Nicaragua, Honduras, Belize, Guatemala and El Salvador) and South American countries (Guyana, Paraguay and Bolivia). Studies indicate that crop yields and crop viability in Mesoamerica in particular will be widely impacted by climate change, emphasising the importance of adaptation for this sub-region. In the Caribbean, heavily tourism-dependent economies on many islands are similarly exposed to climate change impacts. Sea level rise, beach erosion, changing precipitation patterns, water security concerns, increased disease ranges and a potential increase in hurricane intensity all pose significant threats to this sector.

Government capacity to implement effective adaptation is difficult to accrue and can be hindered by poor coordination between actors in many LAC countries. Implementation, in turn, is hampered by low levels of technical capacity, which is linked to the availability of resources to invest in education, research and awareness-raising. The perception of corruption in many LAC countries also threatens adaptive capacity, both in terms of government effectiveness and in influencing how external donors direct funds. In addition, external funding for climate change adaptation in the LAC region has been difficult to secure, with support for mitigation projects in the past 10 years over seven times the amount spent on adaptation. This has been largely focused in larger, more developed countries, with small island states receiving only 10% of climate finance approved for the wider region despite their acute need to adapt.

Map 4.
Adaptive Capacity Index 2014, LAC Region

Adaptive Capacity Index 2014
Low risk — Extreme risk
No data
Data source: Maplecroft, 2014

4.2 Introduction

As the climate changes and decision makers are provided with better information on future climate-related impacts, countries must adapt to the emerging conditions. The Intergovernmental Panel on Climate Change (IPCC) has defined adaptive capacity as "the whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures".[1] Maplecroft's Adaptive Capacity Index evaluates the ability or potential of a country's institutions, economy and societal framework to adjust to, or to take advantage of, existing or anticipated stresses resulting from climatic change. In so doing, the Index focuses on macro-level, structural factors which enable adaptive action such as good governance and the structure and performance of economies.

Alongside rapid onset and extreme weather events, longer term changes in baseline parameters will also affect the exposure of the population, economy and infrastructure of a country, for example as rising temperatures and sea level impact coastlines, plant and animal species, agriculture and human health. As these changes become apparent, the ability to cope with and adapt to a changing climate is becoming an increasingly important matter of public policy.

In order to address both the current and future impacts of climate change, governments must lead adaptation on a nationwide scale to ensure that the necessary institutional framework is in place to cope with the changing conditions. This requires not only effective governance and financial resources, but also a sufficient knowledge base and technical capability to identify the impacts and respond appropriately. Key factors that influence a country's adaptive capacity are:

— the strength of the economy;
— the level of dependence on agriculture, or other vulnerable activities, to support the economy;
— the effectiveness and stability of the government;
— the ability of a country to develop innovative technologies or practices; and
— the level of knowledge transfer and communication to the populace;
— the availability of natural resources.

Countries with low adaptive capacity, particularly those where this is combined with high exposure and sensitivity to climate change, are likely to suffer most from the effects of climate change. How well a country is likely to adapt to, or take advantage of, these changes will determine its circumstances in future. For example, as the climate changes, previously inhospitable regions will become suitable for pests and disease vectors to inhabit. Countries with lower technical and financial capabilities are less likely to be able to address the emergence of new diseases and the threats to health and food security that these shifts present. Many regions will face increasing water shortages and countries unable to implement and enforce prudent sustainable water management strategies will encounter increased risks of competition and conflict over this resource.

4.3 Results

Considerable variation in adaptive capacity across the region

Table 8: Adaptive Capacity Index for the LAC region presents the rankings, scores and risk categories for this dimension of vulnerability within the region's countries, demonstrating considerable variation in the state of adaptive capacity. As Haiti (1st) struggles to recover from the widespread devastation to its governance systems and civic infrastructure caused by the 2010 earthquake, it is classified as the riskiest country in the LAC region in terms of Adaptive Capacity (where lower scores equate to greater risks). The Dominican Republic (9th) is the only other Caribbean state appearing in the top ten riskiest countries in the region for adaptive capacity. Mesoamerican countries dominate the remainder of the top five rankings, with Nicaragua, Honduras and Guatemala in 2nd, 3rd and 4th positions respectively. Guyana (5th) is the first South American country to appear in the rankings. The top nine countries in this LAC region are all classed as 'extreme risk' for Adaptive Capacity.

The remainder of the Caribbean nations are classified as 'medium risk' countries, with the exception of Cuba (29th), Barbados (32nd) and The Bahamas (33rd) which are classified as 'low risk'. These countries are all ranked as lower risk for Adaptive Capacity than the rapidly developing nations of Mexico (26th) and Brazil (27th), although these are also classified as 'low risk' countries. The only Mesoamerican countries to be classified as "low risk" are Costa Rica (30th) and Mexico (26th), with Panama (19th) being the only 'medium risk' country.

Table 8.
Adaptive Capacity Index for the LAC region

Country	Rank	Score	Category
Haiti	1	0.00	extreme
Nicaragua	2	0.13	extreme
Honduras	3	0.50	extreme
Guatemala	4	0.64	extreme
Guyana	5	0.66	extreme
Bolivia	6	0.80	extreme
Paraguay	7	0.94	extreme
El Salvador	8	1.44	extreme
Dominican Republic	9	2.31	extreme
Belize	10	2.75	high
Suriname	11	3.31	high
Venezuela	12	3.62	high
Ecuador	13	4.44	high
Peru	14	5.32	medium
Colombia	15	5.66	medium
Argentina	16	6.07	medium
Jamaica	17	6.15	medium
Saint Lucia	18	6.31	medium
Panama	19	6.70	medium
Saint Vincent and the Grenadines	20	6.74	medium
Trinidad and Tobago	21	6.78	medium
Dominica	22	6.86	medium
Antigua and Barbuda	23	7.00	medium
Grenada	24	7.26	medium
Saint Kitts and Nevis	25	7.50	medium
Mexico	26	7.66	low
Brazil	27	7.88	low
Uruguay	28	8.18	low
Cuba	29	8.44	low
Costa Rica	30	9.23	low
Chile	31	9.40	low
Barbados	32	9.58	low
Bahamas	33	9.89	low

South American countries exhibit a split in rankings and scoring with smaller, poorer countries generally ranked as 'extreme' and 'high risk' and larger, more developed countries with largely stable business environments, diverse economies and global export markets classified as low and medium risk. Guyana (5th), Bolivia (6th), and Paraguay (7th) are all classified as 'extreme risk' and Suriname (11th), Venezuela (12th) and Ecuador (13th) as 'high risk'. In contrast, Chile (31st), Uruguay (28th), and Brazil (27th) are all ranked as 'low risk' countries for Adaptive Capacity. The 'medium risk' rating of Argentina (16th), just behind Peru (14th) and Colombia (15th), is in part attributable to comparatively lower performance on university education and technical innovation indicators.

The following section highlights some of the key features underlying the relative adaptive capacity present within the countries of the LAC region. This is not intended as a comprehensive review of each country's circumstances, but rather to provide examples of the components which can influence this critical aspect of vulnerability to climate change.

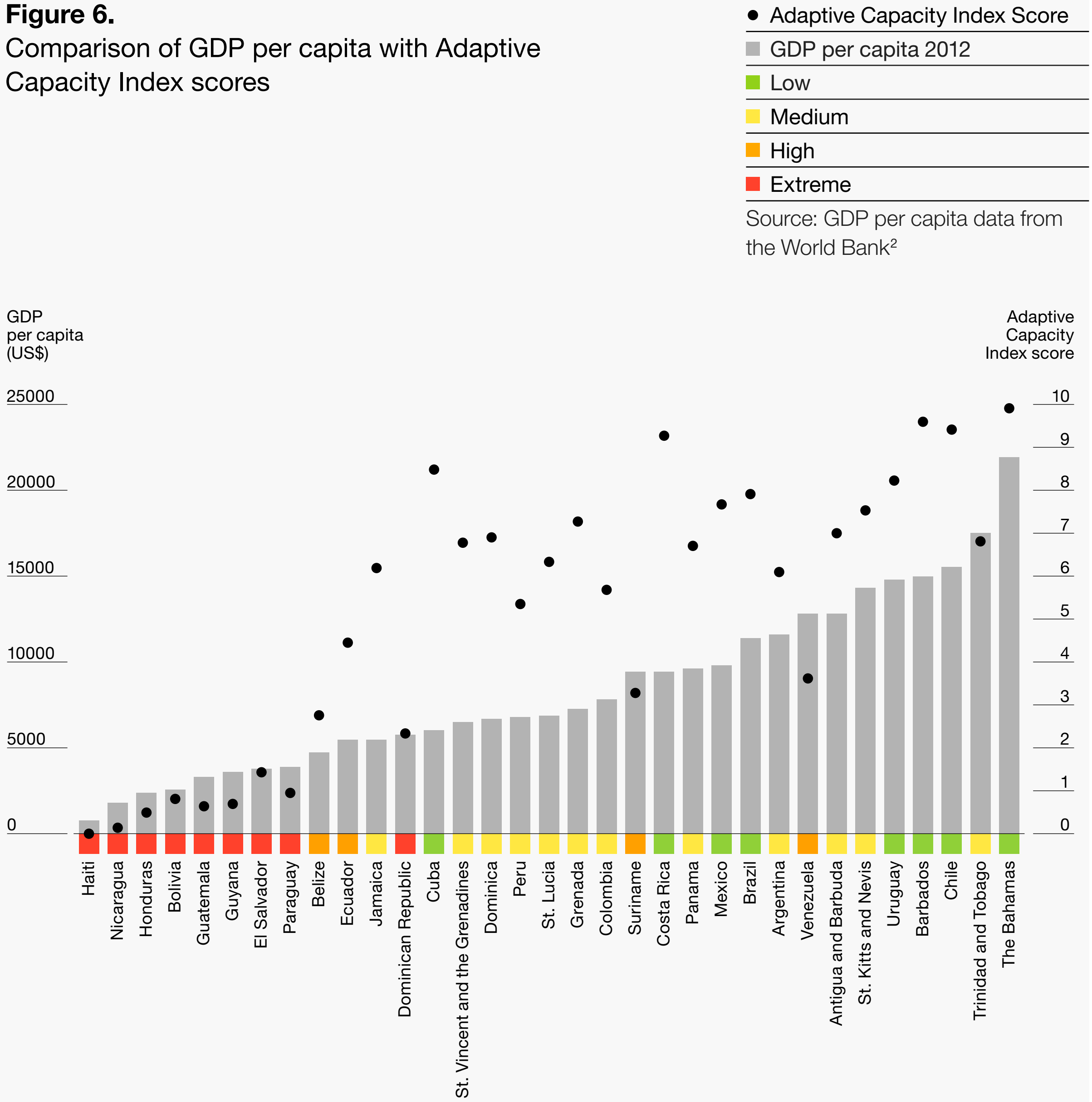
4.4 Key drivers of adaptive capacity

4.4.1 Financial capacity and the economy

Financial resources important for effecting adaptation but not the sole determinant

Adaptive Capacity is not solely a function of financial status and LAC countries present a range of additional factors contributing to their relative aptitudes. The Adaptive Capacity Index is comprised of numerous factors relating to institutional capacity, technical capacity and natural resource security, all of which may be considered to be ultimately dependent on financial resources and historic development patterns. A moderately positive relationship between adaptive capacity and economic resources is broadly borne out in *Figure 6: Comparison of GDP per capita with Adaptive Capacity Index scores*. However there are notable exceptions, indicating that relative capacity to adapt is not necessarily a direct consequence of economic circumstances in all cases. Even with relatively high GDP per capita rates within the region, Suriname and Venezuela score poorly for adaptive capacity and are considered 'high risk' countries. In contrast, Cuba and Costa Rica score well and are classified as 'low risk' countries, despite modest GDP per capita rates.

Figure 6.
Comparison of GDP per capita with Adaptive Capacity Index scores

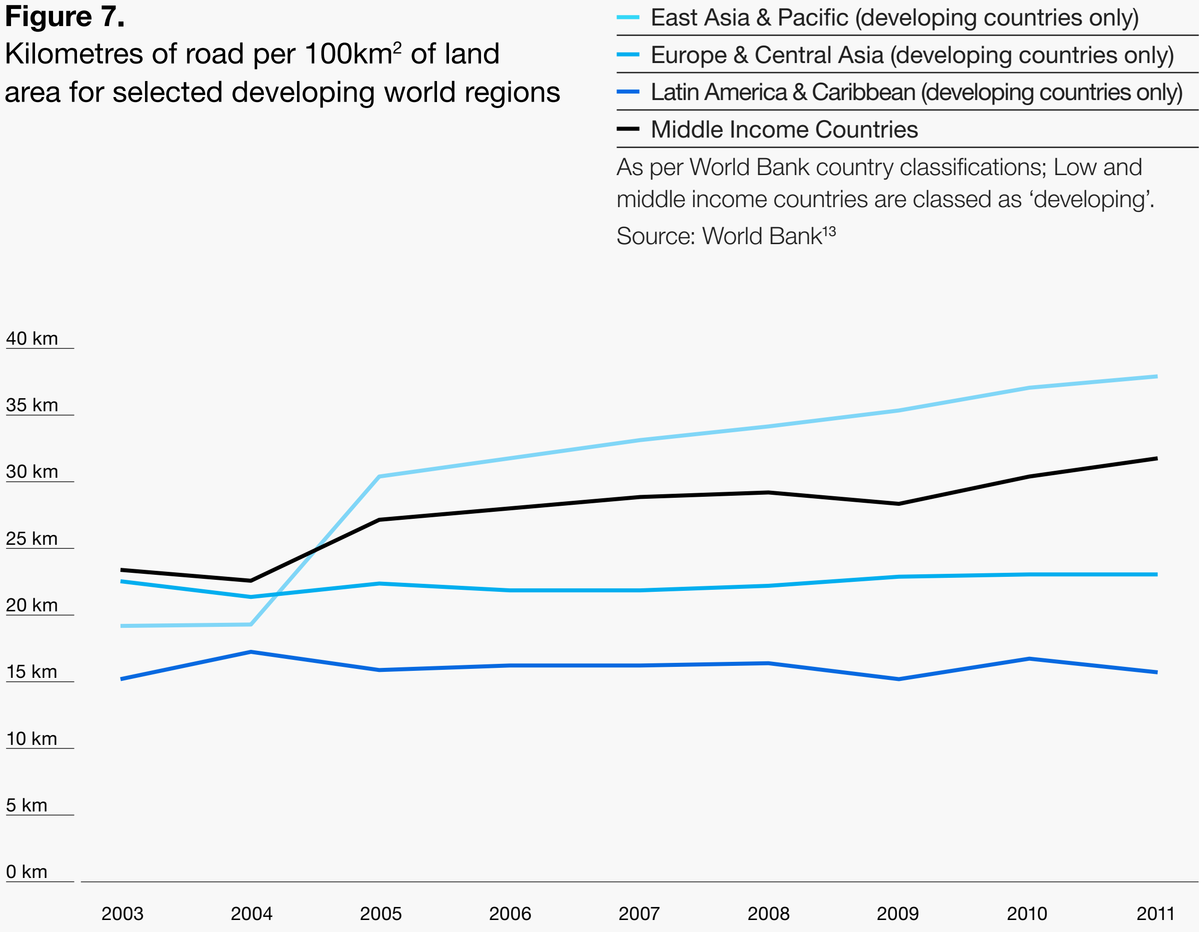


Source: GDP per capita data from the World Bank[2]

Infrastructure gaps limit adaptive capacity in the LAC region

Much of the LAC region lacks adequate infrastructure services, impeding economic development. Despite recent improvements in infrastructure for the LAC region,[3] a 2010 study by the World Bank identified that, with some exceptions, the quantity and quality of infrastructure in the region as a whole lies behind that of Middle Income Countries and East Asia.[4] The United Nation's Economic Commission for Latin America and the Caribbean (ECLAC) has estimated that the LAC region would need to spend 7.9% of GDP annually between 2006 and 2020 to achieve the levels of infrastructure stock that will be present in rapidly developing East Asian territories such as Malaysia, Singapore and Hong Kong by 2020.[5] As demonstrated in *Figure 7: Kilometres of road per 100km2 of land area for selected developing world regions*, middle and low income countries of the LAC region have made limited progress in the construction of transportation routes in comparison with other similar income countries in different parts of the world. The infrastructure gap in the LAC region has serious and urgent implications for the economic development[6] and its wider vulnerability to climate change.

Figure 7.
Kilometres of road per 100km² of land area for selected developing world regions



As per World Bank country classifications; Low and middle income countries are classed as 'developing'. Source: World Bank[13]

If approached in a sustainable manner, infrastructure development can help to reduce climate change vulnerability. Economic development can positively influence adaptive capacity, for example, by enabling greater access to technology and resources which can be invested in adaptation.[7] More indirectly, the expansion of energy, transport and communications networks provide greater connectivity and access to markets for trade, thereby contributing to poverty and inequality reduction. These networks can also increase access to services, such as health and education, potentially reducing population sensitivity to climate change.8 In part, the historical dominance of public sector provision of such services has constrained their development as governance and financial difficulties have limited progress. Regulatory obstacles have also hindered private sector involvement in infrastructure delivery in the region.9 For example, in the Caribbean, limited public sector finances for improving infrastructure present opportunities for alternative delivery vehicles, such as public-private partnerships (PPP). However, the World Bank has reported that PPP endeavours are being challenged by the absence of legislative frameworks to guide these partnerships.[10]

Current levels of infrastructure investment in the region are insufficient to meet the needs of domestic and commercial end users.[11] For example, aspects of Brazil's energy concerns stem from a lack of distribution infrastructure rather than a lack of generating capacity - the construction of large scale projects and associated power lines are often subject to delays. Media reports from February 2014 indicate that 48 constructed wind farms in Brazil remain inoperative as they await connection to the grid. In addition, expansion of these services faces further challenges, such as a lack of financial incentive for private sector investors to expand coverage to poorer rural areas, where technical costs to deliver supplies or roads may be high and the end users have limited ability to pay for the services.[12]

Case study

Current investment plans for Colombia and Peru seek to close infrastructure gap

The World Economic Forum's Global Competitiveness Report for 2013-2014 identifies that, with the exception of corruption risks, inadequate supply of infrastructure is considered the most problematic factor for doing business in Colombia. The findings for Peru are similar, with inadequate infrastructure identified as the third-most problematic factor for this country, behind inefficient government bureaucracy and corruption.[14]

According to the Peruvian Chamber of Construction (Capeco), Peru has an infrastructure deficit of approximately US$40 billion.[15] The Peruvian Association for the Promotion of National Infrastructure (AFIN) points to a wider gap, with a 2012 analysis indicating that Peru will need to make investments of US$88 billion (or a third of GDP) by 2021 in order to close its infrastructure gap with the rest of the developing world.[16] It is estimated that this will require a tripling of annual investment to more than 3% of GDP. One major implication is that the government's current US$20 billion five-year infrastructure investment plan (due to conclude in 2016), will not be enough to fully rectify the challenges facing Peru in achieving competitiveness. In particular, Peru's transportation sector requires significant investment to achieve greater social integration and inclusion, reduce logistical costs, and enhance competitiveness. In 2011, only 54% of the country's roads were paved, and there was no expansion of the rail network between 2005 and 2010, leaving rail infrastructure largely confined to the south and central parts of the country.[17]

In Colombia, poor road infrastructure, compounded by complex topography, is also harming the country's economic competitiveness.[18] According to the US Department of Commerce, only 20% of the total road network in the country is paved and only 1,200 kilometres of paved roads have dual-lane highways.[19] The poor state of the road network and the lack of alternative transport options results in high trucking costs and exposes companies to severe delays. More and better transport infrastructure is needed to enhance the integration of coastal ports and economic hubs with the interior of the country. The National Infrastructure Agency (ANI) is responsible for a new and ambitious programme of concessions (the 'Fourth-Generation Concessions' programme), including more than 30 transport infrastructure projects worth US$24.1 billion which it is seeking to secure investment for.[20]

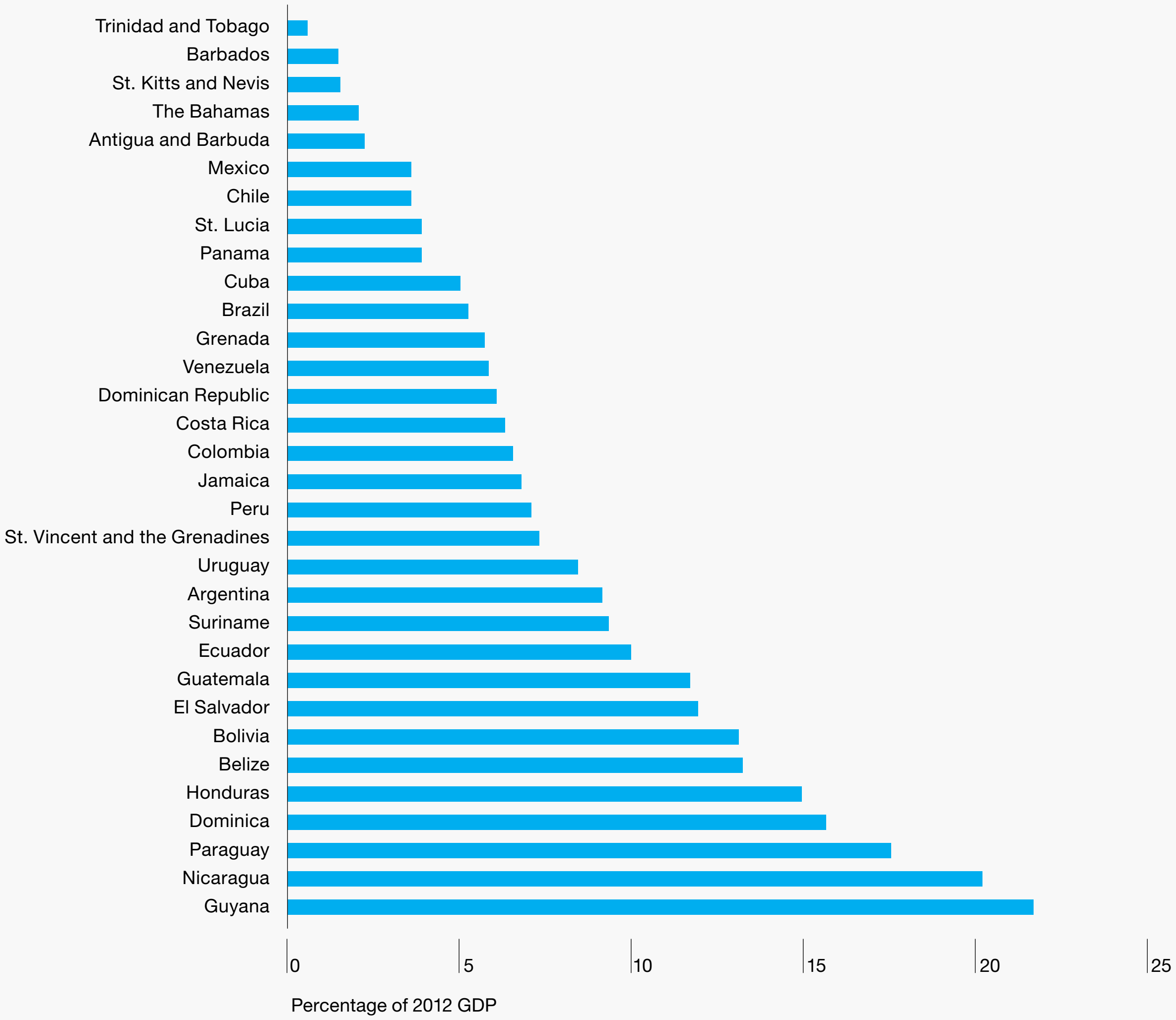
Significant economic reliance on the agricultural sector a weakness for Mesoamerica

Where climate change has the potential to significantly impact on a country's economy, this presents a significant challenge for governments to address in terms of securing both financial stability and population livelihoods. Meteorologically sensitive sectors, such as fishing, agriculture and tourism, are considered particularly at risk. According to ECLAC climate change could cost countries in temperate zones of the LAC region around 1% of annual GDP up to 2100 under a higher emissions scenario, with costs expected to be higher in Andean, Mesoamerican and Caribbean countries.[21]

The relative importance of agriculture to many Mesoamerican countries in comparison with other countries in the region elevates the vulnerability of these economies to climate change impacts. Although agriculture's relative contribution to the GDP of Mesoamerican countries has decreased over the past 10 years (with the exception of El Salvador[22]), the sector still represents 18% of Mesoamerica's GDP when agro-industry is included.[23] In 2012, agriculture comprised over 15% of Nicaragua's GDP (see *Figure 8: Agriculture as a percentage of GDP in 2012*) and over 10% for Honduras, Belize, Guatemala and El Salvador. These countries are all classified as 'extreme' or 'high risk' within the Adaptive Capacity Index, and ranked within the top ten for the LAC region.

Figure 8.
Agriculture as a percentage of GDP in 2012

No data available for Haiti
Data for Cuba and Belize is from 2011
Data for Venezuela is from 2010
Source: World Bank[24]



Several South American countries also exhibit a considerable economic reliance on agriculture, presenting a sensitivity which is likely to be compounded by their low per capita GDP rates. Guyana, Paraguay and Bolivia derive 21.5%, 17.4%, and 13.0% of their GDPs from agriculture respectively, are classified as 'extreme risk' countries on the Adaptive Capacity Index, and have the lowest per capita GDP levels for this sub-region (see *Figure 7: Comparison of GDP per capita with Adaptive Capacity Index scores*). This combination is likely to reduce the ability of these countries to finance climate change adaptation measures relative to other South American countries, while simultaneously indicating the urgent need to implement such changes.

Forward looking research shows that crop yields and crop viability across Mesoamerica will be impacted by climate change, emphasising the urgent need for the sector to adapt to changing conditions. Sensitivity to variations in temperature, humidity and rainfall patterns can influence cultivation components such as soil water retention capacity and soil fertility, and also change the suitability of particular locations for particular crops. A number of investigations have examined projected crop impacts in the sub-region as a result of climate change:

— The Adaptation Partnership has identified that multiple key agricultural products from the Mesoamerican market are under threat from climate change including livestock, coffee, maize, rice, sugarcane and bananas.[25]
— Work undertaken by the Center for Tropical Agriculture (CIAT) and the International Maize and Wheat Improvement Center (CIMMYT) in 2012 estimated that climate change could cause a 25% reduction in bean production volume in Mesoamerica by 2050, and significant reductions in maize production in Honduras and El Salvador.[26]
— A 2010 report by ECLAC projected negative impacts for crop productivity in Mesoamerica by 2100 under various emissions scenarios. The report estimates that under some circumstances maize and bean yields could fall to zero in Guatemala and El Salvador without adaptation.[27]
— A 2013 report by ECLAC projected rice yield decreases of 30-50% in the sub-region by 2100.[28]
— An assessment undertaken by ECLAC in conjunction with the Mesoamerican Commission for Environment and Development predicted declines in maize, bean, sugar cane and orange yields in Belize without adaptation, estimating that accumulated losses in the agricultural sector could reach 35% of 2007 GDP by 2100.[29]

Agricultural extension services will be key to adaptation and maintaining revenues for economic stability, however capacity varies between countries. In Mesoamerica extension is often constrained by limited public finances. Belize is largely reliant on public-private extension partnerships. Efforts in Honduras tend to be project-specific rather than strategic, although some elements of extension services are provided by government bodies and academic institutions. Nicaragua is heavily reliant on funding from international development institutions to assist with its efforts to decentralise extension services. The US-based International Food Policy Research Institute has identified that considerable scope for improvement remains in Mesoamerica, particularly with respect to practical knowledge transfer and accessibility of information.[30] In the Caribbean, although commercial interests drive specific private sector inputs, extension services tend to be primarily from the public sector.[31] A lack of institutional and financial capacity to develop these services means that extension programmes are typically lacking in comparison with those of Central and South America.[32]

Impacts to productivity may further threaten already fragile food security

The ability of LAC governments to enable adaptation within the agricultural sector is critical for domestic food security as well as economic stability. Food security in the LAC region is a complex issue, driven by endogenous factors such as government policy and productivity, and largely exogenous factors such as global food prices.[33] However, in the context of climate change, the prevalence of subsistence farmers highlights the direct impacts on food security as a result of adverse impacts on agricultural production from climate change. Millions of smallholders in the Caribbean and in Mesoamerica live in rural areas and depend on their own crops for food.[34]

Agriculture also exposed to indirect threats from expanding pest habitats

The vulnerability of agriculture-based economies to climate change is not solely a direct relationship with changing conditions for cultivation. The changing climate is also providing scope for species range shifts within disease and pest populations, exposing previously unaffected crop areas to new threats. Where traditional methods are practiced and smallholders have little capital to invest in preventative inputs, these new hazards may lead to significant consequences. In addition to reducing productivity and domestic incomes, these types of climate change impacts may also affect wider world food markets by undermining the production of export-oriented cash crops such as coffee in Brazil and Colombia and bananas in Ecuador. Changes of this nature are already being inferred in the coffee sector (see Case study: Coffee leaf rust epidemic in Mesoamerica linked to changing climate).

Case study

Coffee leaf rust epidemic in Mesoamerica linked to changing climate

A coffee lead rust disease outbreak in parts of Mesoamerica and the Caribbean, which began towards the end of 2012, is projected to cause production losses of US$250 million for the 2014 crop year. Plantations in Panama, El Salvador, Costa Rica and Guatemala are badly affected, with up to 86% infected with the fungus, which is also known as roya. Mauricio Galindo, the Head of Operations at the International Coffee Organisation, has stated that scientists have linked the outbreak to the higher temperatures and increased precipitation in coffee growing regions as a result of climate change, and reports from farmers in the region indicate that the fungus is now infecting crops at higher altitudes than have previously been affected by the disease.

Many of the producers in this region are smallholders. As well as suffering serious financial losses from affected yields, they lack the capital necessary to invest in pesticides to control the epidemic or to purchase roya-resistant seed varieties developed in Colombia. The inability of the governments of these countries to provide subsidies for the affected coffee sector in Mesoamerica will hamper its ability to recover from this shock, and to adapt to the changing profile of this ongoing threat to productivity.[35]

Tourism-dependent Caribbean nations likely to suffer from changing climatic conditions

For many Caribbean island countries, agriculture forms a much less significant proportion of GDP, however the tourism sector plays a critical role in these economies and is also highly exposed to the impacts of climate change. Figures produced by the World Travel and Tourism Council indicate the significance of tourism in the economies of the majority of Caribbean island nations.

Favourable climatic conditions and coastal features are key elements of the Caribbean tourism industry, both of which are at risk as a result of climate change. Sea level rise, beach erosion, coral reef bleaching from sea temperature rise, changing precipitation patterns and water availability, increased disease ranges and a potential increase in the intensity of hurricanes all

Table 9.
Travel and Tourism as a percentage of GDP in 2013 for Caribbean countries

Country	Total contribution of travel and tourism to GDP in 2013
Antigua and Barbuda	62.9%
The Bahamas	46.0%
Barbados	36.2%
Cuba	9.8%
Dominica	32.0%
Dominican Republic*	15.2%
Haiti	4.2%
Grenada	20.3%
Jamaica	25.6%
St. Kitts and Nevis	22.5%
St. Lucia	38.8%
St. Vincent and the Grenadines	21.1%
Trinidad and Tobago	8.2%

*figure for 2012

Source: World Travel and Tourism Council [36]

pose significant threats to this sector (see *Section 2: Exposure to climate change in the LAC region*).[37] States with over a third of GDP coming from tourism, such as Antigua and Barbuda, The Bahamas, Barbados and St. Lucia, could experience significant economic impacts due to their dependence on prevailing conditions and coastally clustered infrastructure. Sub-regionally, Dominica stands out as a nation which is substantially reliant on both agriculture and tourism and thus will require considerable innovation to diversify commercially.

Tourism infrastructure is also concentrated in coastal zones, meaning these islands typically exhibit high relative economic exposure to climate change impacts for the industry. Estimates of proportional losses and rebuild costs as a result of climate change are generally higher for countries with smaller economies where tourism is prominent in the national economy, such as Antigua and Barbuda, St. Kitts and Nevis and The Bahamas.[38] According to the UNDP, almost one third of Caribbean tourist resorts would be at risk from sea level rise (SLR) of 1 metre, including 64% of resorts on St. Kitts and Nevis and 36% in the Bahamas.[39] The airport on Grenada would also be entirely submerged, as would 50% of the air travel infrastructure on St. Lucia, St. Vincent and the Grenadines and Trinidad and Tobago.[40] Aside from the longer-term vulnerabilities this illustrates, it also highlights the sensitivity of key elements of the sector to storm surge impacts associated with tropical cyclones.

Case study

Multi-stakeholder partnership develops climate risk tool to support decision making in the Caribbean

Caribbean countries face substantial challenges in developing and implementing effective climate change adaptation strategies. Key risks facing many countries within the region include exposure to extreme weather events such as hurricanes and severe storms, the increasing intensity and frequency of droughts, and damage to coastal and marine environments as a result of sea level rise and ocean acidification. Amongst the many barriers to climate change adaptation in the region are the lack of local information that can help identify those areas or sectors that are most susceptible to the impacts of climate change, and the availability of risk tools that can help integrate climate change into decision making.

In response to the threat posed by climate change to the region and the urgent need to adapt, an online decision-support website was launched in July 2013 to assist decision makers identify and manage climate change risks. The tool, the 'Caribbean Climate Online Risk and Adaptation tooL' (CCORAL), is primarily designed for government users involved in national developing planning and finance. A unique feature of the tool is that it enables users to assess climate risks to legislation, national policy or strategy, or to projects within land and marine environments[41].

CCORAL is owned by the Member Countries of the Caribbean Community and managed by the Caribbean Community Climate Change Centre, which coordinates the region's response to climate change. It was funded by the UK Department for International Development and the Netherlands Directorate-General for International Cooperation.

4.4.2 External climate change funding

Overseas assistance figures mask inequitable distribution of climate funds

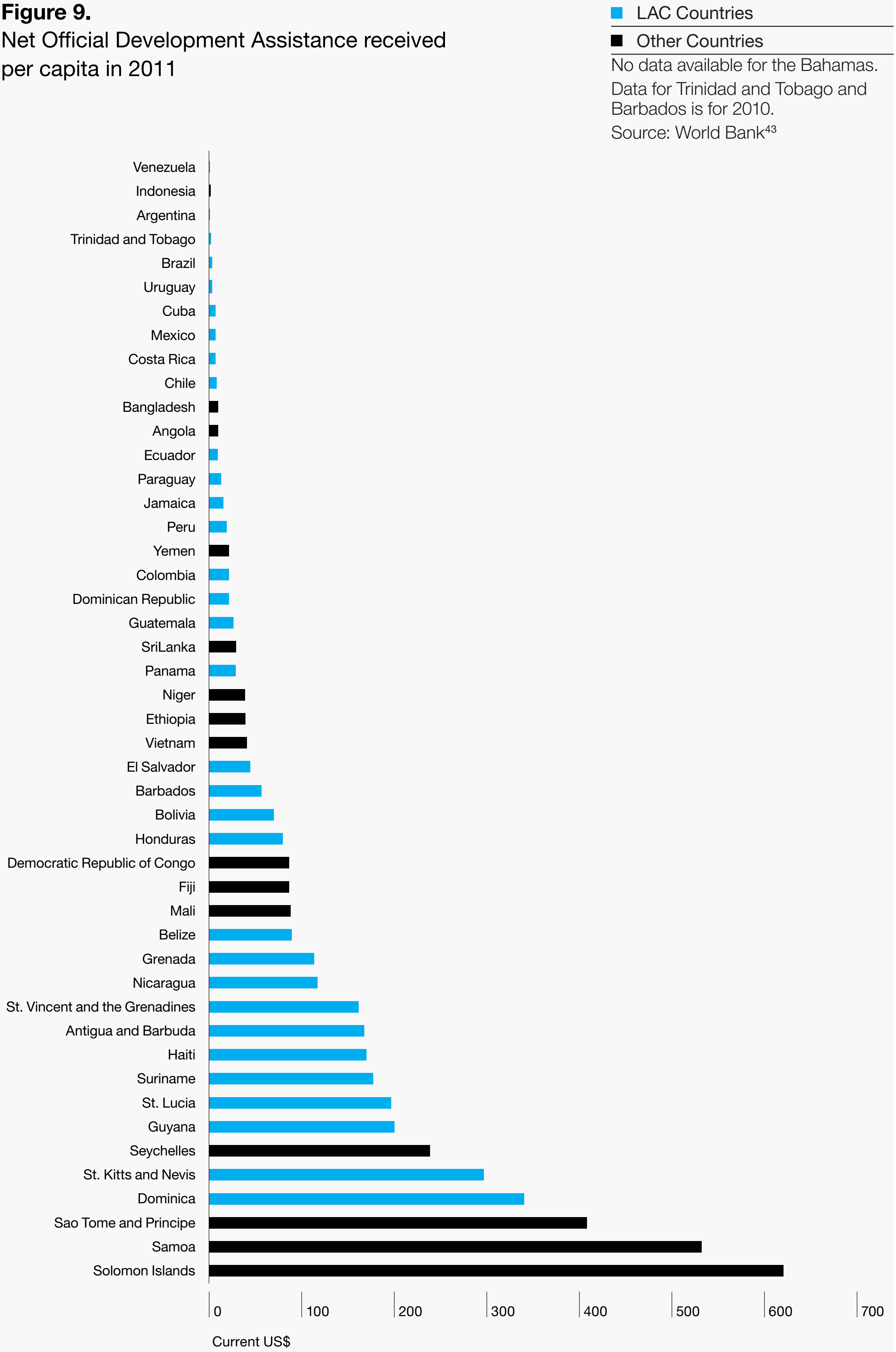
While Caribbean island states tend to receive the highest levels of official development assistance (ODA) per capita, climate change funding for these nations is comparatively low relative to the wider LAC region. Data compiled by the World Bank indicates that Dominica, St. Kitts and Nevis, St. Lucia, Haiti, Antigua and Barbuda, St. Vincent and the Grenadines and Grenada all received over US$100 per capita of ODA in 2011, well above the regional average of around US$78 per capita. This is partially a function of the lower populations in these nations, as demonstrated by comparison with other Small Island Developing States (SIDS) from other world regions included in *Figure 9: Net Official Development Assistance received per capita in 2011*. However, a November 2013 study by the UK-based Overseas Development Institute (ODI) identified an uneven distribution of climate change funding between LAC countries – Mexico, Brazil and Colombia have been granted 66% of all approved climate finance in the region, while SIDS as a group within the region have received only 10%.[42]

Climate change funding for the region heavily weighted towards mitigation efforts

Access to targeted climate change funding is critical for a region with limited internal resources, but current contributions seem targeted towards mitigation not adaptation. The ODI report highlights the difficulties the LAC region has experienced in securing funding targeted at adaptation strategies, which are echoed in a 2012 report by the United Nations Environment Programme.[44] Mitigation projects, primarily in larger countries such as Mexico and Brazil, including those within the UNFCCC programme for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+), receive the great majority of climate change funds in the region (see *Figure 10: Climate change funding for adaptation and mitigation programmes in the LAC region since 2003*). According to the ODI, in the last ten years, funding for mitigation projects in the LAC region has outstripped that for adaptation projects by over seven times – US$1.43 billion compared to US$200 million.[45]

The focus on mitigation measures to date is perhaps a factor of the quantifiable nature of their returns – gains can be expressed as CO_2 equivalents, which in turn can be economically quantified via carbon markets. The benefits of adaptation are more difficult to precisely quantify in advance and to tangibly measure post-completion.[46] However, the United Nations Framework Convention on Climate Change (UNFCCC) identified that globally, increased funding for adaptation in particular is needed to facilitate adjustments, indicating that this is a priority area of action for addressing climate change.[47]

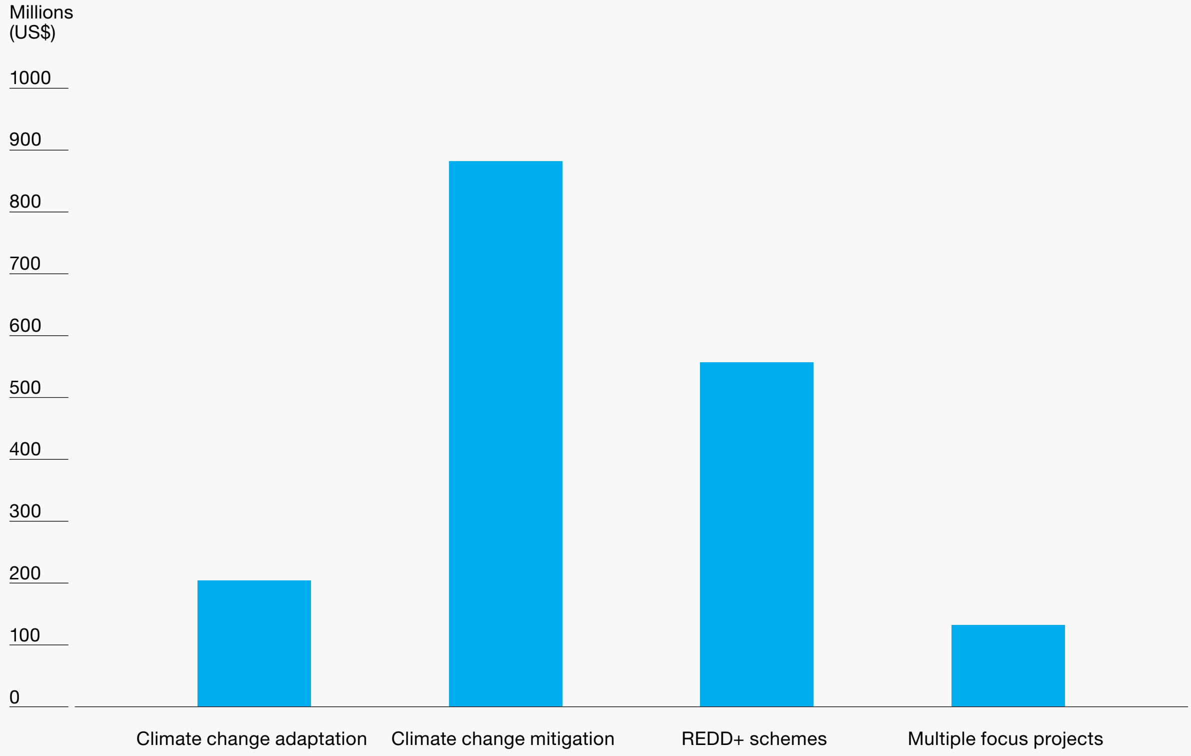
Figure 9.
Net Official Development Assistance received per capita in 2011



No data available for the Bahamas.
Data for Trinidad and Tobago and Barbados is for 2010.
Source: World Bank[43]

Figure 10.
Climate change funding for adaptation and mitigation programmes in the LAC region since 2003

Source: Overseas Development Institute/Heinrich Boll Stiftung North America[48]



4.4.3 Governance issues and technical capacity

Limited institutional and technical capacity for adaptation raising problems in many LAC countries

Institutional capacities requiring strengthening across many LAC countries to enable the successful development and implementation of climate change adaptation strategies. Responding to a 2009 EC questionnaire on climate change implementation, the governments of 18 LAC countries identified that coordination weaknesses were contributing to adaptation challenges. For those countries for which data was available, poor coordination between institutions was identified as a particular problem in Bolivia, Chile, Guatemala and Nicaragua, while low levels of coordination between donor agencies was cited as an issue in Argentina and Cuba. A lack of financial resources and a lack of subject-specific knowledge were the most frequently identified problems associated with project implementation.[49] Indeed, strong institutions play an important role in helping local communities adjust to climate variability and deal with the consequences.[50] The fact that the EC did not include countries such as Guyana and Suriname, identified as the 5th and 11th riskiest countries in the LAC region for adaptive capacity respectively, further highlights the ongoing struggle faced by those with the greatest needs.

Historical under-investment in education and research has constrained the development of skills and experience required to enable climate change adaptation, disadvantaging many poorer nations. The World Economic Forum's Global Competitiveness Report 2013-2014 examines dimensions of productivity and prosperity within 148 national economies. The report does not provide coverage of the situation in many Caribbean nations, however for those countries in the wider LAC region which are included, on a scale of 1.0 (low) to 7.0 (high) for 'Capacity for Innovation', Haiti, Venezuela and Trinidad and Tobago all score below 3.0 and Paraguay, Honduras, Peru and Suriname 3.1 or below.[51] Closely linked with this, where data is available on national research and development (R&D) expenditure for these countries, less than 0.2% of their GDP is spent on R&D overall, in comparison with Brazil and Argentina, for example, which spend 1.1% and 0.6% respectively.[52]

Tertiary education rates within the workforce are low in many of the countries identified as having some of the most extreme adaptive capacity risks. Data from the International Labour Organization (ILO) reveals that within the LAC region, in 2011 less than 21% of the labour force had a tertiary education.[53] Tertiary education corresponds to education provided at universities, teacher-training colleges and higher professional schools requiring the prior completion of secondary level education.[54] The LAC region rate compares unfavourably with rates of over 30% in many European countries, Australia and New Zealand, and over 40% in Japan and Israel (based on the latest available data for each country).[55] This further underlines the lack of necessary skill levels within the LAC region's working population that are required to develop and deliver effective adaptation strategies.

The workforces of those countries with the riskiest prospects for adapting to climate change suffer from a comparative paucity of educational achievement. These comparative differences are demonstrated in *Table 10: Percentage of labour force with tertiary education in CAF countries and countries ranked as 'extreme risk' on the Adaptive Capacity Index*. For example, although there is no data available for Haiti, Nicaragua, Honduras and Guatemala have low workforce tertiary education rates. In contrast, within the group of 'extreme risk' countries, Guyana and the Dominican Republic fare comparatively better, with rates which are close to the regional average. This variation provides an indication of the differing contribution that this risk driver has to adaptive capacity across 'extreme risk' countries. For example, Peru is ranked as 'medium' risk on the Adaptive Capacity Index, despite a workforce tertiary education rate of just 15.1%. CAF member countries exhibit a range of tertiary education rates, ranging from Trinidad and Tobago at 11.1% to Panama at 36.9%.

Table 10.
Percentage of labour force with tertiary education in CAF countries and countries ranked as 'extreme risk' on the Adaptive Capacity Index

Country (CAF member countries in bold)	**Adaptive Capacity Index rank**	**Percentage of labour force with tertiary education in 2011**
Haiti	1	no data available
Nicaragua	2	12.9%*
Honduras	3	6.1%
Guatemala	4	6.3%
Guyana	5	19.1%*
Bolivia	6	14.5%**
Paraguay	7	16.5%
El Salvador	8	11.8%
Dominican Republic	9	20.1%
Venezuela	12	28.3%
Ecuador	13	20.8%
Peru	14	15.1%
Colombia	15	22.6%
Argentina	16	34.7%
Jamaica	17	no data available
Panama	19	36.9%
Trinidad and Tobago	21	11.1%***
Mexico	26	23.3%
Brazil	27	17.2%
Uruguay	28	19.7%
Costa Rica	30	23.3%
Chile	31	19.7%

*2010 data

**2009 data

***2008 data

Source: World Bank[56]

A government's ability to transfer appropriate knowledge and skills to the population is a key part of building resilience to climate change in the LAC region. The importance of public awareness and engagement in adaptation is well established, and community knowledge about climate change risks is also key to obtaining support for adaptation strategies. The distribution of information is therefore an important element of enhancing the capacity to adapt within communities.[57] The fifth assessment report (AR5) from the Intergovernmental Panel on Climate Change (IPCC) has identified that for small island nations, the greatest benefit from adaptation programmes is derived when these are delivered in conjunction with development activities so that community awareness of risks and future climate change impacts is increased.[58] For South and Mesoamerica, the IPCC has concluded that "actions combining public communication (and education), public decision-maker capacity-building and a synergetic development-adaptation funding will be key to sustain the adaptation process that CA and SA require to face future climate change challenges".[59]

Case study

Public education around disaster risk reduction requires further development in CAF member countries

Empowering communities with knowledge and awareness of disaster risk reduction (DRR) strategies is an important component of adapting to climate change as many parts of the region are expected to experience more acute and potentially more frequent climate extremes in future. A measure of country progress towards achieving this aspect of community resilience-building is summarised in national self-reporting to the Hyogo Framework for Action (HFA), a United Nations initiative to encourage preparedness. Under the HFA's 'Priority Area 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels', two core indicators record country-reported achievements in incorporating DRR into educational curricula and in the existence of countrywide public awareness strategies for DRR.[60]

Most CAF member countries have submitted reporting to the HFA for the period 2011 to 2013. The reports reveal that some level of public education campaigns about disaster risks exist in all CAF member countries, with the exception of the Dominican Republic.[61] However, there is considerable variation in the nature and degree of implementation of these programmes between countries. Some nations, such as Argentina, Ecuador and Paraguay, state that 'substantial achievement' has been attained with respect to public awareness strategies.[62] Others, such as Bolivia, Brazil and Uruguay state that institutional commitment has been secured for such actions but progress has not been comprehensive.[63] Towards the lower end of the scale of progress, Panama has rated its efforts with this aspect of community DRR as incomplete due to limited commitment and capacity.

With respect to integrating DRR into the education system, the majority of CAF member countries have DRR within the educational curriculum at either primary, secondary or university level. Countries such as Chile, Colombia and Costa Rica include DRR at all levels of education. Brazil and Paraguay are exceptions, as both report that no DRR has yet been functionally integrated into any stage of the education system.[64] Given the comparatively low rates of tertiary education within the working populations of many LAC countries, those which only include DRR at university level, such as Argentina, Ecuador, Uruguay and Venezuela,[65] are missing an opportunity to transfer knowledge to a greater proportion of the population during their earlier years of education.

In their reporting, many countries cited financial and operational capacity as limiting factors in achieving progress against these indicators, again highlighting the influence of governance in capacity-building.

Case study

Improving adaptation to climate change in small and medium-sized cities

Small and medium-sized cities (SMSCs) across the LAC region face substantial threats from natural hazards and climate change. In addition to hurricanes, floods, earthquakes, landslides and volcanic eruptions, many of the region's cities experience rapid and often unregulated growth, as well as economic and political volatility. Within this challenging context, most city administrations lack access to climate change adaptation training, knowledge networks and finance.

In response, a World Bank-sponsored study was undertaken between 2010 and 2013 to support SMSCs in their adaptation planning for floods and landslides. These hazards were selected because they are amongst the most frequent climate-related impacts in the region. Research inputs and technical advice to the project were provided by regional and international partners, including the Massachusetts Institute of Technology, University of the West Indies, Federal University of Rio de Janeiro and the London School of Economics.

Five cities were selected for participation in the piloting of technical assistance, with each city facing a unique and challenging hazard risk profile and socio-economic context. The selected cities were El Progreso, Honduras; Castries, Saint Lucia; Esteli, Nicaragua; Santos, Brazil; and Cuzco, Peru. The technical assistance provided through the project centred on building or strengthening city-level institutional capacity to enable climate change adaptation. The work programme was designed to enable pilot cities to embed climate change challenges into planning and policy making. A final output from the project will be a sourcebook on climate change adaptation for city officials, ultimately boosting local adaptive capacity by mainstreaming climate change adaptation.[66]

In certain locations, institutional limits for adaptive capacity are compounded by elevated corruption risks

Corruption is a recognised threat to adaptive capacity for climate change, undermining government effectiveness, compromising programme outcomes and limiting the development of institutional capabilities and economic prospects. The UNDP[67] and Transparency International[68] have both assessed the direct and indirect consequences of corruption's impact on climate change adaptation. In addition to reducing the funds available for adaptation efforts, corruption may also deter donors from providing funds for adaptation requirements or addressing other underlying drivers of climate risk where concerns exist over the authenticity of the final recipients. This situation arose in Haiti after the 2010 earthquake, where international donors avoided channelling funds through Haitian organisations and the Haitian government amidst concerns the sums would not reach the intended targets. This also has indirect effects on vulnerability in terms of limiting economic regeneration capabilities within the country.

A degree of corruption is an embedded feature of many operating environments in the LAC region, however Haiti and Venezuela are particularly affected by this issue. Transparency International's 2013 Corruption Perceptions Index scores Haiti and Venezuela as two of the top 20 riskiest countries globally for perceived public sector corruption,69 with high levels of corruption considered entrenched in both locations. Paraguay, Honduras, Guyana and Nicaragua also appear within the top 51 countries in this Index. The LAC region's reliance on external development assistance escalates the prospect of corruption influencing adaptation efforts as this process typically makes large sums of money available.

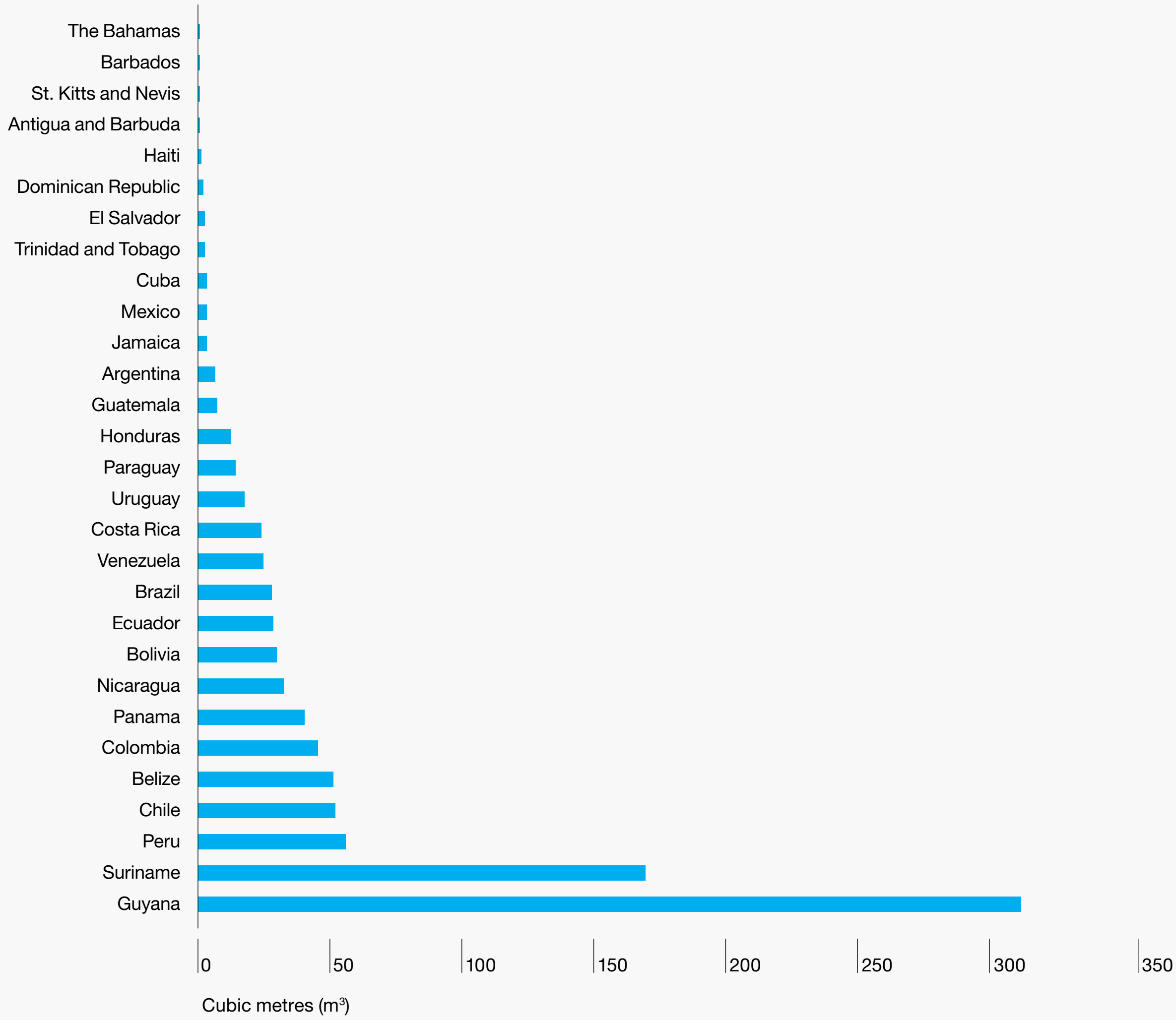
4.4.4 Water security

Water security an increasing concern for Caribbean island nations

The ability of Caribbean governments to deliver a reliable source of useable water to island populations is becoming a critical component of adaptive capacity for these at risk nations. Water is fundamental to wellbeing and livelihoods and plays an important role in the social and economic development of Caribbean nations.[70] In addition to supporting fundamental services such as sanitation systems, potable supply and hospitals, the region's important economic sectors - industry, agriculture and tourism - are all heavily reliant on water. Drought in the region in 2009/10 resulted in water shortages which caused substantial agricultural losses, increased food prices and impacts to the tourism sector.[71]

Figure 11.
Renewable internal freshwater resources per capita in 2011

Data not available for Dominica, Grenada, St. Lucia, St. Vincent and the Grenadines.
Source: World Bank[78]



With their limited terrestrial footprint for storing and absorbing water, security of supply is a particular problem for Caribbean islands. Climate change in this sub-region is increasing temperatures, altering precipitation patterns, and placing coastal freshwater resources (both surface and ground water) at risk of salinization from SLR.[72] Total annual precipitation is also expected to decrease across the area.[73] However, regional climate models suggest that there will be considerable variation in how these factors affect different parts of the Caribbean. For example, the northern Caribbean is projected to experience more intense rainfall events but fewer rainy days, while the southern area is projected to experience the opposite.[74] The changing patterns and dynamics are likely to result in impacts to availability, at the very least on a seasonal basis. Water resources are also affected by tropical cyclones (hurricanes), which can erode top soil, and lead to the contamination of aquifers and surface water sources.[75]

As illustrated in *Figure 11: Renewable internal freshwater resources per capita in 2011*, of the top ten countries within the region with the fewest internal renewable freshwater resources, eight are Caribbean islands, with the Bahamas, Barbados, St. Kitts and Nevis and Antigua and Barbuda all exhibiting less than 1000m^3 of renewable freshwater per capita. Resource availability in the Bahamas and Barbados is particularly acute - these countries fall within the top 20 countries globally with the lowest renewable internal freshwater levels per capita.[76]

A variety of approaches have been taken to address water availability on the islands, although each of these entails associated risks. Antigua and Barbuda and The Bahamas rely on desalination plants for a substantial portion of their freshwater, which requires extensive investment and intensive energy use. Rainwater harvesting is another technique used on smaller islands, such as the Grenadines, and thus supply is vulnerable to disruptions in weather patterns. Ground water supplies are exploited to varying levels on many islands and are intensively used in countries such as the Bahamas and Barbados. However, these are typically very shallow and thus vulnerable to saltwater intrusion and over exploitation.[77]

Water security is not solely related to the availability and adequacy of the resource, it is also characterised by accessibility, assurance, and affordability, all of which are greatly influenced by efficiency of governance.[79] Factors such as resource management, water quality, projected demand and service provision all influence the sustainability of water usage. In the Caribbean, concerns over the financial sustainability of water services (supplies), the state of existing water infrastructure, the need to prevent pollution and the impacts of natural hazards on water quality and water infrastructure have been identified by the Inter-American Development Bank (IDB) as contributing to water security issues for these nations.

Many islands suffer from inadequate resource management strategies for water, rather than a lack of available water. Paradoxically, some Caribbean nations, such as Haiti and Jamaica,[80] have sufficient resources to meet demands but security is limited by low ability to access and supply water to users.[81] A reliance on surface water sources and a lack of storage reservoirs plays a particular role in water security issues in St. Lucia, St. Vincent and the Grenadines, and Trinidad - figures compiled by the IDB suggest that a 35% deficit already exists between supply and demand in St. Lucia[82] Over-exploitation of the Lower Rio Cobre aquifer in Jamaica resulted in saline intrusion up to 8km inland in some areas in the 1970's.[83] A 2012 OECD review of water management and policy in the Caribbean determined that funding inadequacies and highly centralised policy making were key obstacles for the Dominican Republic and Cuba.[84]

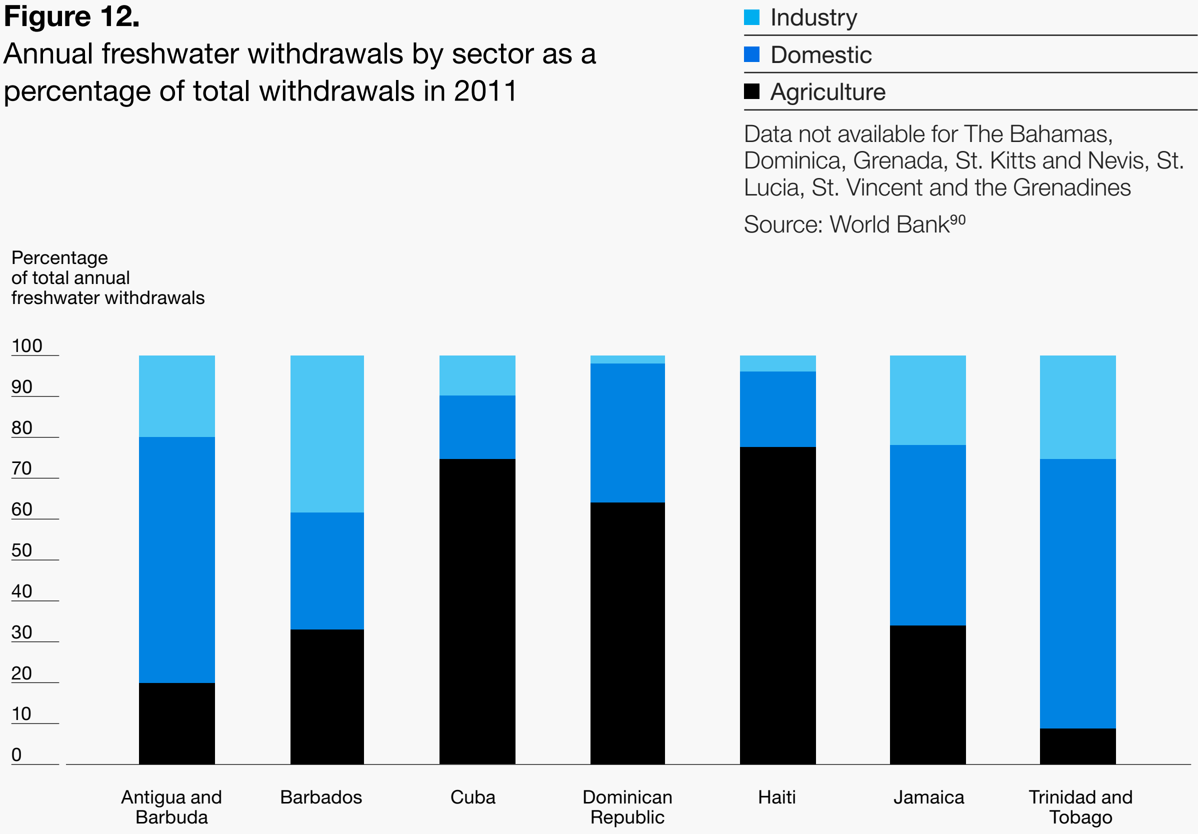
With the notable exception of Haiti, access to improved water supplies is generally above 90% for Caribbean countries.[85] However, the poor state of water supply infrastructure is a significant factor in driving insecurity. A lack of investment in maintaining networks contributes to losses through leakages and also to the vulnerability of supplies to external shocks such as natural hazard events. Affordability is also affected by the Caribbean's reliance on fossil fuels for the energy which powers water treatment and supply networks, including energy-intensive desalinisation plants, which increases costs for operators and therefore users.[86]

The lack of available data on hydrological dynamics in many areas is compounding management issues. As climate change brings greater variation to the hydrological cycle, this is likely to require assessment to identify changes to flows and recharge rates, in order to inform water management,[87] but this is also likely to be hampered by a lack of technical capacity.

Attempts to address water security issues on island nations will require a tailored approach

Varied water user profiles indicate that efforts aimed at Integrated Water Resource Management (IWRM) will require tailoring to the specifics of each island. *Figure 12: Annual freshwater withdrawals by sector as a percentage of total withdrawals in 2011* illustrates that the profile of water users varies significantly from island to island. Although data is unavailable for many of these states, which will compound water management issues for these nations, it can be seen that agriculture accounts for over 60% of withdrawals in Cuba, Haiti and the Dominican Republic, in contrast with Trinidad and Tobago and Antigua and Barbuda where it is 20% or less. Those islands with high relative withdrawals for the agriculture sector also correspond to those with some of the lowest available renewable resources within the region, elevating risks that the sector will come under pressure from competition for water resources in future in these locations. Given the critical importance of subsistence agriculture on many Caribbean islands, water security is inherently linked with poverty.[88]

Figure 12.
Annual freshwater withdrawals by sector as a percentage of total withdrawals in 2011



Data not available for The Bahamas, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines

Source: World Bank[90]

A universal approach to IWRM for the Caribbean sub-region is unlikely to be effective given the range of conditions present. In locations where agriculture accounts for a significant proportion of use, more efficient irrigation and processing practices can be investigated, in addition to alternative seed varieties and less water-intensive crops. Improved delivery and storage infrastructure may also play a part in reducing wastage for islands with high domestic and industrial use. Technology transfer to assist with reducing water usage in industrial processes is also a potential approach for this sector. On islands where concerns over food security have sparked an expansion of agriculture, such as the Dominican Republic,[89] adaptation will be critical to take advantage of this opportunity for growth in a sustainable manner.

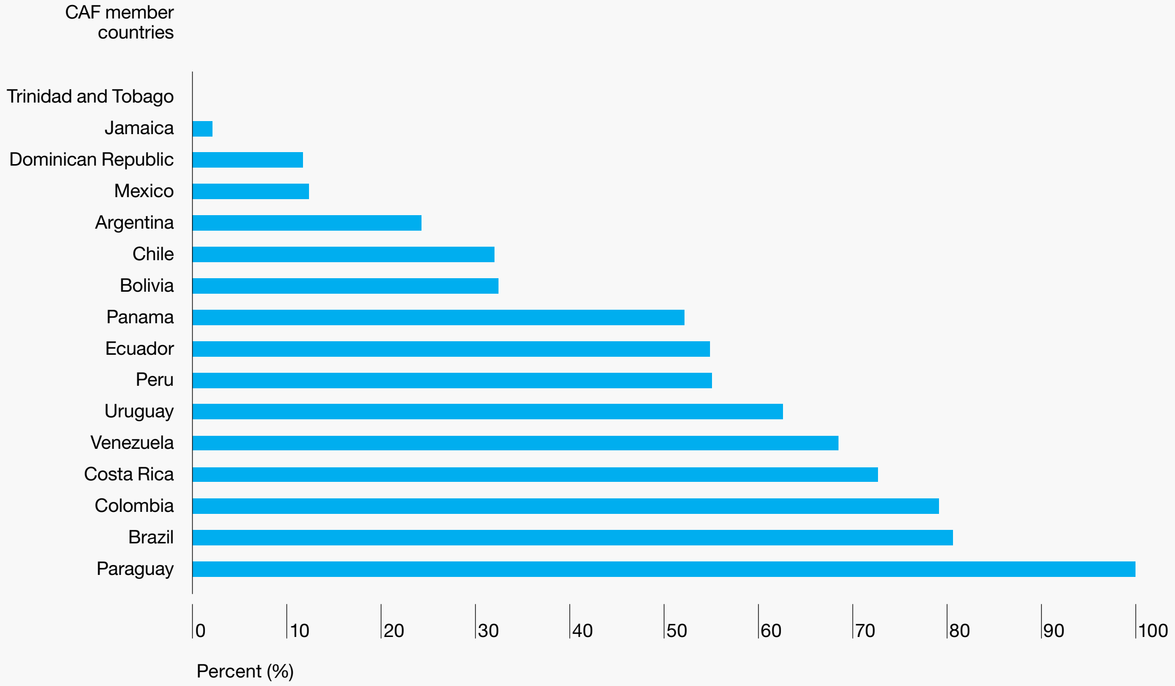
4.4.5 Energy security

A reliance on hydroelectric power presents climate-related energy security concerns

Energy security is a key factor in sustaining and advancing economic development, which has an important influence on adaptive capacity. Energy security is crucial for economic development and enhanced prosperity. In turn, this means that energy security also has implications for wellbeing and livelihood opportunities, and thus aspects of a population's sensitivity to climate change impacts. A nation's energy security can also reflect government capacity in terms of the institutional ability to plan and regulate for future circumstances and requirements. The changing climate has the potential to impact on energy in a number of ways, including changing energy demand as temperatures increase, influencing generating capacity at various types of power plants which rely on substantial and continuous water supplies for generation or cooling, and reducing transmission efficiency.[91] Extreme events also have the potential to affect production and the integrity of energy infrastructure.

Figure 13.
Percentage of total electricity produced from hydroelectric sources in CAF member countries in 2011

Source: World Bank[96]



With a high proportion of electricity generated from hydroelectric sources, Latin America is particularly exposed to climate change-related energy security risks.[92] Because of the likelihood that climate change will alter precipitation patterns in many parts of the region, and the projected continuation of the glacial melt already occurring in the Andes, countries such as Paraguay, Brazil, Colombia and Costa Rica, which rely heavily on hydropower for electricity, are exposed to long-term energy security risks. Many countries in the LAC region will likely need to improve water resource management and diversify power sources in order to maintain supplies. This has costly implications for governments and end users. For example, in Peru, where around 55% of electricity is derived from hydropower sources,[93] future water shortages predicted as a result of glacial retreat are very likely to affect hydroelectric output. Researchers estimate that there will be increased annual costs for energy generation ranging between US$212 million, if adaptation measures are introduced, and US$1.5 billion.[94] *Figure 13: Percentage of total electricity produced from hydroelectric sources in CAF member countries in 2011* illustrates the extent of the exposure to this potential risk faced by the region.

Countries planning to expand hydropower generation capacity to meet energy demands may also be affected by the impacts of climate change in future, particularly in areas where river flows are expected to decline as a result of climate change. For example, in the Rio Lempa basin, the largest river system in Mesoamerica which covers parts of El Salvador, Honduras, and Guatemala, modelling of climate change impacts suggests that reliable hydropower generation capacity within this system could be reduced by between 33 – 53% by 2070 to 2099.[95] El Salvador, lying downstream of Honduras and Guatemala, relies on this system especially for hydropower generation.

The impacts of prolonged drought on hydropower production have already caused significant disruption to South American countries. Over 80% of Brazil's electricity comes from hydropower. The prolonged drought experienced in Brazil over the 2013/2014 season severely restricted hydropower output in the southeast and central-west regions and led to power shortages. This has forced the government to subsidise electricity from other sources at the cost of billions of dollars. In February 2014, the media reported that reservoir levels had fallen to 34.6% of capacity in these regions. In March 2014, Brazilian imports of liquefied natural gas (LNG) reached record levels as alternative sources of energy were sought to keep pace with demand.

4.4.6 Adaptive capacity context in CAF member countries

Low adaptive capacity within CAF members closely linked with economic and governance factors

Bolivia (6th), Paraguay (7th) and the Dominican Republic (9th) are classified as 'extreme risk' on the Adaptive Capacity Index, representing the worst performing CAF member countries for this dimension of vulnerability. These countries have three of the five lowest GDPs per capita of the CAF member countries,[97] contributing to reduced financial capacity to adapt to climate change. Of the CAF member countries, agriculture makes the greatest contribution to the economies of Paraguay and Bolivia, forming 17.36% and 12.95% of GDP in 2012,[98] increasing their comparative economic exposure through climate sensitive activities.

Following Venezuela, the CAF member countries with the highest corruption risk scores on Transparency International's 2013 Corruption Perceptions Index are Paraguay and the Dominican Republic,[99] pointing to the role of effective governance in contributing to capacity concerns in these nations. Governance limitations also play a part in concerns over water management[100] and energy security in the Dominican Republic, both of which have the potential to hamper the country's economic growth and thus affect capacity to adapt. The Dominican Republic has net energy imports of approximately 89%,[101] the highest in the LAC region, making it susceptible to supply interruption. In Bolivia, despite improvements in government stability in recent years, moderate to high levels of poverty and inequality remain and the country still faces considerable governance challenges which contribute to its adaptive capacity risks.[102]

The CAF member countries exhibiting the lowest relative risks on the Adaptive Capacity Index are Chile (31st), Costa Rica (30th), Uruguay (28th), Brazil (27th) and Mexico (26th).These countries are all classified as 'low risk' on the Index. In 2012, Chile and Uruguay had two of the top three GDPs per capita for CAF member countries.[103] In general, governance indicators for these countries demonstrate moderate to high levels of performance in comparison other CAF member countries for many dimensions, although Mexico has relatively greater water security and corruption concerns than the other 'low risk' CAF countries. Within this 'low risk' group, comparatively lower university undergraduate completion rates and a higher relative proportion of GDP from agriculture are also a feature of Uruguay's adaptive capacity profile, although this is balanced by the country having the lowest corruption risks within the CAF member countries.[104]

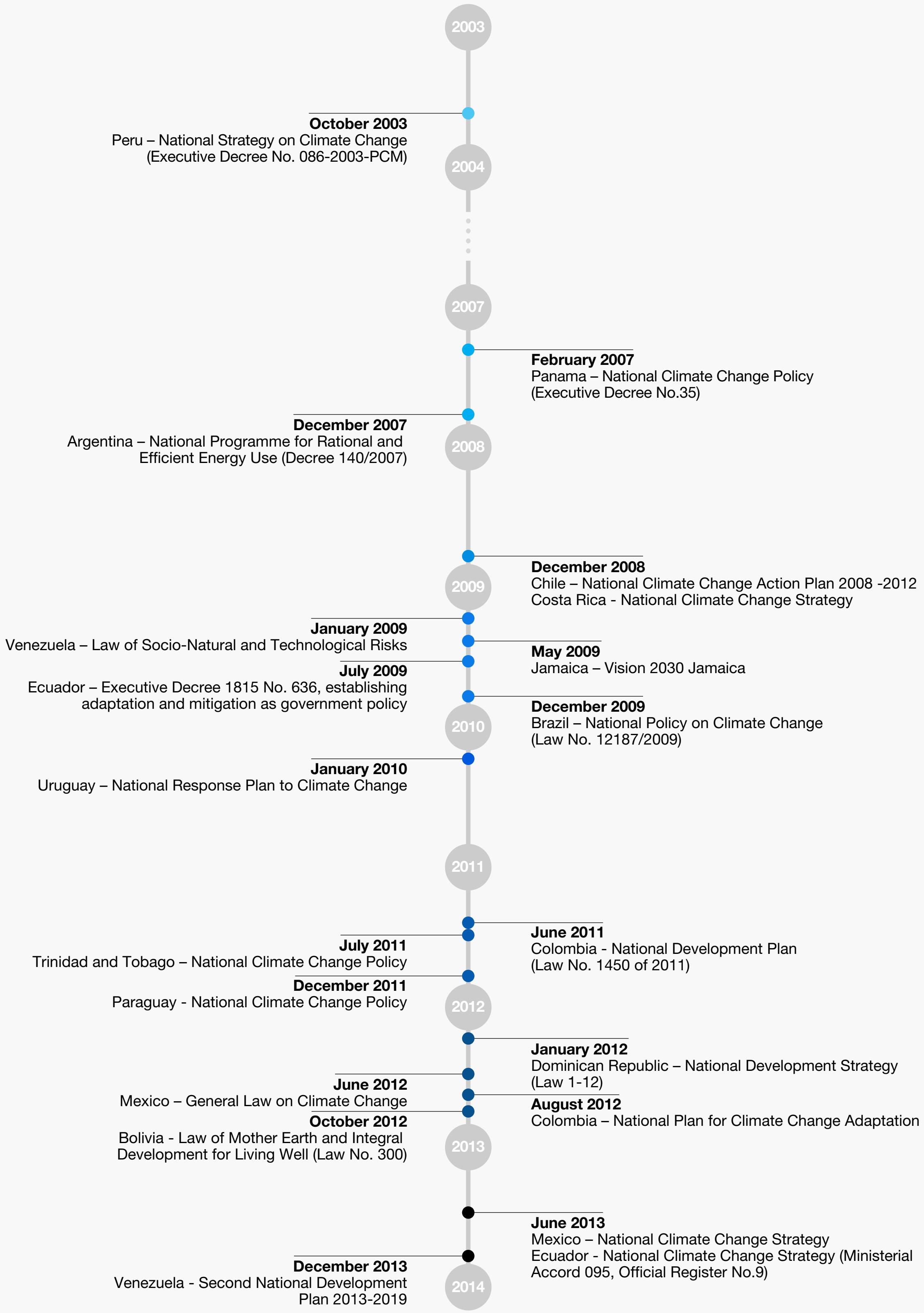
CAF members demonstrate policy commitments to tackling climate change

CAF members have climate change policy and associated governance frameworks in place, providing the foundations for climate change adaptation. *Figure 14: Timeline - Key climate change governance in CAF member countries* charts the development of key climate change policy and legislation within CAF member countries. The majority of these laws, policies and plans have been identified as 'flagship' legislation on climate change in a 2014 review conducted by the Global Legislators Organisation (GLOBE International).[105] The timeline indicates that all CAF member countries, with the exception of Venezuela (which has incorporated climate change into wider laws and development plans), have instituted specific climate change legislation and policies, with focus on this subject area increasing notably in the last seven years.

While the development of regulatory frameworks indicate the proactive management of climate change impacts across the region in general, the relative ability of countries to implement these laws and programmes will differ as a function of the governance, economic and societal factors driving their adaptive capacities. Reinforcing this point, at the GLOBE Climate Legislation Summit in January 2013 UNFCCC Executive Christiana Figueres highlighted the importance of implementing policies which have been developed. She reminded nations that "The legislation on paper does you no good, and certainly does the planet no good. You have to ensure that once the very difficult work of adopting legislation is done, your next chapter, your next challenge, is implementation."[106]

Figure 14.
Timeline - Key climate change governance in CAF member countries

Sources: GLOBE International and the Grantham Research Institute [107]; Republica de Panama, Ministerio de Economic y Finanzas[108]; Government of the Republic of Trinidad and Tobago[109]; Republica del Uruguay, Minsterio de Vivienda[110]; Republica de Paraguay, Secretaria del Ambiente[111]



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5— Vulnerability Index to Climate Change in the LAC Region

5.1 Overview

Climate change vulnerability in the LAC region is a multi-dimensional issue comprised of physical exposure to change in conjunction with population and societal circumstances which facilitate or hinder the ability to adapt. Understanding these components allows resilience-building efforts to target the drivers of risk to effectively increase capacities to address climate change impacts. The LAC region demonstrates a diverse range of circumstances contributing to its relative climate change vulnerabilities and risks. Countries will need to work in collaboration with each other and external partners to leverage national, regional and international technical and financial resources to reduce vulnerability to climate change across the region.

Substantial proportions of the population and GDP with the LAC region are exposed to 'high' or 'extreme' vulnerability risks. Over 50% of the population is currently residing in countries with 'high' or 'extreme' climate vulnerability risks. A significant proportion of future growth is expected to take place in urban areas, further emphasising the importance of improving land use regulation to avoid escalating climate vulnerability risks in these areas. Almost half of the LAC region's GDP is exposed to 'high' or 'extreme' climate change vulnerability, emphasising the urgent need to build resilience and economic diversity. As many of the countries with the highest adaptive capacity risks also have the lowest GDPs per capita within the region, any shocks to their economies are likely to significantly impact on prospects for building resilience.

Agriculturally dependent Mesoamerican countries and the larger Caribbean island nations present the most extreme vulnerability risks. Haiti is assessed as the having the highest climate change vulnerable risks in the LAC region, and is likely to experience the greatest adversity from climate impacts with very little capacity to build resilience to gradual changes or extreme events. In South America, Paraguay and Bolivia demonstrate the highest vulnerability, underscoring the development challenges in these countries and their comparatively low GDPs per capita within the region.

Analysis of climate change vulnerability at the city level revealed that capitals in the LAC region demonstrate significant vulnerability to climate change, with 48% categorised as 'extreme risk'. Cities were also found to elevate vulnerability in many countries, often due to their exposed locations and the concentration of population and assets. The most extreme vulnerability risks at the city level were exclusively located in key urban areas within Haiti, smaller Mesoamerican countries and the Dominican Republic.

Map 5.
Climate Change Vulnerability Index 2014, LAC region

5.2 Introduction

Building climate change resilience requires a holistic understanding of vulnerability

The global climate is changing due to human activities, requiring countries to adapt to the effects on the natural environment and their wider implications for society. The effects of climate change will be felt in both the short and long term. Future projected changes in the frequency and intensity of forest fires, severe weather events, droughts and flooding will result in context-specific impacts on populations, economies and infrastructure. The effects of rising temperatures, shifting rainfall patterns and rising sea level will also be felt across national borders, impacting coastlines, plant and animal species, agriculture and human health. Additionally, due to globalisation, the consequences of localised climate impacts on ecosystems, industrial processes, supply chains, and tourism may be felt internationally. In order to minimise the worst effects of climate change, it is necessary to fully understand the extent and degree of regional, national and sub-national vulnerability to extreme events and long-term climate change.

Climate change impacts are determined by a combination of physical exposure to hydro-meteorological variations, the underlying circumstances of a population and the degree to which a country's governance system is able to implement effective adaptation. According to the Intergovernmental Panel on Climate Change (IPCC), vulnerability to climate change is "a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity".[1] Therefore, vulnerability to potential climate change is dependent on:

— The level of **exposure** to the hazard;
— The degree of **sensitivity** within the system; and
— The ability of the system to **adapt** to change.

The Maplecroft Climate Change Vulnerability Index (CCVI) for the LAC region evaluates the vulnerability of human populations to extreme climate related events and changes in major climate parameters over the next 30 years. The CCVI combines the risk of exposure to changes in climate and extreme events, with the current human sensitivity to that exposure and the capacity of the country to adapt to, or take advantage of, the potential impacts of climate change. This balance between the extent of the changes which a country is likely to be exposed to and the resilience present within the population and its government provides an overall picture of the level of vulnerability.

Understanding vulnerability as a composite of multiple factors highlights the importance of preparing for physical exposure to climate change as well as addressing the drivers of sensitivity and low adaptive capacity. It is possible to lower vulnerability to climate change by reducing the sensitivity of the affected population and by improving the capacity of society to adapt. This requires awareness of the wider social, economic, political and environmental context of a country and it systems, which will shape the levels of resilience present and the potential for achieving improvements.

5.3 Results

5.3.1 LAC region

Countries with low socio-economic development exhibit highest levels of vulnerability

Within the LAC region, extreme vulnerability to climate change is concentrated in the agriculturally dependent Mesoamerican countries and the larger Caribbean island nations that have high relative exposure levels. Economic, political and social challenges in Haiti present the highest risks in the region for vulnerability, and this country is considered likely to suffer extensively from both the gradual and acute impacts of climate change (see Case study: Frequent natural disasters undermine development in Haiti, increasing climate change vulnerability). The comparatively less developed nations concentrated within Mesoamerica, which do not benefit from the economic diversity and trade connections which characterise countries such as Mexico, also display high levels of vulnerability within the LAC region. With two of the lowest GDP per capita rates within the region, Paraguay and Bolivia stand out as the South American nations with greatest vulnerability to climate change, although Venezuela, Ecuador and Colombia also have extensive areas characterised by high levels of vulnerability.

Table 11.
Climate Change Vulnerability Index for the LAC region

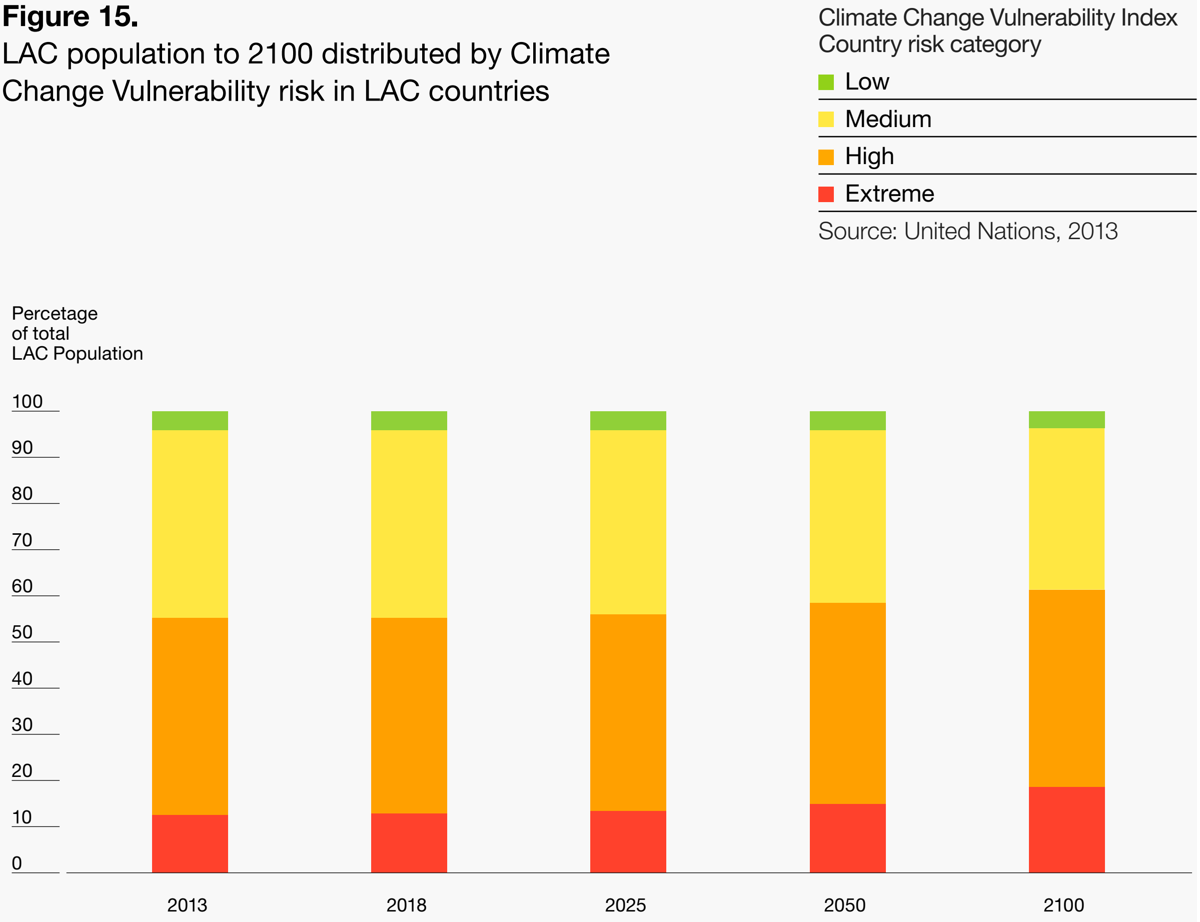
Country	Rank	Score	Category
Haiti	1	0.58	extreme
Guatemala	2	0.75	extreme
El Slavador	3	0.79	extreme
Honduras	4	0.92	extreme
Dominican Republic	5	1.01	extreme
Nicaragua	6	1.19	extreme
Jamaica	7	1.50	extreme
Paraguay	8	1.58	extreme
Belize	9	2.25	extreme
Bolivia	10	2.48	extreme
Venezuela	11	3.64	high
Ecuador	12	3.76	high
Dominica	13	3.85	high
Cuba	14	3.90	high
Guyana	15	4.23	high
Colombia	16	4.30	high
Mexico	17	4.47	high
Peru	18	4.98	high
Panama	19	5.57	medium
Antigua and Barbuda	20	5.64	medium
Brazil	21	5.77	medium
Suriname	22	5.85	medium
Saint Kitts and Nevis	23	6.24	medium
Argentina	24	6.66	medium
Trinidad and Tobago	25	7.22	medium
Costa Rica	26	7.70	low
Saint Lucia	27	8.25	low
Uruguay	28	8.33	low
Bahamas	29	8.68	low
Chile	30	9.54	low
Grenada	31	9.58	low
Saint Vincent and The Grenadines	32	9.63	low
Barbados	33	9.77	low

Population and GDP exposure to climate change vulnerability likely to increase without adaptation

The proportion of the LAC population residing within 'high' or 'extreme risk' areas for climate change vulnerability is projected to increase to 2100. *Figure 15: LAC population to 2100 distributed by Climate Change Vulnerability risk in LAC countries* indicates that over 50% of the population in the LAC region is currently residing in countries with 'high' or 'extreme' climate vulnerability risks. This increases to over 60% by 2100 using population projections from the United Nations Department of Economic and Social Affairs (UNDESA). *Figure 17: LAC population growth rate (2013-2025) distributed by Climate Change Vulnerability risk in LAC countries* indicates that population growth rates between 2013 and 2025 will be significantly higher in countries classified as 'extreme risk' on the CCVI than in other less vulnerable countries.

These figures are significant as particular growth is anticipated in the region's urban population, further increasing and concentrating risk in areas already experiencing high climate change vulnerabilities. Across the region, unregulated development in many low-income, urban communities is already contributing towards increased hazard exposure, so further growth in these areas underscores the importance of strategic land use control within municipal areas to address potential risks.

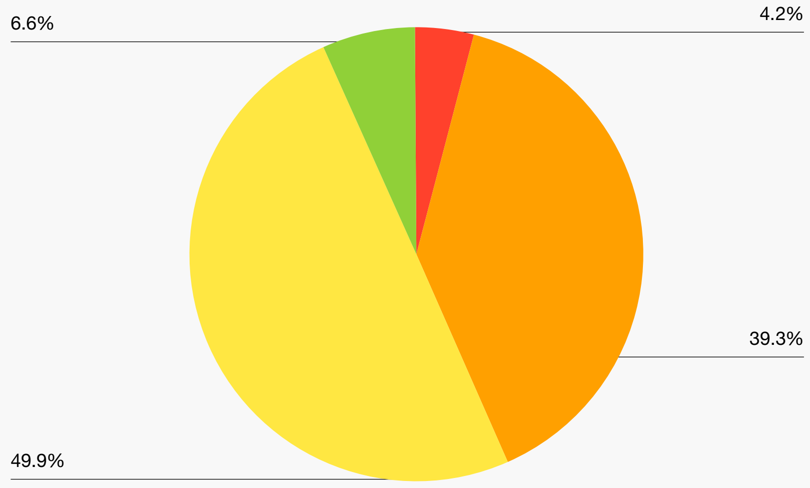
Figure 15.
LAC population to 2100 distributed by Climate Change Vulnerability risk in LAC countries



Source: United Nations, 2013

Almost half of the LAC region's GDP is exposed to high or extreme climate change vulnerability, highlighting the urgent need for these countries to address climate change risks. Just under 50% of GDP in the LAC region originates from areas categorised as 'high' or 'extreme risk' on the CCVI (see *Figure 16: Proportion of LAC GDP in each Climate Change Vulnerability risk category*). This compares to a figure of 20% of global GDP in 'high' or 'extreme risk' areas, as categorised by Maplecroft's global CCVI. For countries with the biggest development gaps and highest levels of vulnerability, this degree of economic exposure exacerbates the challenges posed by climate change in terms of supporting economic development and poverty alleviation efforts. It is likely that considerable reliance will be placed on external support to implement adaptation strategies.

Figure 16.
Proportion of LAC GDP in each Climate Change Vulnerability risk category



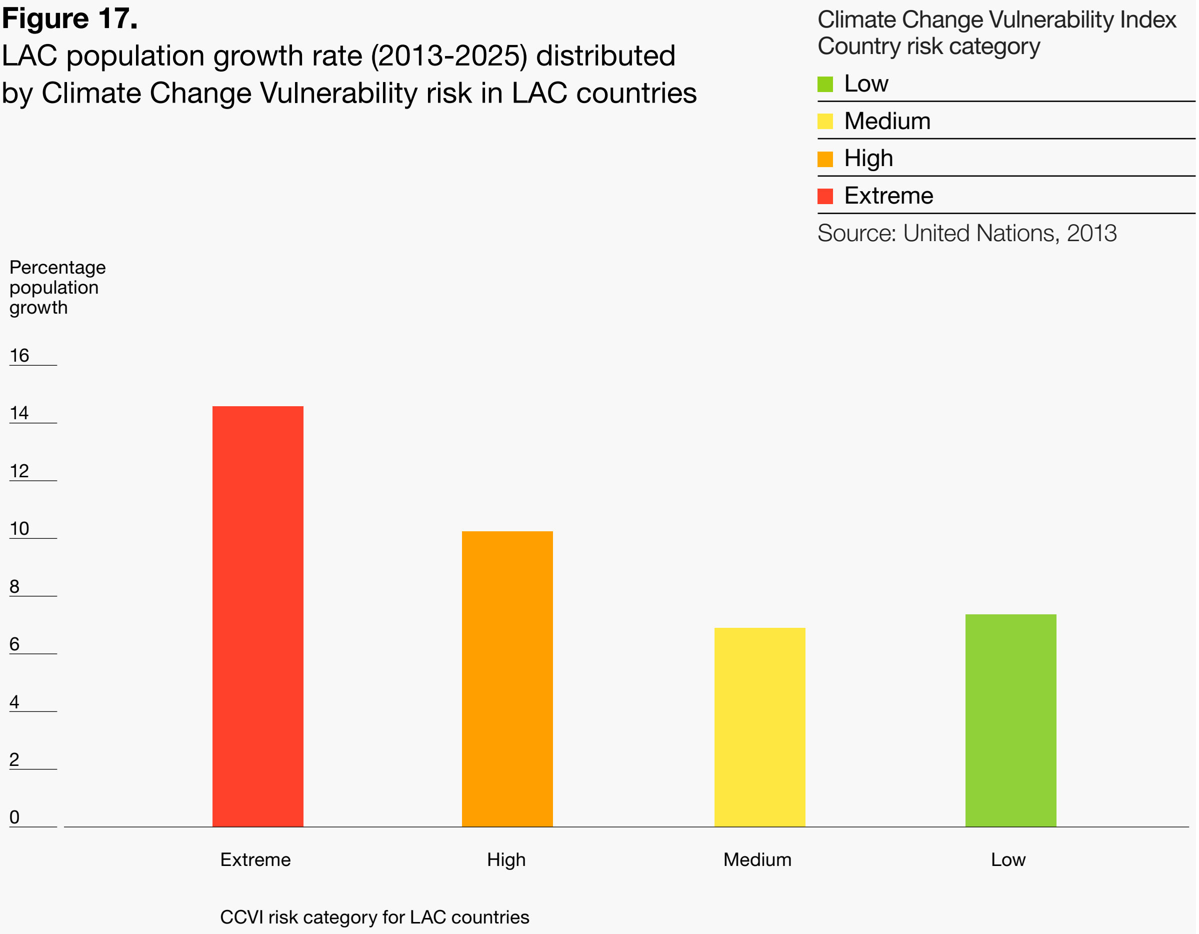
5.3.2 Mesoamerica

Vulnerability worst in Mesoamerican nations where poverty rates are highest

Mesoamerican countries constitute five of the top ten riskiest nations on the CCVI. **Guatemala** (2nd), **El Salvador** (3rd), **Honduras** (4th), **Nicaragua** (6th) and **Belize** (9th) are all classed as 'extreme risk' on the Index. With the exception of Belize, these countries are all classified as 'extreme risk' on the Adaptive Capacity Index and Sensitivity Index, demonstrating both the susceptibility of their populations to climate change impacts and their low inherent capacities to adapt to these challenges. Guatemala also has the 4th highest exposure risks, contributing to its position as the second most vulnerable nation to climate change in the LAC region. Belize is classed as 'high risk' for both exposure and adaptive capacity, although its relatively lower position on the CCVI is due to the much lower population sensitivity it exhibits, which is partially a function of its smaller population and poverty density relative to the other nations in this sub-region.

Mexico (17th), **Panama** (19th) and **Costa Rica** (26th), the nations with the three highest GDP per capita rates for Mesoamerica[2] and only countries from this sub-region classed as having 'high human development' on the UNDP's Human Development Index,[3] present a different pattern of vulnerability. Although Panama is 'high risk' on the Sensitivity Index, it presents only 'medium risk' on the Adaptive Capacity Index and has the lowest exposure score (5.26, medium) for the sub-region. Costa Rica is also classified as 'high risk' on the Sensitivity Index and in addition has the 14th highest exposure risk for the entire LAC region (3.70, high). However this is balanced by good prospects for adaptation – Costa Rica is ranked 30th on the Adaptive Capacity Index. Mexico has higher relative climate change exposure risks than either Panama or Costa Rica, however it is scored as 'low risk' on the Adaptive Capacity Index and the population sensitivity is classified as 'medium risk'.

Figure 17.
LAC population growth rate (2013-2025) distributed by Climate Change Vulnerability risk in LAC countries



Source: United Nations, 2013

High exposure compounds risks for rural disadvantaged communities

Despite the regional trend towards urbanisation, many Mesoamerican countries have high rural populations which remain isolated from essential services and markets. In Belize, Guatemala, Honduras and Nicaragua over 40% of the population is rural, compared with under 25% in the less vulnerable countries of Panama and Mexico.[4] Climate-sensitive agriculture forms a substantial component of these societies, both in terms of subsistence production and income generation. Regionally high levels of poverty are present in both urban and rural areas. Generally low government capacity to develop and deliver services is particularly pronounced in rural areas, affecting education and health provision for large proportions of the populations. The economies exhibit limited diversity and market access, and low GDP per capita outcomes, limiting the financial resources of both governments and individuals to build capacity.

These elements result in limited prospects for socio-economic development and reduced human capital to improve institutional abilities to adapt to climate change. The structure of these countries, in conjunction with their consistently high exposure to both acute weather extremes and gradual climate events, presents the population with little aptitude for building resilience to climate change and indicates that these countries will be highly reliant on external technical and financial assistance to develop and implement strategies to adapt.

Case study

Rural poverty and agricultural reliance increasing climate change vulnerability in Guatemala's dry corridor

Guatemala is the 2nd most vulnerable country in the LAC region to climate change impacts. Not only is it highly exposed to climate change and natural hazards, but the high proportion of Guatemala's population that is rural, living in poverty and reliant on agriculture increases overall sensitivity to these impacts. Approximately 51% of Guatemala's population live in rural areas,[5] 32% of the national workforce are employed in agriculture[6] and over 50% of the population lives below the poverty line.[7]

One area demonstrating acute vulnerability to climate change is the country's 'dry corridor', a semi-arid area covering the states of Baja Verapaz, El Proreso, Zacapa, Chiquimula, Jutiapa and Jalapa. Poverty levels amongst some rural populations in this area have been estimated at 70%.[8] Many families in the region toil in subsistence agriculture, extracting low yields from their crops on account of the degraded, dry soil and limited use of inputs. Food insecurity runs high due to frequent droughts and variable rainfall patterns yet the most productive, irrigated lands within the area are utilised for the production of export-oriented cash crops such as melons.

Subsistence farmers in the region experienced a decrease in yields in 2008 due to a combination of the high costs of fertilizers, delays in the delivery of government-subsidised products, and excessive rainfall which led to outbreaks of crop pests and diseases.[9] The subsequent decrease in food available the following year caused acute malnutrition in children under five, with particularly severe impacts observed in the dry corridor. In 2009, 2.5 million Guatemalans across 21 provinces were affected by severe drought. The extended dry period was exacerbated by the El Nino weather pattern. Once again the dry corridor suffered immense economic and social hardship. Crop losses in certain areas hit 80% (some farmers were not even able to recover seeds for the next year's crops) and approximately 400,000 families were affected.[10] Additionally, 25 children in the region were reported to have died as a consequence of the event and 30% of all pregnant women were malnourished.[11]

Mesoamerica is expected to experience increasing temperatures, substantial decreases in precipitation and extended periods of drought as a result of climate change. Without substantial interventions to reduce sensitivity to these impacts, particularly in areas such as the dry corridor, current and future generations are likely to suffer severe immediate and long-term consequences.

5.3.3 The Caribbean

Geographical range contributes to differences in Caribbean island vulnerabilities

Highly vulnerable Haiti is likely to experience the greatest adversity from climate change impacts. As the country exhibiting the highest sensitivity and adaptive capacity risks within the region and the fifth highest exposure risk, Haiti is ranked as the most vulnerable country to the impacts of climate change. Given its location within the typical North Atlantic tropical cyclone storm track and classification as a 'least developed country' by the United Nations,[12] Haiti experiences repeated impacts from extreme weather events and has little opportunity to develop the financial, technical or institutional resources required to recover from these impacts and adapt to future climate changes.

Neighbouring **Dominican Republic** (5th) and **Jamaica** (7th) are also classified as 'extreme risk' on the CCVI, with **Cuba** (14th) 'high risk'. The high physical exposure of these larger Caribbean island nations to climate change – Haiti is 5th, the Dominican Republic 6th Jamaica 1st and Cuba 3rd on the Exposure Index - drives much of the inherent vulnerability for these nations. 'High' or 'extreme' population sensitivity scores for all of these nations serve to compound the exposure risks.

The smaller island nations of the Caribbean generally display a less risky vulnerability profile, with all except Dominica (13th) classified as 'medium' or 'low risk' for climate change vulnerability. Dominica has very high exposure risks relative to the region, which result from a combination of topography-driven precipitation related landslide risks, tropical cyclones and drought potential. Despite the high exposure of many of the more northerly smaller islands to the physical impacts of climate change, such as **St. Kitts and Nevis** (23rd), the **Bahamas** (29th), **Antigua and Barbuda** (20th), these nations have good relative levels of GDP per capita and score well for adaptive capacity.

Conversely, despite sensitive populations, low relative exposure for islands such as **Barbados** (33rd), **Grenada** (31st) and **St. Vincent and the Grenadines** (32nd) is complemented by good prospects for adaptive capacity, reducing vulnerability in these states. **Trinidad and Tobago** (25th) and **St. Lucia** (27th) are classified as 'medium risk' for each of the three component aspects of vulnerability (except Exposure, for which St. Lucia is classified as 'low risk'), contributing to their lower levels of vulnerability relative to many other states in the LAC region.

Economic reliance on favourable weather conditions a particular vulnerability given high levels of exposure

A substantial element of vulnerability in the Caribbean is driven by the reliance on prevailing weather conditions for large sectors of the economy. Island nations are constrained by extremely finite levels of resources and space, which, in combination with poverty and unemployment issues on some islands, leaves little flexibility to absorb variations in conditions, even under current circumstances. For example, water resources are already scarce on some islands. Many of the economies in this region exhibit low levels of diversity and simultaneously high levels of vulnerability to climate change impacts, due to the importance of climate-sensitive tourism and/or agricultural sectors. A notable exception to this is Trinidad and Tobago, where the petroleum sector comprises around 40% of GDP.[13] Due to its relevance to the tourism industry, much extensive and vital infrastructure, critical to the functioning of commercial businesses and livelihoods, is located in coastal locations.

The social, economic and environmental challenges currently facing many Caribbean islands highlight limited buffers against the consequences of a changing climate. This is aptly demonstrated by the impacts of tropical cyclones (hurricanes) on the region. With small land masses and specific commercial profiles, island populations have no options for relocating away from hazardous zones such as typical tropical cyclone tracks, and inherent exposure risks to the associated strong winds, heavy rainfall and storm surges are high, particularly for the more northerly islands. With large amounts of commerce reliant on consistently pleasant weather conditions, economic impacts from extreme weather events, such as lost tourism trade and infrastructure damage, as well as crop losses, can be considerable. These effects are long lasting, because a lack of financial capacity at the institutional level contributes to lengthy recovery timescales.

Case study

Frequent natural disasters undermine development in Haiti, increasing climate change vulnerability

Haiti's vulnerability to climate change is exacerbated by high levels of poverty, weak governance and recurring natural hazard events, which have combined to reduced its resilience to both the acute and gradual impacts of climate change.

When Hurricane Sandy passed through the Caribbean in 2012, Haiti had not yet recovered from the effects of the Port-au-Prince earthquake in January 2010 and the subsequent cholera epidemic. The magnitude seven earthquake had a devastating impact upon Haiti's population - with 300,000 estimated deaths, the displacement of 1.3 million people into temporary shelter, and destruction of hospitals, courts of law and administration buildings.[14] The impact of this disaster greatly compounded the country's historically very low levels of resilience to leave the island particularly vulnerable to the effects of Hurricane Sandy. As a result, although the island was only hit by the outer rain bands of the storm, it destroyed 70% of crops in the south, while 54 people were killed across the country.[15] In contrast, while the United States bore the full brunt of the storm and over 50 million were affected (over five times the population of Haiti), only 72 people were killed, reflecting the population's lower sensitivity to such events and higher capacity of the government to adapt.

Very limited resilience in Haiti is further illustrated in its slow recovery. A lack of infrastructure, such as transport networks, and permanent buildings has made it difficult to rebuild livelihoods and further slowed redevelopment. With humanitarian support now running dry and limited access to other funding sources, Haiti has a limited financial capacity to rebuild and implement adaptation strategies.

Hurricane Sandy and previous disasters have left the country in a cycle of perpetuating vulnerability which can be hard to break, raising serious concerns over the potential impacts of climate change on the country's development opportunities.

5.3.4 South America

Paraguay and Bolivia exhibit greatest vulnerabilities within the continent

The countries of continental South America display a notable range of vulnerability to climate change. **Paraguay** (8th) is rated as the most at risk country within this sub-region, classified as 'extreme risk' on the CCVI. **Bolivia** (10th) is the only other country classified as 'extreme risk on the Index, however this is closely followed in the rankings by **Venezuela** (11th), **Ecuador** (12th) and **Guyana** (15th). Higher risks for Paraguay, Bolivia and Ecuador are driven by high levels of population sensitivity and low prospects for adaptive capacity. Sensitivity risks are lower in Venezuela, however, in comparison to the rest of the sub-region, exposure and adaptive capacity risks are quite high. Guyana's vulnerability is due in large part to low adaptive capacity. Despite only 'medium' exposure risks, **Colombia** (16th), and **Peru** (18th) are also all classified as 'high risk' on the CCVI, driven by their respective higher population sensitivities within the sub-region.

The more developed nations of **Brazil** (21st) and **Argentina** (24th) are classified as 'medium risk', while **Uruguay** (28th) and **Chile** (30th) are assessed as having the lowest risk for climate change vulnerability. The comparatively low vulnerability of **Suriname** (22nd) is perhaps unexpected for a country with only medium levels of human development,[16] however it has a comparatively high GDP per capita within the region, a low overall population density and large parts of the country exhibit only low exposure to the impacts of climate change.

Amongst the South American countries, Paraguay and Bolivia stand out as exhibiting high or extreme vulnerability to climate change across the largest areas of their land areas. These countries have the lowest per capita GDPs of the sub-region and the most agriculturally exposed economies, proportionally, in South America. The climate vulnerability of this sector is exacerbated by high levels of land degradation in the east and south of Paraguay and low production potential and soil suitability in western parts of Bolivia.[17] Paraguay and Bolivia perform consistently poorly across a number of development indicators such as poverty rates, levels of undernourishment, and access to improved sanitation and water supplies. They are the only South American countries classed as having just 'medium' human development on the UNDP's 2013 HDI.[18]

Natural resources and ecosystem services of particular importance

The wealth of natural resources in both Suriname and Guyana suggests significant opportunities for improving socio-economic circumstances and thus adaptive capacity. While Suriname demonstrates a similar overall vulnerability to Brazil, its prospects for adaptive capacity are much lower, whereas Brazil's vulnerability has a more significant exposure component. Although Suriname and Guyana rank low regionally for population sensitivity, on a par with Brazil, Argentina, Chile and Uruguay, they lag far behind in terms of development. Assistance to derive greater returns from the natural resources present in these countries could in turn contribute to improvements in societal factors such as economic diversity, governance, infrastructure and technical capabilities which would confer greater adaptive capacity. For example, Suriname has over three times and Guyana over five times the amount of renewable internal freshwater resources per capita than the next most abundant country in the region, Peru,[19] indicating that a proportion of this resource could be exploited without impacting on population requirements. Vulnerability in these countries is concentrated in coastal areas where exposure risks are greatest and coincide with where the majority of their populations live, however significant marketable natural resources are located in areas where climate change exposure is low.

The range of geographies and inter-connected social, economic and environmental systems encompassed by the southern countries of South America highlight the importance of considering climate change impacts from a transboundary perspective. Brazil, Argentina, Chile and Uruguay generally demonstrate strong socio-economic development and comparatively low climate vulnerability within the regional context. The technical, financial and institutional capacity that their relative development status confers is critical to their ability to implement adaptation strategies (see Case study: Implementation of innovative drought insurance scheme demonstrates low vulnerability in Uruguay). However, these countries are home to some of the most important natural environments on the continent, which are critical for maintaining economic prosperity and underpin many livelihoods/economies in the region. These resources span national boundaries and are influenced by a range of hydro-meteorological factors. Regional environmental assets which are at risk from climate change impacts include ecosystem services provided by the Amazon basin,[20] water resources in the Andes; and soil resources in the rangelands which stretch from north-eastern Brazil to Patagonia.[21] The importance of these features suggests that, for these more developed nations, preservation of ecosystem services will be a key factor in continuing to lower the sensitivity of their populations and implementing effective adaptation.

Case study

Implementation of innovative drought insurance scheme demonstrates low vulnerability in Uruguay

Hydropower can be highly sensitive to climate change impacts, such as variations in rainfall which result in reduced electricity generation and subsequently undermine the financial viability of existing or potential schemes.[22] This poses a significant risk to Uruguay's state-owned electricity company, Administracion Nacional de Usinas y Transmisiones Electricas (UTE), and the wider economy as Uruguay obtains more than 80% of its electric power from a network of hydro-electric dams.

The country has experienced substantial economic harm as a result of previous droughts. Additionally, although climate projections of precipitation in Uruguay show minimal change over the next century relative to the period of 1980-2004,[23] research indicates that there is increased potential for prolonged droughts over the period to 2100.[24] As such, the country's energy sector faces serious risks from variations in rainfall.

In 2008, erratic rainfall resulted in a drought that cost the country US$900 million in crop losses. In addition, falling reservoir levels had a perceptible effect on the generating capacity of Uruguay's hydroelectric dams. In 2012, drought forced the UTE to substitute hydropower for fossil fuel generated electricity at significant cost to the company, the government and consumers.

To protect itself from future droughts, the government of Uruguay obtained from the World Bank a US$450 million weather and oil price insurance transaction for UTE. According to the terms of the agreement, if rainfall drops below a certain pre-determined level, UTE receives a payout of up to US$450 million, depending on how severe the drought is and the current price of oil. A key factor enabling the agreement is Uruguay's strong hydrological expertise and the maintenance of detailed precipitation records over the past 100 years. The historical records helped the team that created the mechanism to better understand rainfall variables and develop more accurate measurements to help underpin the insurance.

The government of Uruguay's ability to reduce the vulnerability of its energy sector to climate change impacts demonstrates a high degree of technical and financial capacity. This reflects the country's low relative vulnerability to climate change in comparison to regional and international peers.

5.3.5 Urban areas

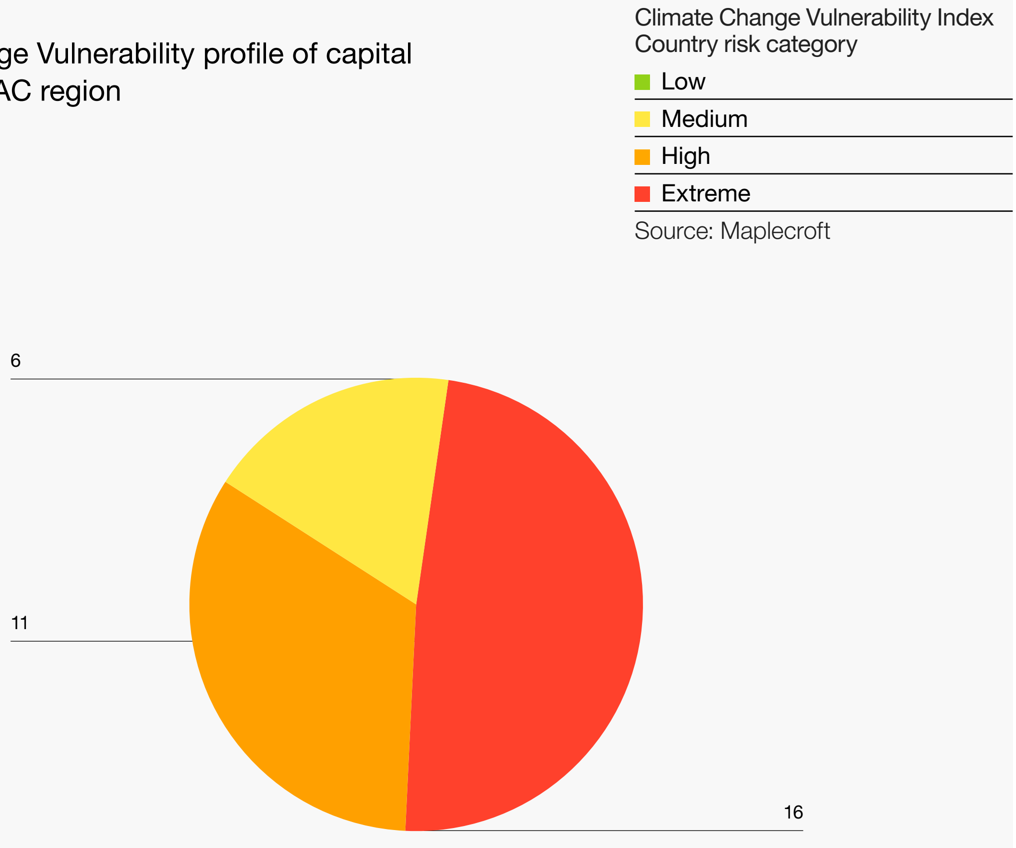
Extensive climate change vulnerability across the capital cities of the LAC region

Capital cities in the LAC region demonstrate significant vulnerability to climate change, with 48% categorised as 'extreme risk' on the CCVI. The extent of this vulnerability is of considerable concern given the key role of capitals in national governance and as drivers of economic development. These cities are distributed across the LAC sub-regions, emphasising the relative weaknesses in many areas to address climate change risks (see *Table 12: Climate Change Vulnerability profile of capital cities in the LAC region*). There are no capital cities in the region categorised as 'low risk' for vulnerability. The capitals include some of the largest cities in the world, such as Mexico City and Buenos Aires - even accounting for the vast populations of these metropolitan areas, these cities are only classified as 'high risk' on the CCVI and rank far below other much smaller cities such as Georgetown in Guyana with 127,000 inhabitants, and St. John's on Antigua with 27,000 inhabitants (see *Table 12: Climate Change Vulnerability Index for capital cities in the LAC region*).[25] Although population sensitivity is comparatively high in the larger cities, adaptive capacity prospects moderate their vulnerability levels.

Table 12.
Climate Change Vulnerability Index for capital cities in the LAC region

Capital city	Country	Capital city CCVI score	Country CCVI Score
Guatemala City	Guatemala	0.39	0.75
Managua	Nicaragua	0.39	1.19
Port-Au-Prince	Haiti	0.42	0.58
Santo Domingo	Dominican Republic	0.55	1.01
Georgetown	Guyana	0.56	4.23
Tegucigalpa	Honduras	0.63	0.92
San Salvador	El Salvador	0.74	0.79
Quito	Ecuador	0.90	3.76
Kingston	Jamaica	1.14	1.50
Bogota	Colombia	1.28	4.30
Paramaribo	Suriname	1.35	5.85
Panama City	Panama	1.37	5.57
Saint John's	Antigua and Barbuda	1.55	5.64
Roseau	Dominica	1.77	3.85
Belmopan	Belize	2.30	2.25
Havana	Cuba	2.47	3.90
La Paz	Bolivia	2.52	2.48
Caracas	Venezuela	2.56	3.64
Asuncion	Paraguay	2.63	1.58
Nassau	Bahamas	2.86	8.68
San Jose	Costa Rica	3.26	7.70
Port Of Spain	Trinidad and Tobago	3.32	7.22
Mexico City	Mexico	3.38	4.47
Montevideo	Uruguay	3.38	8.33
Saint George's	Grenada	3.48	9.58
Brasilia	Brazil	3.52	5.77
Buenos Aires	Argentina	3.73	6.66
Basseterre	Saint Kitts And Nevis	5.26	6.24
Lima	Peru	5.51	4.98
Bridgetown	Barbados	5.60	9.77
Kingstown	Saint Vincent and the Grenadines	5.69	9.63
Santiago	Chile	5.70	9.54
Castries	Saint Lucia	6.47	8.25

Figure 18.
Climate Change Vulnerability profile of capital cities in the LAC region



Source: Maplecroft

Highest levels of urban vulnerability not concentrated solely in the region's megacities

Amongst the largest cities in the LAC region, Bogota has the greatest climate change vulnerability risks despite having a population less than half the size of Sao Paulo and Mexico City. Climate risks in Bogota stem from a number of factors. Much of the city is prone to flooding, particularly in southern zones where it is crossed by rivers such as the Tunjuleo, Fucha and Juan Amarillo.[26] Around 2.5 million, mostly low income residents live in the Tunjuelo River Basin in the south of the city, a flood hazard area.[27] Unregulated, illegal low income development has expanded on landslide prone slopes on both the northern and southern sides of the city,[28] although some household relocation is occurring.[29] High levels of socio-economic inequality also characterise the city,[30] increasing sensitivity for the large proportion of the population on low income. In addition, Bogota relies on the glaciers and Paramo grasslands of the northern tropical Andes for water supplies, ecosystems that are under threat from climate change.[31]

Key urban areas in Haiti and the smaller nations of Mesoamerica dominate the most extreme risk scores within the Index, presenting a significant challenge for capacity building. Of the cities scored within the LAC region, Les Cayes, Jacmel, Gonaives and Fortliberte in Haiti demonstrate the four highest CCVI scores, consistent with Haiti's position as the riskiest country on the regional CCVI. Cities within the Mesoamerican nations of Guatemala and Nicaragua also receive the greatest majority of the very highest risk scores, followed by cities in Guyana, Honduras and the Dominican Republic. These Latin American countries also exhibit erratic and unreliable GDP trends (see *Figure 4: GDP growth 2000-2012 for LAC countries with the lowest HDI scores*). They also occupy the top five rankings within the Adaptive Capacity Index, (the Dominican Republic is 9th), suggesting that creating climate resilience within these municipalities will be very difficult to achieve.

Table 13.
Climate Change Vulnerability Index scores for the largest cities in the LAC region

City	Population (2011)	City Climate Change Vulnerability Index score
Mexico City, Mexico	20,446,000	3.38
Sao Paulo, Brazil	19,649,000*	5.53
Buenos Aires, Argentina	13,528,000	3.73
Rio de Janeiro, Brazil	11,867,000*	4.39
Lima, Peru	9,130,000	5.51
Bogota, Colombia	8,743,000	1.28
Belo Horizonte, Brazil	5,407,000*	3.01

*figure for 2010

Source for population data: United Nations Department of Economic and Social Affairs[32]

Cities can concentrate vulnerability to climate change, having greater population densities relative to rural regions and often located in inherently risky geographies. Even countries with moderate climate change vulnerability at the national level can exhibit much higher risks in their cities. This is the case in Paramaribo, Suriname, which is home to the majority of the country's population[33] and is its economic centre. It is also located along Suriname's low lying coast, which is by far the most exposed part of the country, being particularly susceptible to SLR and severe storm impacts. Whereas some of the Bahamian islands have very low populations, which contributes to low vulnerability and sensitivity risks for the country overall, the population concentration in the city of Nassau serves to elevate sensitivity and thus vulnerability. Coastal Montevideo in Uruguay is at particular risk from SLR which is expected to be higher than the global average around this part of the South American continent. This elevates vulnerability within the city, although Uruguay as a whole is exposed to minimal climate change impacts, as it is located outside of tropical cyclone latitudes and has lower relative risks for flooding and droughts.

Countries with a greater proportion of key urban areas assessed as having higher vulnerability risks may face additional challenges in delivering effective adaptation. The profile of urban vulnerability within the national context varies tremendously across the LAC region. *Figure 19: City Climate Change Vulnerability Index risk distribution by country* shows the proportion of key urban areas (administrative capitals and other major cities) in each country assessed as extreme, high, medium or low risk.

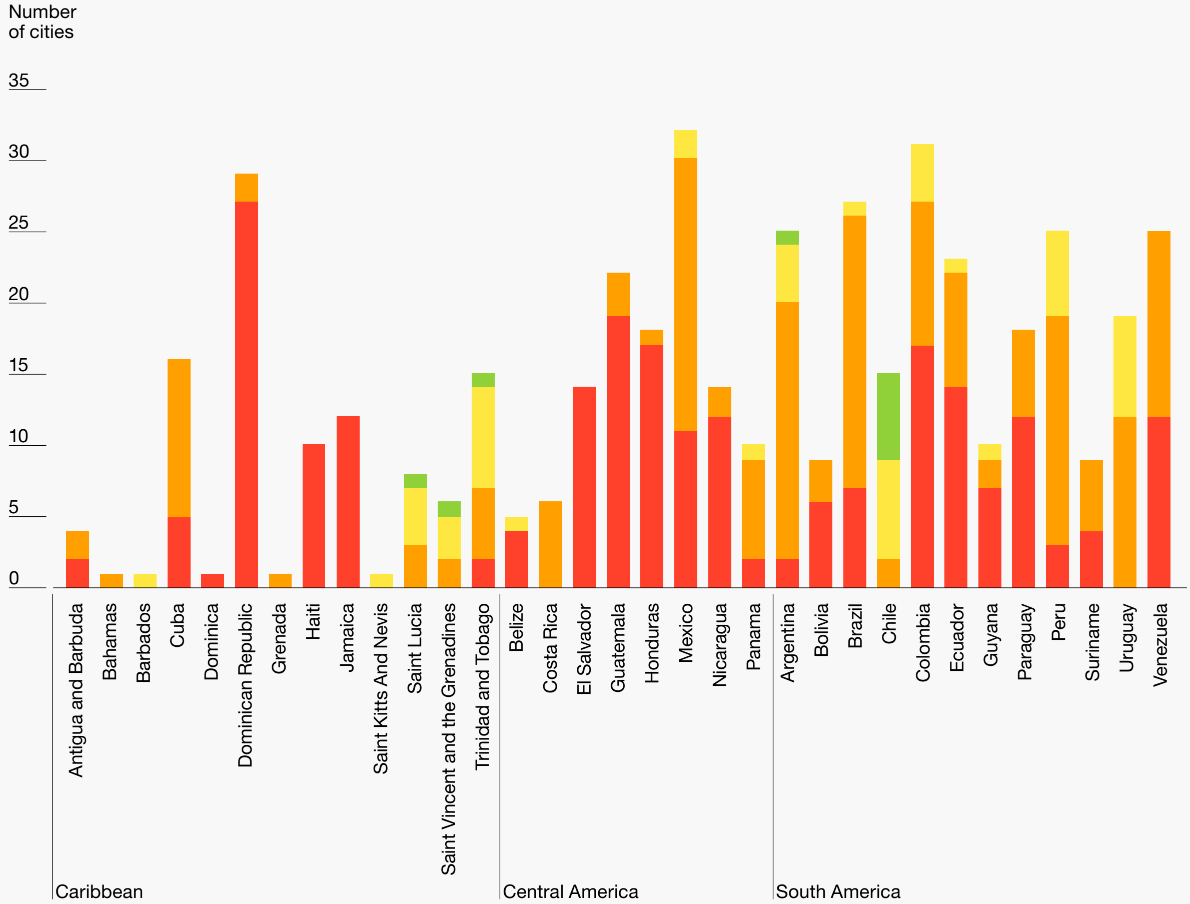
This shows that the majority of the cities in Mesoamerica are categorised as 'extreme risk' on the CCVI, and for El Salvador, Guatemala, Honduras, Costa Rica and Nicaragua, all of their major urban areas are classed as 'high' or 'extreme risk'. This is also the case for Bolivia, Paraguay, Suriname and Venezuela in South America. This contrasts with other South American countries which have cities with a range of vulnerability risks, such as Chile, Peru, Uruguay and Argentina. A country may have increased adaptive capacity requirements, particularly financial and technical resource needs, if it contains a large number of key urban areas exhibiting high or extreme vulnerability to climate change.

Although it may be simpler to prioritise resources for addressing urban vulnerability in countries with very few key urban areas, the concentration of nationally-significant assets makes the need to adapt equally important. In particular, some of the smaller Caribbean nations, such as the Bahamas, Dominica and Grenada, contain only one major urban area. However each of these has a 'high' or 'extreme risk' score on the CCVI. Due in part to local administrative arrangements, the larger islands in the Caribbean have a greater number of key urban centres, although most of these are also 'high' or 'extreme risk'.

Figure 19.
City Climate Change Vulnerability Index risk distribution by country

Climate Change Vulnerability Index
Country risk category
- Low
- Medium
- High
- Extreme

Source: Maplecroft



5.4 Conclusion

Efforts to improve adaptive capacity in the LAC region must continue

The analysis presented in this report provides a comparative lens to inform climate change adaptation (CCA) efforts in the LAC region. It is important that the region's vulnerability is understood as a multi-dimensional issue comprised of physical exposure to change in conjunction with the population and structural circumstances which can facilitate or hinder the ability to adapt. This allows resilience-building efforts to target the drivers of risk to effectively increase capacities to address climate change impacts. With this perspective on the factors which underlie susceptibility to climate change comes the recognition that CCA can take many forms. These may include disaster risk reduction strategies to address natural hazard risks, poverty reduction initiatives to improve socio-economic prospects, educational improvements which increase employment prospects and capacity for innovation; and knowledge transfer and capacity building at the government level to improve implementation of projects and programmes, to name just a few.

The LAC region demonstrates a diverse range of circumstances contributing to relative vulnerabilities and risks, not least because of the extensive variation in latitudes and geographies present within this part of the world. In addition to the array of hydro-meteorological threats presented by climate change across the region, the economic, social and governance circumstances in each country are unique. Economically more prosperous nations such as Chile and Brazil sit alongside countries such as Paraguay and Bolivia which face serious development challenges which act to constraint efforts to address climate risks. The concerns for Caribbean islands, with highly exposed economic activities and finite resources, differ greatly from countries with lower levels of human development but an abundance of natural resources, such as Suriname.

These very different country profiles of vulnerability present a challenge in determining how assistance initiatives should be guided to derive maximum benefits. Those offering assistance may face choices between protecting existing resources and assets to maintain capacities present, or addressing development requirements in those countries with low capacities in order to improve resilience prospects. Deciding where the greatest risks lie is a complex proposition. Whether severity of exposure is used to direct funding, or if this is assessed by absolute numbers likely to be affected or by other considerations, is a daunting task for decision-makers. At the same time, quantifying the returns from CCA initiatives is notoriously difficult. It depends on the chosen perspective under consideration and if the assessment is purely financial or includes social or environmental dimensions, which are harder to monetise.

The countries of Latin America and the Caribbean will need to work in collaboration with each other and external partners to leverage national, regional and international technical and financial resources to reduce vulnerability to climate change across the LAC region. While many LAC administrations require improved capacities to address climate change, the unique vulnerability profiles of each country in the region highlight the importance of governments, with strong domestic understanding and authority, in leading their nation’s CCA efforts. At the same time, climate change is a global, transboundary issue that requires holistic rather than fragmented approach to address effectively. Partnerships between nations and with private and civil sectors, academic institutions and international agencies will be key to assembling the required capabilities to tackle the impacts of the changing climate in the LAC region.

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Appendix 1

Climate Change Vulnerability Index by country

Climate Change Vulnerability

Country	Rank	Score	Category
Haiti	1	0.58	extreme
Guatemala	2	0.75	extreme
El Slavador	3	0.79	extreme
Honduras	4	0.92	extreme
Dominican Republic	5	1.01	extreme
Nicaragua	6	1.19	extreme
Jamaica	7	1.50	extreme
Paraguay	8	1.58	extreme
Belize	9	2.25	extreme
Bolivia	10	2.48	extreme
Venezuela	11	3.64	high
Ecuador	12	3.76	high
Dominica	13	3.85	high
Cuba	14	3.90	high
Guyana	15	4.23	high
Colombia	16	4.30	high
Mexico	17	4.47	high
Peru	18	4.98	high
Panama	19	5.57	medium
Antigua and Barbuda	20	5.64	medium
Brazil	21	5.77	medium
Suriname	22	5.85	medium
Saint Kitts and Nevis	23	6.24	medium
Argentina	24	6.66	medium
Trinidad and Tobago	25	7.22	medium
Costa Rica	26	7.70	low
Saint Lucia	27	8.25	low
Uruguay	28	8.33	low
Bahamas	29	8.68	low
Chile	30	9.54	low
Grenada	31	9.58	low
Saint Vincent and The Grenadines	32	9.63	low
Barbados	33	9.77	low

Exposure Index

Country	Rank	Score	Category
Jamaica	1	0.84	extreme
Dominica	2	1.24	extreme
Cuba	3	1.39	extreme
Guatemala	4	1.66	extreme
Haiti	5	2.14	extreme
Dominican Republic	6	2.28	extreme
Saint Kitts and Nevis	7	2.36	extreme
Bahamas	8	2.5	extreme
El Salvador	9	2.68	high
Honduras	10	2.73	high
Antigua and Barbuda	11	3.16	high
Mexico	12	3.35	high
Belize	13	3.56	high
Costa Rica	14	3.7	high
Nicaragua	15	3.81	high
Paraguay	16	4.3	high
Venezuela	17	5.07	medium
Brazil	18	5.11	medium
Panama	19	5.26	medium
Colombia	20	5.41	medium
Ecuador	21	5.82	medium
Bolivia	22	6	medium
Peru	23	6.69	medium
Trinidad and Tobago	24	7.02	medium
Uruguay	25	7.27	medium
Argentina	26	7.32	medium
Guyana	27	7.58	low
Suriname	28	7.99	low
Chile	29	8.57	low
Saint Lucia	30	8.7	low
Barbados	31	9.07	low
Grenada	32	9.79	low
Saint Vincent and The Grenadines	33	9.85	low

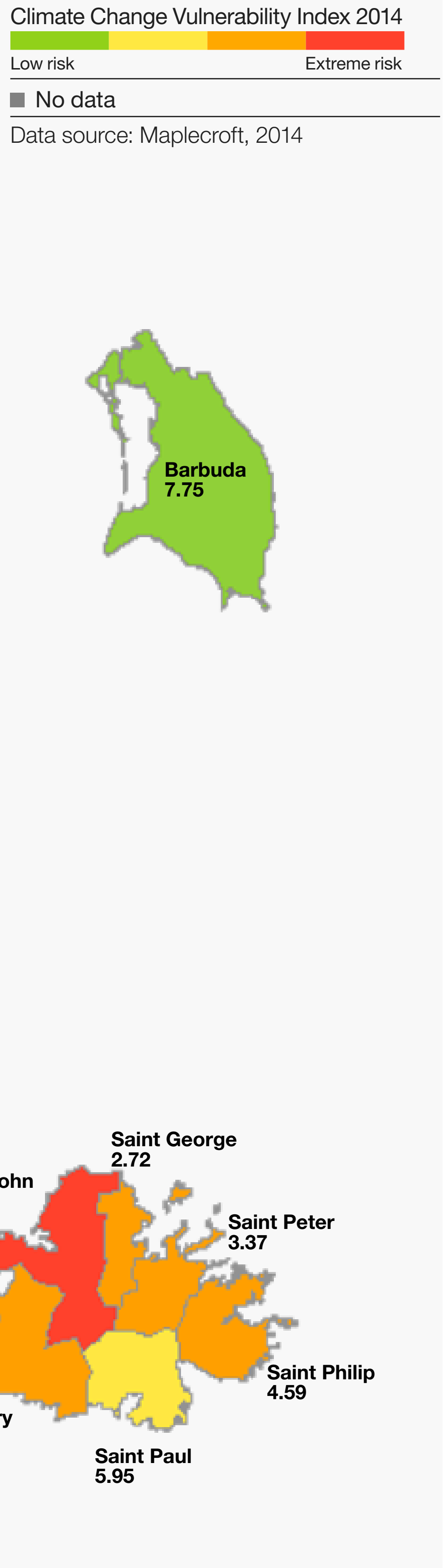
Sensitivity Index

Country	Rank	Score	Category
Haiti	1	0.22	extreme
Dominican Republic	2	0.76	extreme
El Salvador	3	0.93	extreme
Guatemala	4	1.38	extreme
Nicaragua	5	2.01	extreme
Jamaica	6	2.11	extreme
Honduras	7	2.43	extreme
Cuba	8	3.15	high
Barbados	9	3.3	high
Ecuador	10	3.47	high
Colombia	11	3.72	high
Paraguay	12	3.9	high
Grenada	13	4.12	high
Costa Rica	14	4.22	high
Peru	15	4.5	high
Bolivia	16	4.58	high
Panama	17	4.61	high
Saint Vincent and The Grenadines	18	4.69	high
Mexico	19	5.32	medium
Saint Lucia	20	5.45	medium
Trinidad and Tobago	21	5.75	medium
Venezuela	22	6.25	medium
Brazil	23	6.32	medium
Guyana	24	7.17	medium
Argentina	25	7.22	medium
Belize	26	7.81	low
Antigua and Barbuda	27	7.98	low
Chile	28	8.04	low
Dominica	29	8.5	low
Uruguay	30	8.61	low
Saint Kitts and Nevis	31	8.68	low
Suriname	32	8.89	low
Bahamas	33	8.89	low

Adaptive Capacity Index

Country	Rank	Score	Category
Haiti	1	0	extreme
Nicaragua	2	0.13	extreme
Honduras	3	0.5	extreme
Guatemala	4	0.64	extreme
Guyana	5	0.66	extreme
Bolivia	6	0.8	extreme
Paraguay	7	0.94	extreme
El Salvador	8	1.44	extreme
Dominican Republic	9	2.31	extreme
Belize	10	2.75	high
Suriname	11	3.31	high
Venezuela	12	3.62	high
Ecuador	13	4.44	high
Peru	14	5.32	medium
Colombia	15	5.66	medium
Argentina	16	6.07	medium
Jamaica	17	6.15	medium
Saint Lucia	18	6.31	medium
Panama	19	6.7	medium
Saint Vincent and The Grenadines	20	6.74	medium
Trinidad and Tobago	21	6.78	medium
Dominica	22	6.86	medium
Antigua and Barbuda	23	7	medium
Grenada	24	7.26	medium
Saint Kitts and Nevis	25	7.5	medium
Mexico	26	7.66	low
Brazil	27	7.88	low
Uruguay	28	8.18	low
Cuba	29	8.44	low
Costa Rica	30	9.23	low
Chile	31	9.4	low
Barbados	32	9.58	low
Bahamas	33	9.89	low

Map 6.
Antigua & Barbuda

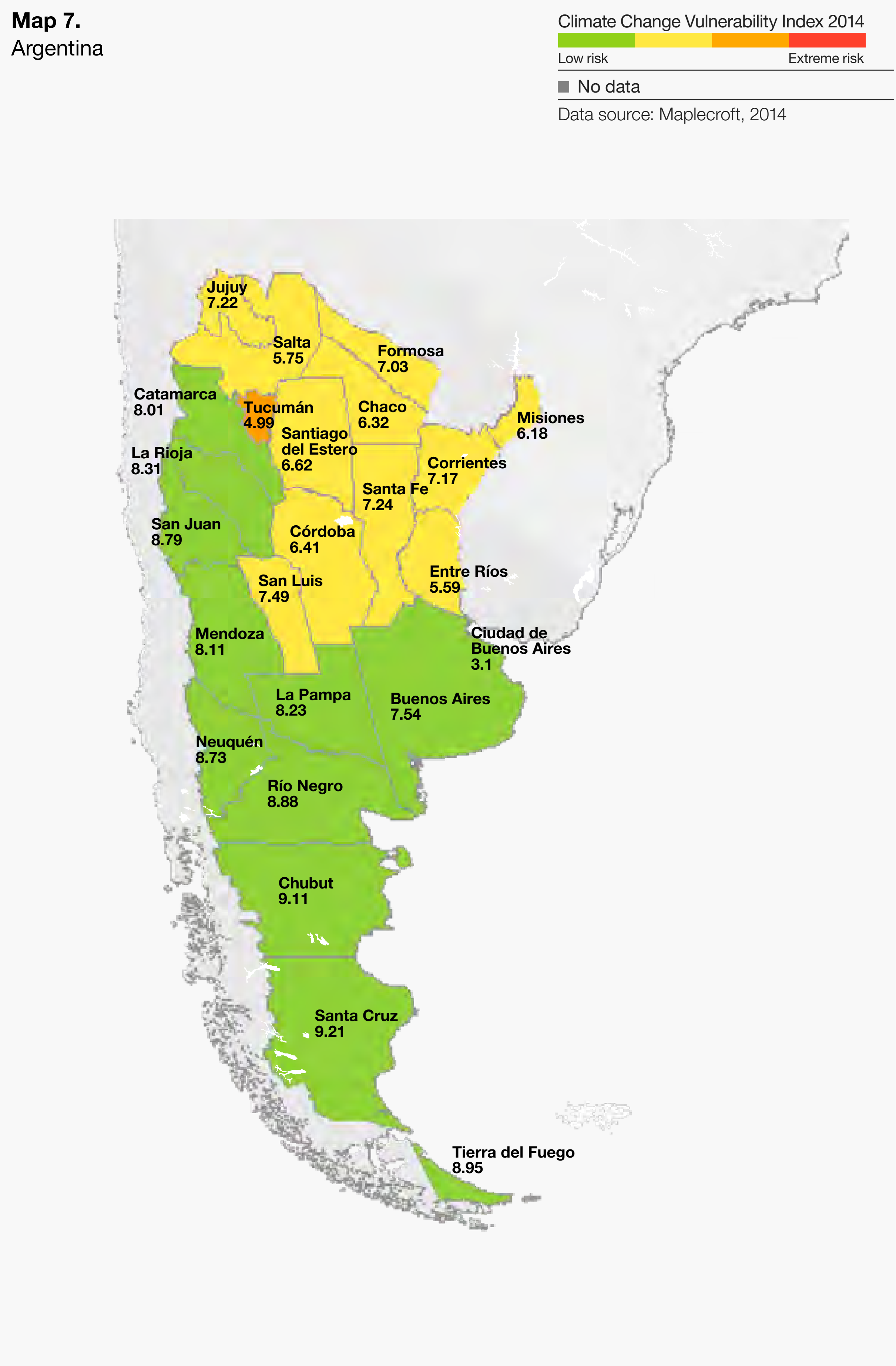


Antigua & Barbuda

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
5.64	3.16	7.98	7.00

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Barbuda	7.75	3.68	9.16	7.00	Codrington	3.22	1.21	7.63	7.00
Redonda	9.29	no data	no data	7.00	-	-	-	-	-
Saint George	2.72	1.93	5.25	7.00	-	-	-	-	-
Saint John	0.83	0.41	2.73	7.00	Saint John's	1.55	0.84	4.48	7.00
Saint Mary	4.31	2.37	7.87	7.00	Bolans	no data	0.79	no data	7.00
					Carlisle	2.59	0.92	6.50	7.00
Saint Paul	5.95	5.37	8.39	7.00	Nelsons Dockyard	no data	no data	no data	7.00
Saint Peter	3.37	2.58	5.69	7.00	Parham	1.95	0.86	5.31	7.00
Saint Philip	4.59	3.19	7.22	7.00	-	-	-	-	-

Map 7.
Argentina



Argentina

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
6.66	7.32	7.22	6.07

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Buenos Aires	7.54	7.12	7.18	6.07	La Plata	3.88	5.23	2.79	6.07
Catamarca	8.01	7.51	8.56	6.07	S. F. del Valle de Catamarca	2.71	3.10	3.48	6.07
Chaco	6.32	4.92	8.11	6.07	Resistencia	3.60	4.29	3.63	6.07
Chubut	9.11	9.64	9.05	6.07	Rawson	5.00	5.78	5.39	6.07
Ciudad de Buenos Aires	3.10	3.75	1.22	6.07	Buenos Aires	3.73	5.21	2.55	6.07
Córdoba	6.41	5.71	6.23	6.07	Cordoba	1.75	2.74	1.99	6.07
Corrientes	7.17	5.12	8.36	6.07	Corrientes	3.17	3.42	4.12	6.07
Entre Ríos	5.59	5.23	6.74	6.07	Parana	3.67	4.69	3.38	6.07
Formosa	7.03	5.23	8.57	6.07	Formosa	2.99	3.03	4.41	6.07
Jujuy	7.22	6.61	7.34	6.07	San Salvador de Jujuy	3.38	4.27	2.96	6.07
La Pampa	8.23	7.15	8.78	6.07	Santa Rosa	5.54	6.81	5.20	6.07
La Rioja	8.31	8.28	8.75	6.07	La Rioja	3.99	3.80	5.82	6.07
Mendoza	8.11	7.09	8.26	6.07	Mendoza	4.27	6.07	2.22	6.07
Misiones	6.18	5.14	6.54	6.07	Posadas	2.17	2.13	4.25	6.07
Neuquén	8.73	9.09	8.83	6.07	Neuquén	5.31	6.36	5.41	6.07
Río Negro	8.88	8.95	9.02	6.07	Viedma	3.81	3.40	6.22	6.07
Salta	5.75	5.18	7.69	6.07	Salta	3.32	4.39	2.71	6.07
San Juan	8.79	9.30	8.38	6.07	San Juan	3.36	4.27	2.81	6.07
San Luis	7.49	6.02	8.48	6.07	San Luis	2.75	3.05	3.72	6.07
Santa Cruz	9.21	9.82	9.06	6.07	Río Gallegos	7.34	8.95	5.91	6.07
Santa Fe	7.24	6.09	6.59	6.07	Santa Fe	2.51	2.63	4.07	6.07
					Rosario	3.01	3.60	3.66	6.07
Santiago del Estero	6.62	5.42	7.48	6.07	Santiago del Estero	4.61	6.29	3.02	6.07
Tierra del Fuego	8.95	9.33	8.80	6.07	Ushuaia	7.76	4.36	6.34	6.07
Tucumán	4.99	4.64	4.00	6.07	San Miguel de Tucumán	3.46	5.12	1.70	6.07

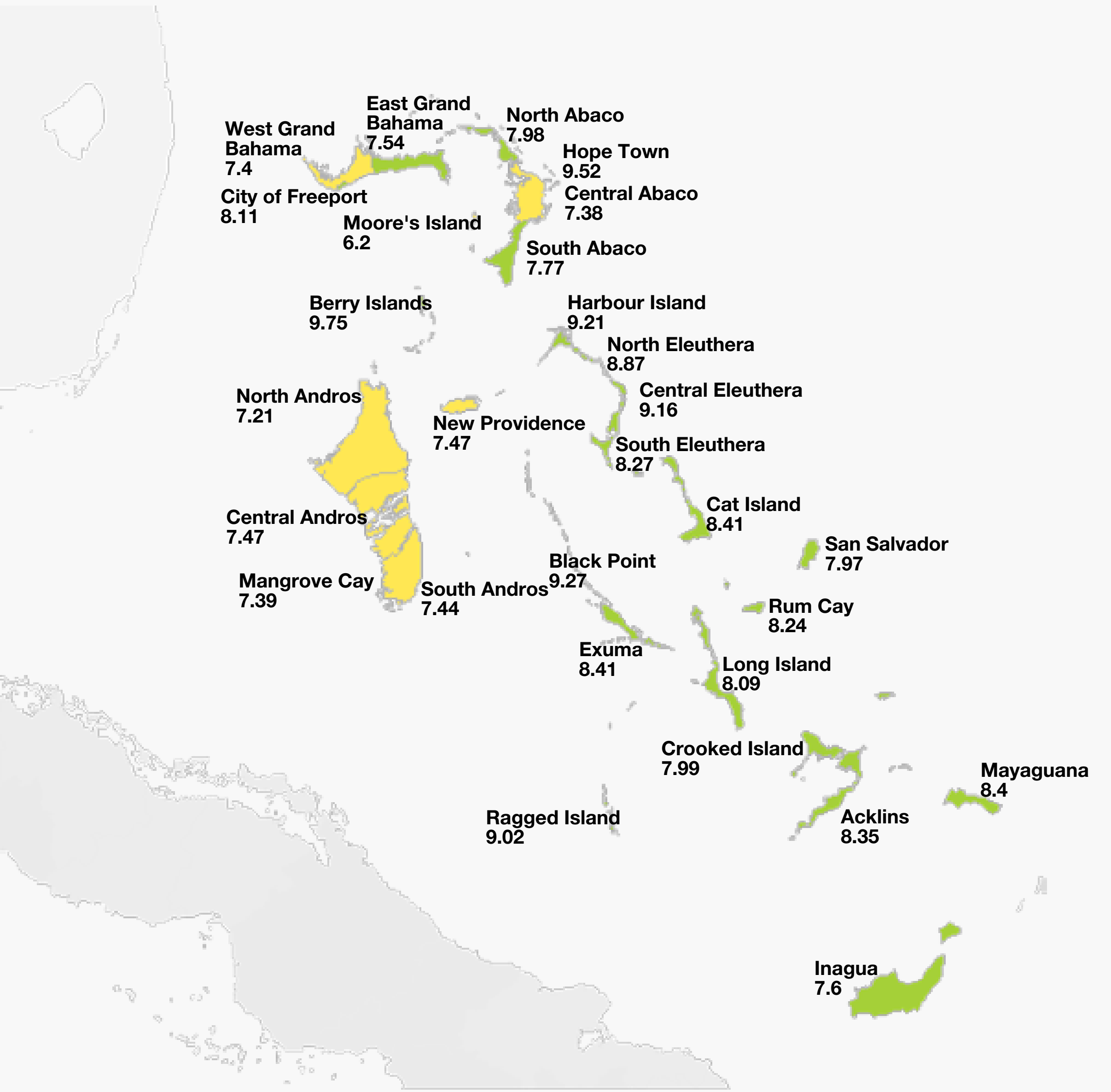
Map 8.
Bahamas

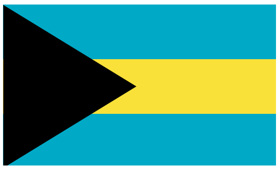
Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014





Bahamas

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
8.68	2.50	8.89	9.89

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Acklins	8.35	5.39	9.05	9.89	-	-	-	-	-
Berry Islands	9.75	8.24	9.60	9.89	-	-	-	-	-
Biminis	no data	no data	no data	9.89	-	-	-	-	-
Black Point	9.27	6.48	no data	9.89	-	-	-	-	-
Cat Island	8.41	5.46	9.09	9.89	-	-	-	-	-
Central Abaco	7.38	2.14	8.67	9.89	-	-	-	-	-
Central Andros	7.47	1.96	8.98	9.89	-	-	-	-	-
Central Eleuthera	9.16	6.47	9.55	9.89	-	-	-	-	-
City of Freeport	8.11	4.17	7.20	9.89	-	-	-	-	-
Crooked Island	7.99	3.23	9.17	9.89	-	-	-	-	-
East Grand Bahama	7.54	2.50	8.25	9.89	-	-	-	-	-
Exuma	8.41	4.43	8.86	9.89	-	-	-	-	-
Grand Cay	no data	no data	no data	9.89	-	-	-	-	-
Harbour Island	9.21	8.67	no data	9.89	-	-	-	-	-
Hope Town	9.52	7.56	9.53	9.89	-	-	-	-	-
Inagua	7.60	2.86	8.73	9.89	-	-	-	-	-
Long Island	8.09	4.52	8.81	9.89	-	-	-	-	-
Mangrove Cay	7.39	1.86	8.94	9.89	-	-	-	-	-
Mayaguana	8.40	6.28	9.07	9.89	-	-	-	-	-
Moore's Island	6.20	4.54	8.05	9.89	-	-	-	-	-
New Providence	7.47	3.06	4.11	9.89	Nassau	2.86	1.44	3.36	9.89
North Abaco	7.98	3.30	9.03	9.89	-	-	-	-	-
North Andros	7.21	1.30	8.78	9.89	-	-	-	-	-
North Eleuthera	8.87	5.85	9.52	9.89	-	-	-	-	-
Ragged Island	9.02	6.35	8.58	9.89	-	-	-	-	-
Rum Cay	8.24	3.85	9.11	9.89	-	-	-	-	-
San Salvador	7.97	3.52	8.91	9.89	-	-	-	-	-
South Abaco	7.77	2.94	8.89	9.89	-	-	-	-	-
South Andros	7.44	1.89	8.86	9.89	-	-	-	-	-
South Eleuthera	8.27	4.14	9.35	9.89	-	-	-	-	-
Spanish Wells	no data	no data	no data	9.89	-	-	-	-	-
West Grand Bahama	7.40	2.29	7.49	9.89					

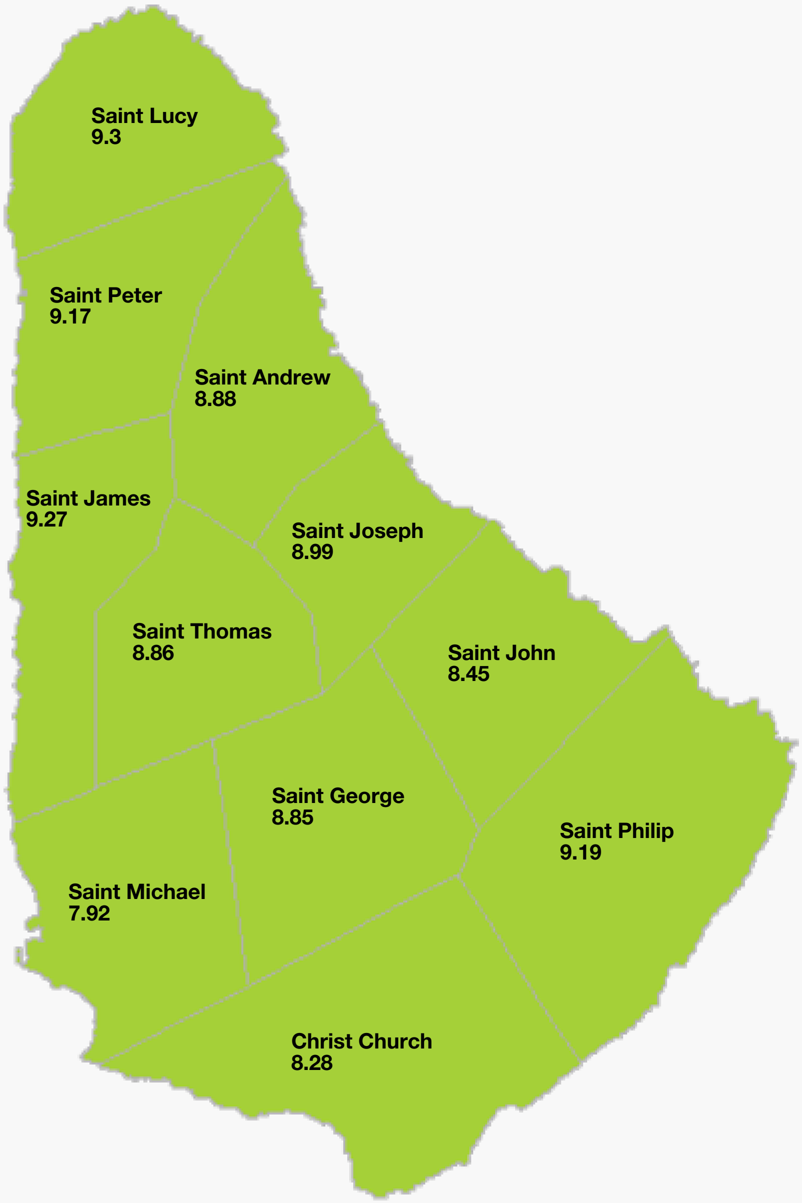
Map 9.
Barbados

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

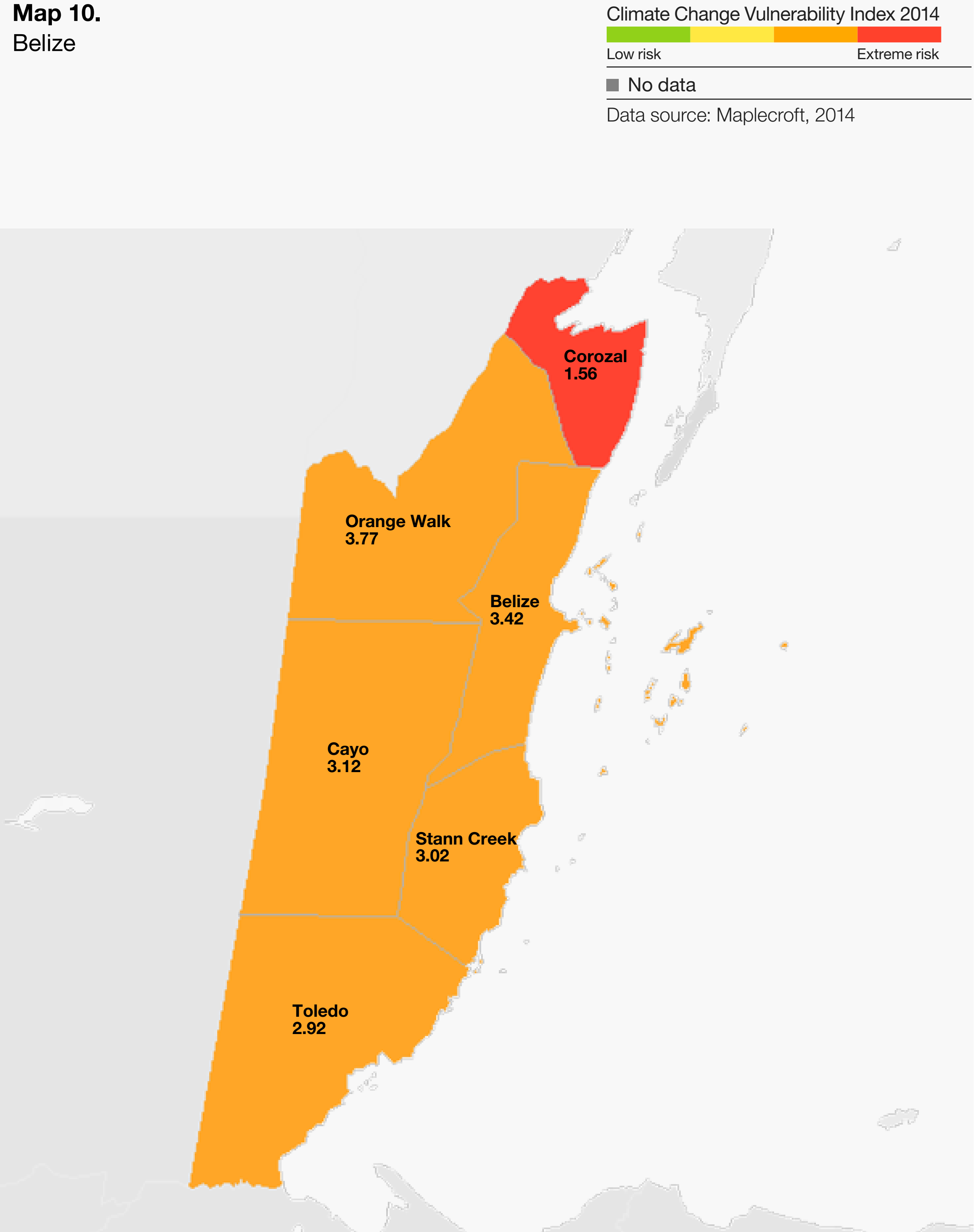


Barbados

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
9.77	9.07	3.30	9.58

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Christ Church	8.28	5.86	4.67	9.58	-	-	-	-	-
Saint Andrew	8.88	9.31	4.15	9.58	-	-	-	-	-
Saint George	8.85	9.42	3.47	9.58	-	-	-	-	-
Saint James	9.27	9.63	6.02	9.58	-	-	-	-	-
Saint John	8.45	6.65	4.04	9.58	-	-	-	-	-
Saint Joseph	8.99	9.48	4.40	9.58	-	-	-	-	-
Saint Lucy	9.30	9.56	6.53	9.58	-	-	-	-	-
Saint Michael	7.92	7.95	3.87	9.58	Bridgetown	5.60	4.61	3.29	9.58
Saint Peter	9.17	9.43	6.03	9.58	-	-	-	-	-
Saint Philip	9.19	9.49	4.30	9.58	-	-	-	-	-
Saint Thomas	8.86	9.47	3.39	9.58	-	-	-	-	-

Map 10.
Belize



Belize

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
2.25	3.56	7.81	2.75

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Belize	3.42	3.74	8.07	2.75	Belize	no data	no data	no data	2.75
Cayo	3.12	3.96	7.80	2.75	Belmopan	2.30	3.08	5.94	2.75
Corozal	1.56	1.12	7.69	2.75	Corozal	0.75	0.57	5.17	2.75
Orange Walk	3.77	5.18	6.91	2.75	Orange Walk	1.54	2.78	4.85	2.75
Stann Creek	3.02	3.67	7.52	2.75	Dangriga	5.88	0.54	6.83	2.75
Toledo	2.92	3.63	7.65	2.75	Punta Gorda	0.74	0.96	4.24	2.75

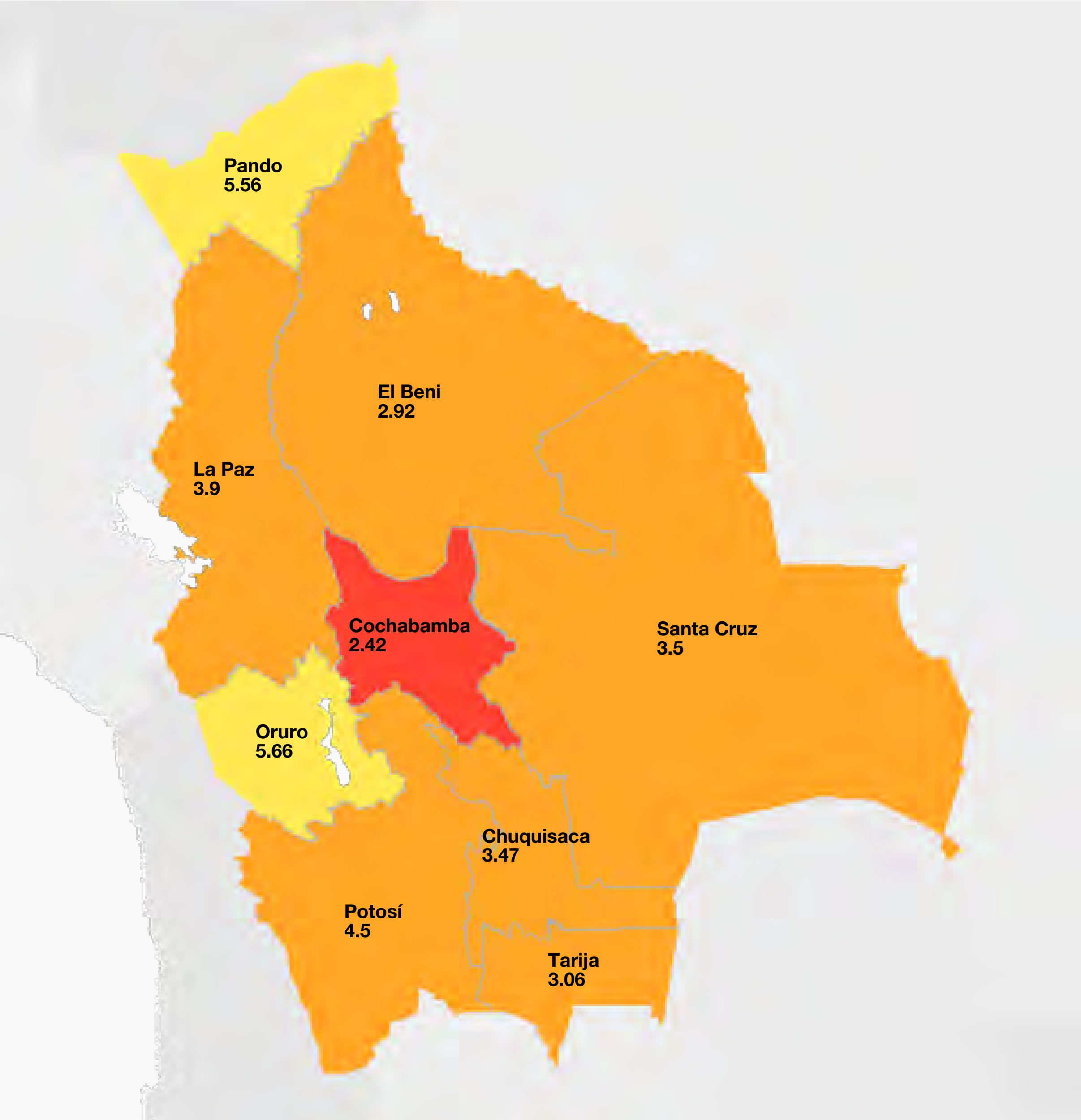
Map 11.
Bolivia

Climate Change Vulnerability Index 2014

Low risk Extreme risk

No data

Data source: Maplecroft, 2014



Bolivia

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
2.48	6.00	4.58	0.80

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Chuquisaca	3.47	6.96	3.44	0.80	Sucre	0.95	3.43	3.49	0.80
Cochabamba	2.42	5.07	3.17	0.80	Cochabamba	1.83	5.53	1.80	0.80
El Beni	2.92	4.71	7.85	0.80	Trinidad	0.65	1.49	4.03	0.80
La Paz	3.90	6.42	4.66	0.80	La Paz	2.52	6.32	1.99	0.80
Oruro	5.66	8.66	6.54	0.80	Oruro	2.41	5.55	3.18	0.80
Pando	5.56	7.92	8.10	0.80	Cobija	3.26	5.76	5.25	0.80
Potosí	4.50	7.09	5.72	0.80	Potosí	1.07	3.56	3.95	0.80
Santa Cruz	3.50	5.46	5.95	0.80	Santa Cruz de la Sierra	2.81	6.90	1.48	0.80
Tarija	3.06	5.46	5.00	0.80	Tarija	1.42	4.73	2.51	0.80

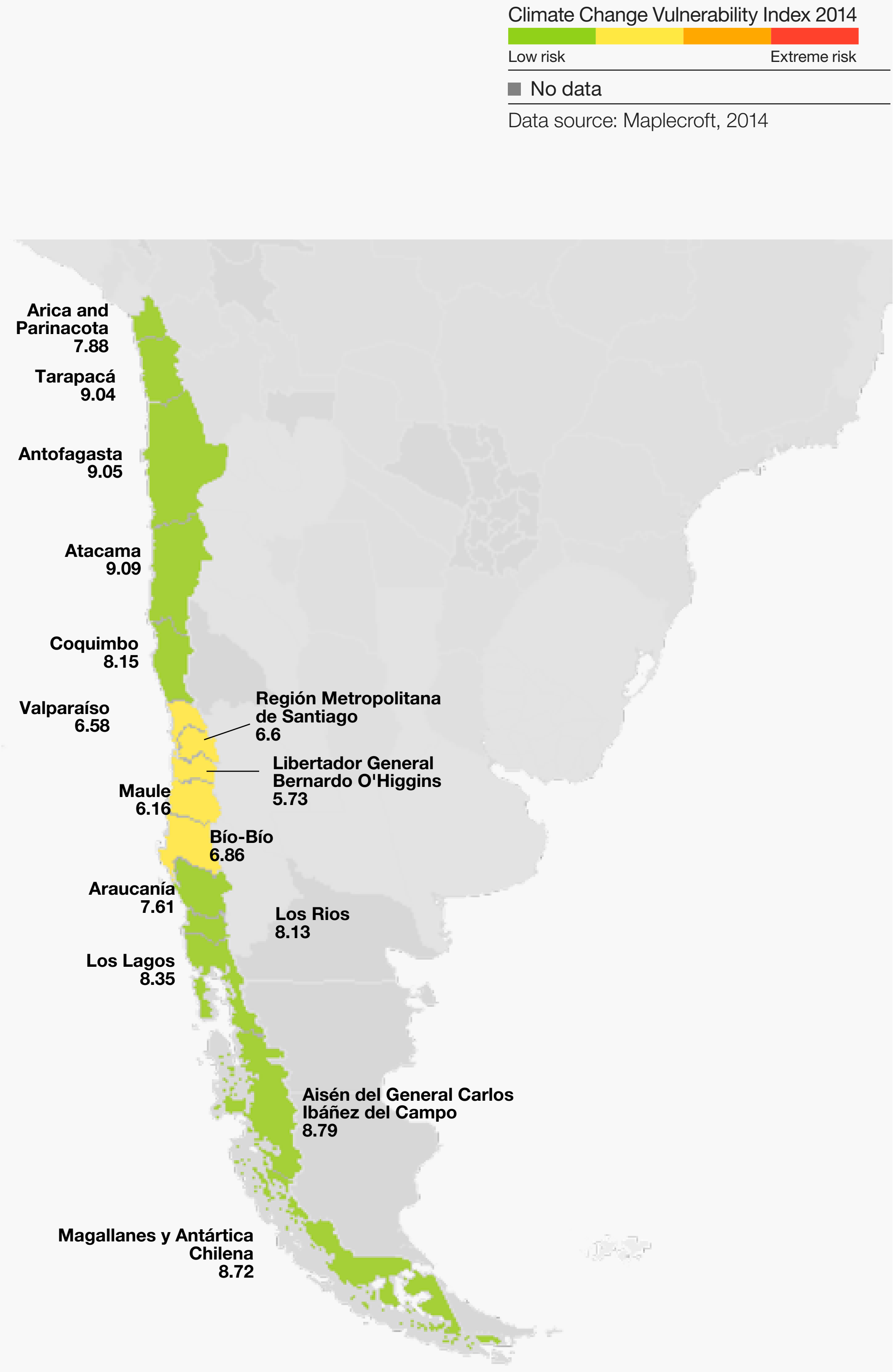
Map 12.
Brazil

Brazil

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
5.77	5.11	6.32	7.88

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Acre	8.36	8.42	8.44	7.88	Rio Branco	4.63	4.71	4.38	7.88
Alagoas	4.57	3.67	2.92	7.88	Maceio	1.62	1.30	2.42	7.88
Amapa	8.33	6.62	8.67	7.88	Macapá	2.44	1.61	4.34	7.88
Amazonas	8.26	7.59	8.59	7.88	Manaus	4.13	4.06	3.96	7.88
Bahia	7.73	6.11	6.06	7.88	Salvador	3.91	4.90	2.03	7.88
Ceara	6.78	5.35	5.08	7.88	Fortaleza	3.12	3.70	1.60	7.88
Distrito Federal	6.26	3.38	3.45	7.88	Brasilia	3.52	3.09	3.89	7.88
Espirito Santo	7.15	6.66	4.07	7.88	Vitória	2.25	1.73	2.10	7.88
Goias	6.63	2.48	7.34	7.88	Goiania	3.56	3.92	2.38	7.88
Maranhao	6.09	4.56	6.57	7.88	São Luis	1.82	1.55	2.69	7.88
Mato Grosso	6.65	3.24	8.19	7.88	Cuiaba	3.31	3.31	2.79	7.88
Mato Grosso do Sul	7.06	4.55	8.10	7.88	Campo Grande	3.30	2.89	3.64	7.88
Minas Gerais	7.26	5.18	6.31	7.88	Belo Horizonte	3.01	2.97	2.75	7.88
Para	7.02	5.00	8.02	7.88	Belém	1.92	1.84	2.49	7.88
Paraiba	6.51	4.49	4.44	7.88	João Pessoa	3.06	3.42	2.27	7.88
Parana	7.35	5.65	5.84	7.88	Curitiba	4.89	6.18	2.54	7.88
Pernambuco	6.86	5.05	4.73	7.88	Recife	3.03	3.23	2.53	7.88
Piaui	7.29	5.14	7.33	7.88	Teresina	2.72	2.35	3.31	7.88
Rio de Janeiro	6.01	5.35	4.65	7.88	Rio De Janeiro	4.39	5.55	2.12	7.88
Rio Grande do Norte	6.84	4.56	4.63	7.88	Natal	2.93	2.81	3.08	7.88
Rio Grande do Sul	7.37	5.99	6.39	7.88	Porto Alegre	4.63	5.81	2.21	7.88
Rondonia	6.74	4.78	7.65	7.88	Porto Velho	3.66	3.36	3.95	7.88
Roraima	8.29	7.47	8.66	7.88	Boa Vista	4.27	3.96	4.59	7.88
Santa Catarina	6.89	5.84	6.07	7.88	Florianopolis	2.33	2.35	2.57	7.88
Sao Paulo	6.68	4.49	5.56	7.88	São Paulo	5.53	7.35	2.30	7.88
Sergipe	6.63	6.78	2.98	7.88	Aracaju	2.28	2.24	1.98	7.88
Tocantins	7.14	3.47	8.17	7.88	Palmas	3.07	2.08	4.65	7.88

Map 13.
Chile



Climate Change Vulnerability Index 2014
Low risk
Extreme risk
No data
Data source: Maplecroft, 2014
Arica and Parinacota 7.88
Tarapacá 9.04
Antofagasta 9.05
Atacama 9.09
Coquimbo 8.15
Valparaíso 6.58
Región Metropolitana de Santiago 6.6
Libertador General Bernardo O'Higgins 5.73
Maule 6.16
Bío-Bío 6.86
Araucanía 7.61
Los Rios 8.13
Los Lagos 8.35
Aisén del General Carlos Ibáñez del Campo 8.79
Magallanes y Antártica Chilena 8.72

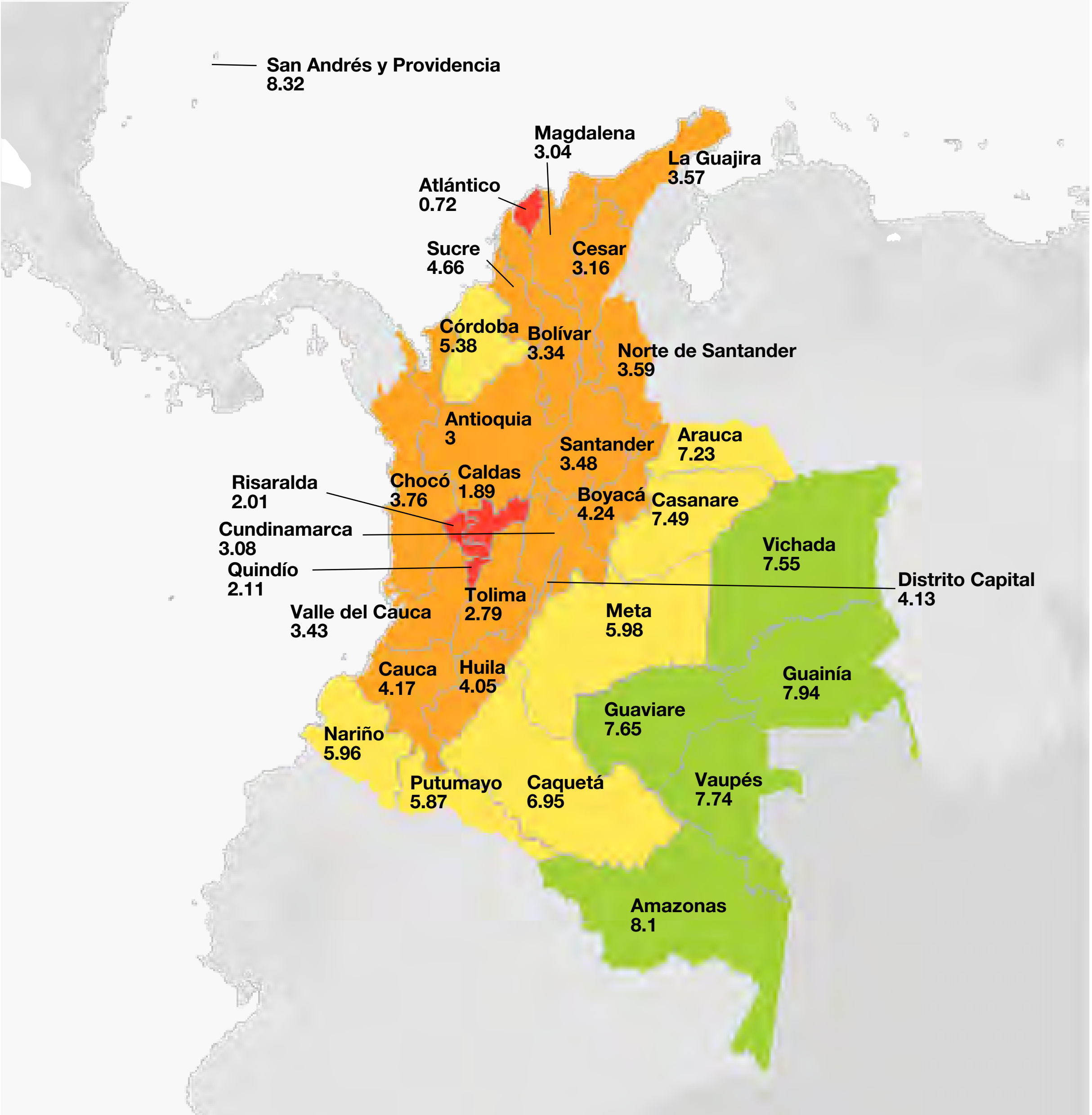
Chile

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
9.54	8.57	8.04	9.40

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Aisén del General Carlos Ibáñez del Campo	9.40	9.35	8.96	9.40	Coihaique	7.78	6.90	7.85	9.40
Antofagasta	9.52	9.67	9.06	9.40	Antofagasta	8.48	9.31	5.76	9.40
Araucanía	8.81	8.61	6.77	9.40	Temuco	7.18	7.77	4.52	9.40
Arica and Parinacota	8.87	8.38	8.93	9.40	Arica	8.14	8.87	5.31	9.40
Atacama	9.54	9.78	8.90	9.40	Copiapo	8.77	9.83	5.85	9.40
Bío-Bío	8.38	6.84	6.31	9.40	Concepcion	3.60	2.60	3.70	9.40
Coquimbo	9.07	8.85	8.50	9.40	La Serena	8.37	9.22	5.41	9.40
Libertador General Bernardo O'Higgins	7.86	6.26	5.55	9.40	Rancagua	5.66	5.65	4.27	9.40
Los Lagos	9.17	7.98	8.08	9.40	Puerto Montt	3.76	2.23	4.65	9.40
Los Rios	9.07	8.61	7.35	9.40	Valdivia	5.50	5.29	4.71	9.40
Magallanes y Antártica Chilena	9.36	9.29	9.05	9.40	Punta Arenas	7.21	7.58	5.22	9.40
Maule	8.08	6.69	6.21	9.40	Talca	6.85	7.69	3.64	9.40
Región Metropolitana de Santiago	8.30	7.81	5.09	9.40	Santiago	5.70	6.58	2.78	9.40
Tarapacá	9.52	9.49	9.21	9.40	Iquique	8.07	9.49	3.33	9.40
Valparaíso	8.29	6.86	5.86	9.40	Valparaiso	6.18	6.57	4.03	9.40

Map 14.
Colombia

Climate Change Vulnerability Index 2014
Low risk
Extreme risk
No data
Data source: Maplecroft, 2014

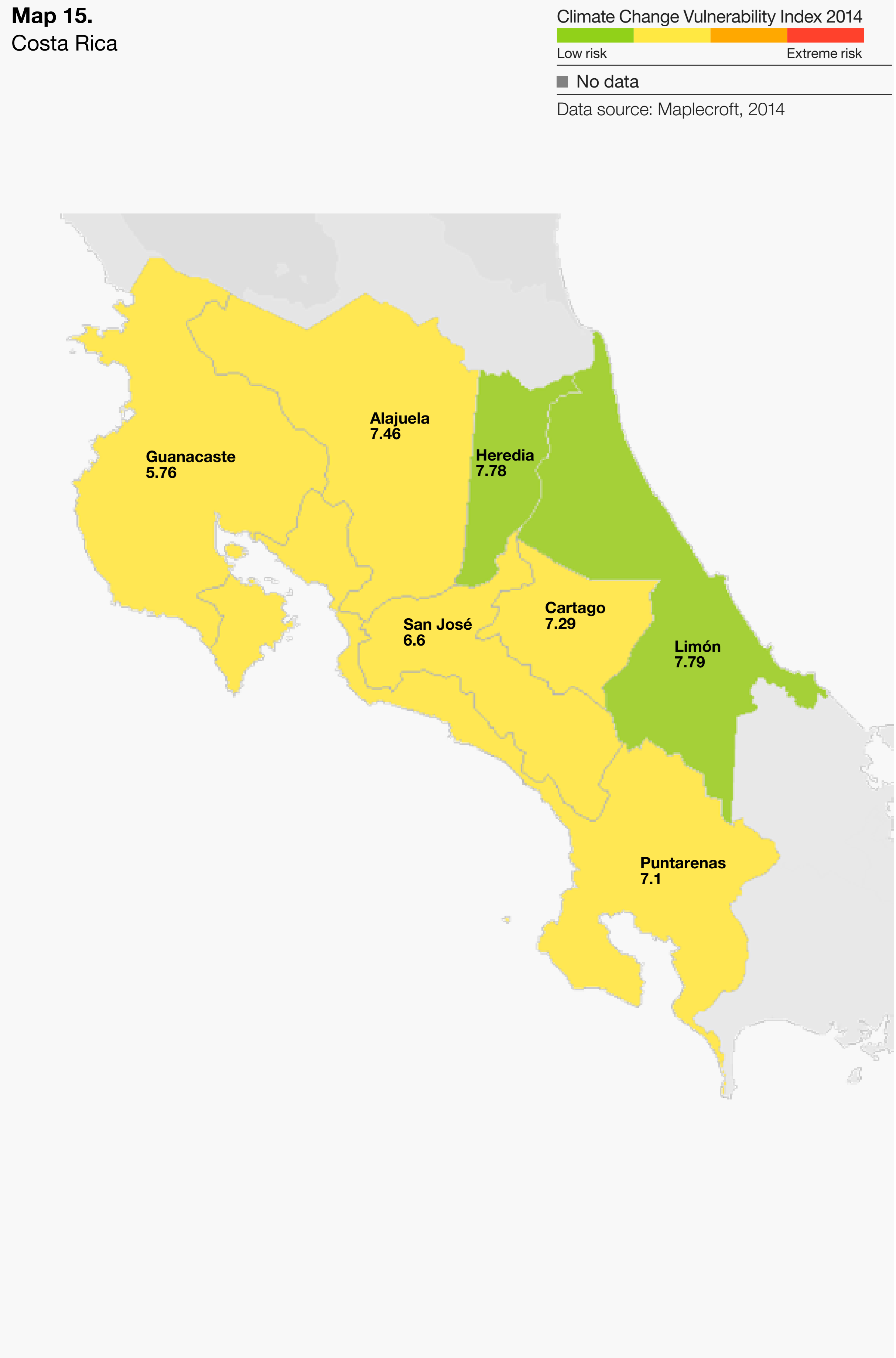


Colombia

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
4.30	5.41	3.72	5.66

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Amazonas	8.10	8.77	7.93	5.66	Leticia	4.37	4.29	4.30	5.66
Antioquia	3.00	2.39	3.47	5.66	Medellin	1.12	2.05	1.92	5.66
Arauca	7.23	7.43	4.69	5.66	Arauca	5.39	6.99	4.80	5.66
Atlántico	0.72	0.81	1.73	5.66	Barranquilla	0.80	1.15	1.38	5.66
Bolívar	3.34	2.63	3.47	5.66	Cartagena	0.77	1.07	1.48	5.66
Boyacá	4.24	4.81	3.22	5.66	Tunja	1.28	2.32	2.27	5.66
Caldas	1.89	1.33	2.84	5.66	Manizales	0.92	1.46	2.27	5.66
Caquetá	6.95	7.07	5.93	5.66	Florencia	4.29	5.81	3.19	5.66
Casanare	7.49	8.14	5.57	5.66	Yopal	5.63	8.31	2.89	5.66
Cauca	4.17	4.89	3.21	5.66	Popayan	2.17	3.27	2.37	5.66
Cesar	3.16	2.53	3.44	5.66	Valledupar	1.32	1.96	2.98	5.66
Chocó	3.76	3.05	4.80	5.66	Quibdo	1.88	2.24	3.74	5.66
Córdoba	5.38	5.70	3.00	5.66	Monteria	3.51	4.79	2.74	5.66
Cundinamarca	3.08	2.69	2.97	5.66	-	-	-	-	-
Distrito Capital	4.13	4.97	1.74	5.66	Bogota	1.28	2.58	1.52	5.66
Guainía	7.94	8.53	7.91	5.66	Puerto Inirida	5.97	8.27	4.11	5.66
Guaviare	7.65	7.75	7.29	5.66	San Jose del Guaviare	4.93	6.83	3.55	5.66
Huila	4.05	4.47	3.04	5.66	Neiva	1.90	2.92	2.42	5.66
La Guajira	3.57	3.34	3.28	5.66	Rio Hacha	1.04	1.83	2.75	5.66
Magdalena	3.04	2.35	3.06	5.66	Santa Marta	1.03	1.30	2.22	5.66
Meta	5.98	6.10	5.55	5.66	Villa Vicencio	3.10	4.08	3.15	5.66
Nariño	5.96	6.52	2.72	5.66	Pasto	3.77	5.72	1.42	5.66
Norte de Santander	3.59	2.64	3.65	5.66	Cucuta	2.81	4.54	1.70	5.66
Putumayo	5.87	6.38	4.81	5.66	Mocoa	2.78	3.99	2.29	5.66
Quindío	2.11	1.14	2.17	5.66	Armenia	1.18	2.22	2.10	5.66
Risaralda	2.01	1.22	2.69	5.66	Pereira	1.33	2.23	2.34	5.66
San Andrés y Providencia	8.32	6.40	8.90	5.66	San Andres	no data	no data	no data	5.66
Santander	3.48	2.94	3.44	5.66	Bucaramanga	1.46	2.86	1.55	5.66
Sucre	4.66	5.26	2.71	5.66	Sincelejo	2.67	3.85	2.46	5.66
Tolima	2.79	2.31	2.99	5.66	Ibague	1.63	2.35	2.91	5.66
Valle del Cauca	3.43	3.62	2.77	5.66	Cali	1.52	2.50	2.02	5.66
Vaupés	7.74	8.21	7.88	5.66	Mitu	5.01	6.11	5.36	5.66
Vichada	7.55	7.30	7.79	5.66	Puerto Carreno	2.76	3.11	4.00	5.66

Map 15.
Costa Rica

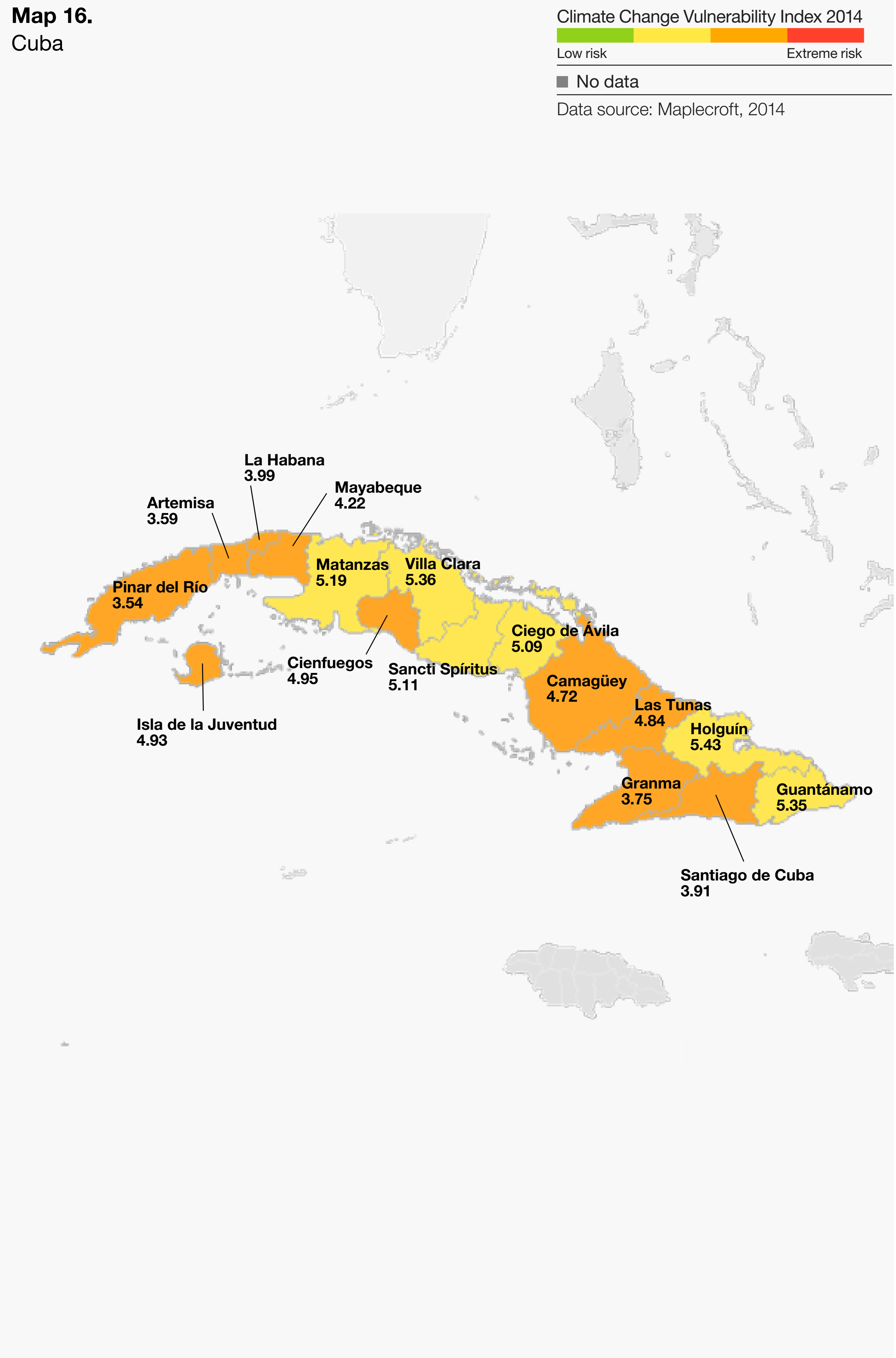


Costa Rica

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
7.70	3.70	4.22	9.23

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Alajuela	7.46	5.36	4.38	9.23	Alajuela	3.31	3.24	1.55	9.23
Cartago	7.29	5.55	4.60	9.23	Cartago	4.08	3.65	3.15	9.23
Guanacaste	5.76	1.84	5.66	9.23	Liberia	3.08	1.63	4.24	9.23
Heredia	7.78	6.21	5.47	9.23	Heridia	3.03	2.45	2.42	9.23
Limón	7.79	6.13	5.57	9.23	Puerto Limon	3.83	2.71	4.22	9.23
Puntarenas	7.10	3.37	5.94	9.23	Puntarenas	no data	no data	no data	9.23
San José	6.60	2.32	3.37	9.23	San Jose	3.26	2.62	2.82	9.23
Vichada	7.55	7.30	7.79	5.66	Puerto Carreno	2.76	3.11	4.00	5.66

Map 16.
Cuba

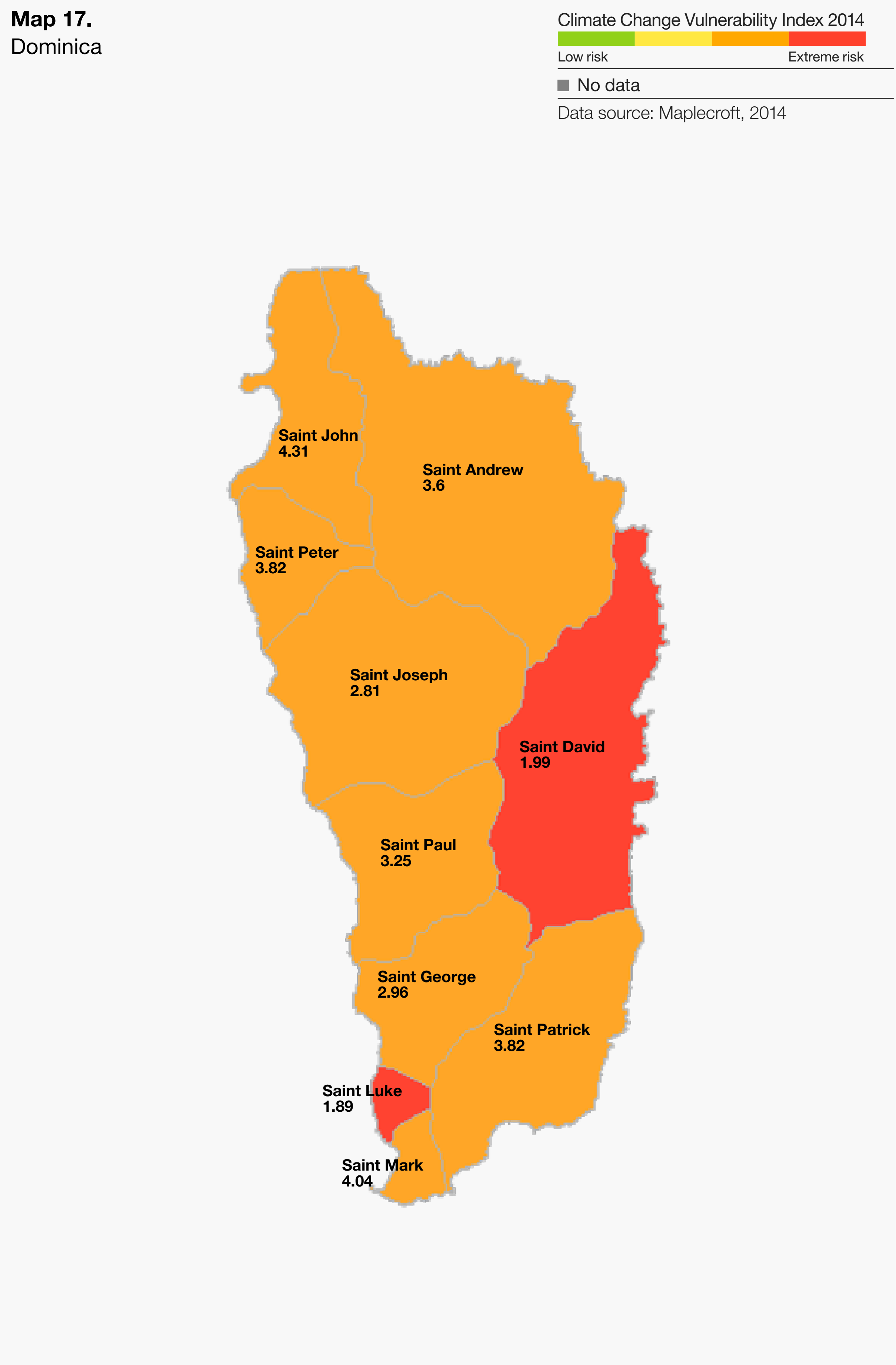

Climate Change Vulnerability Index 2014
Low risk
Extreme risk
No data
Data source: Maplecroft, 2014
La Habana
3.99
Mayabeque
4.22
Artemisa
3.59
Pinar del Río
3.54
Matanzas
5.19
Villa Clara
5.36
Ciego de Ávila
5.09
Cienfuegos
4.95
Sancti Spíritus
5.11
Camagüey
4.72
Las Tunas
4.84
Holguín
5.43
Isla de la Juventud
4.93
Granma
3.75
Guantánamo
5.35
Santiago de Cuba
3.91

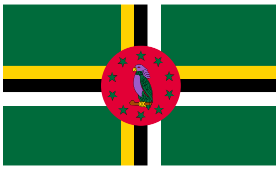
Cuba

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
3.90	1.39	3.15	8.44

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Artemisa	3.59	1.29	2.65	8.44	Artemisa	2.35	1.64	3.16	8.44
Camagüey	4.72	1.56	4.14	8.44	Camagüey	2.89	2.01	3.79	8.44
Ciego de Ávila	5.09	2.03	4.42	8.44	Ciego de Ávila	2.95	1.85	4.21	8.44
Cienfuegos	4.95	1.00	3.77	8.44	Cienfuegos	2.30	0.95	4.50	8.44
Granma	3.75	1.38	3.23	8.44	Bayamo	2.68	1.63	3.99	8.44
Guantánamo	5.35	3.76	3.53	8.44	Guantánamo	2.84	2.03	3.57	8.44
Holguín	5.43	3.05	3.40	8.44	Holguín	2.99	2.55	2.93	8.44
Isla de la Juventud	4.93	1.28	5.82	8.44	Nueva Gerona	2.55	1.21	4.56	8.44
La Habana	3.99	3.16	1.75	8.44	Havana	2.47	2.19	2.30	8.44
Las Tunas	4.84	1.50	3.37	8.44	Las Tunas	3.11	1.78	4.77	8.44
Matanzas	5.19	1.33	4.97	8.44	Matanzas	3.85	3.51	3.76	8.44
Mayabeque	4.22	2.16	3.03	8.44	San José de las Lajas	2.87	1.62	4.48	8.44
Pinar del Río	3.54	0.88	3.61	8.44	Pinar del Río	1.64	1.25	2.42	8.44
Sancti Spíritus	5.11	2.10	3.79	8.44	Sancti Spíritus	3.63	2.79	4.21	8.44
Santiago de Cuba	3.91	1.66	3.16	8.44	Santiago de Cuba	2.22	1.79	2.98	8.44
Villa Clara	5.36	1.68	3.79	8.44	Santa Clara	2.95	1.97	3.98	8.44

Map 17.
Dominica





Dominica

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
3.85	1.24	8.50	6.86

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Saint Andrew	3.60	1.13	7.34	6.86	-	-	-	-	-
Saint David	1.99	0.91	7.92	6.86	-	-	-	-	-
Saint George	2.96	0.98	6.33	6.86	Roseau	1.77	0.46	5.86	6.86
Saint John	4.31	1.64	7.01	6.86	-	-	-	-	-
Saint Joseph	2.81	0.51	6.96	6.86	-	-	-	-	-
Saint Luke	1.89	0.41	6.22	6.86	-	-	-	-	-
Saint Mark	4.04	3.14	7.43	6.86	-	-	-	-	-
Saint Patrick	3.82	2.71	8.72	6.86	-	-	-	-	-
Saint Paul	3.25	2.51	8.38	6.86	-	-	-	-	-
Saint Peter	3.82	1.91	7.43	6.86	-	-	-	-	-

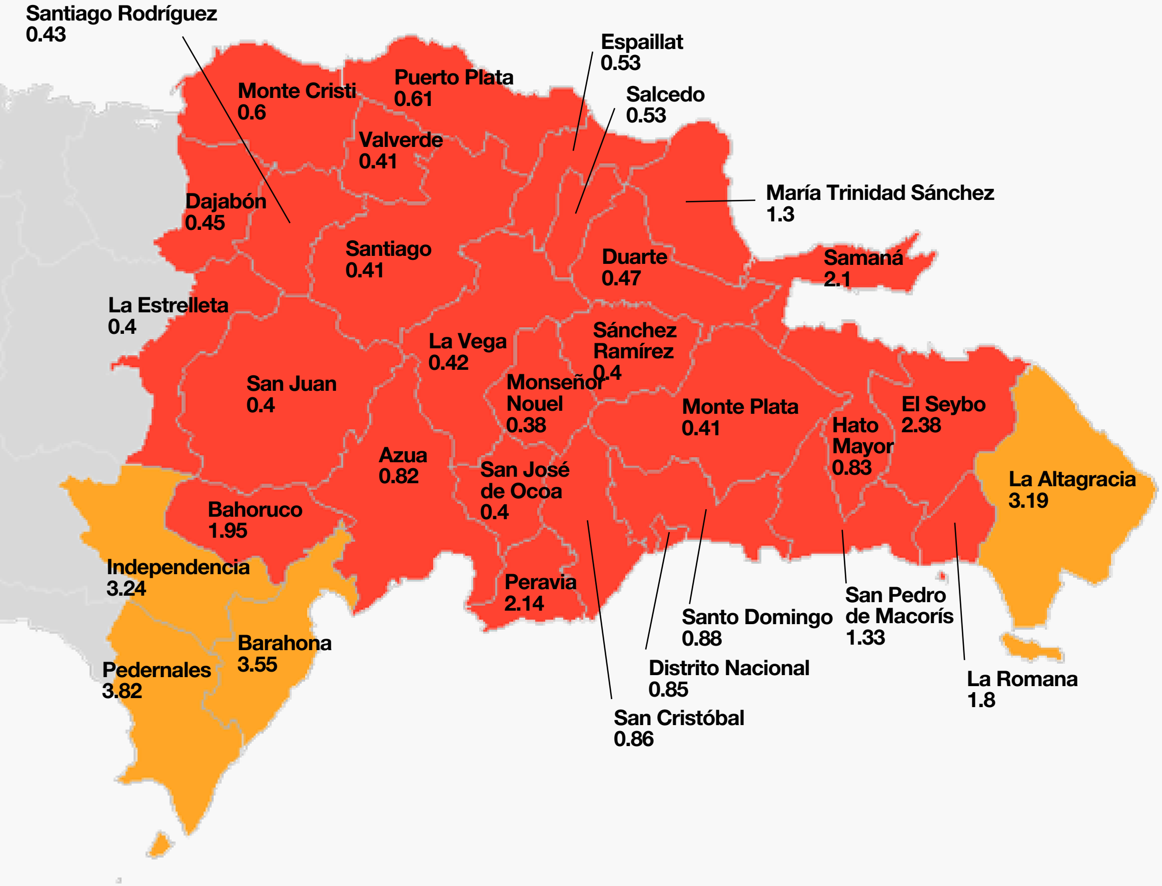
Map 18.
Dominican Republic

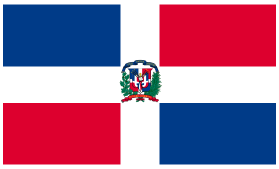
Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014



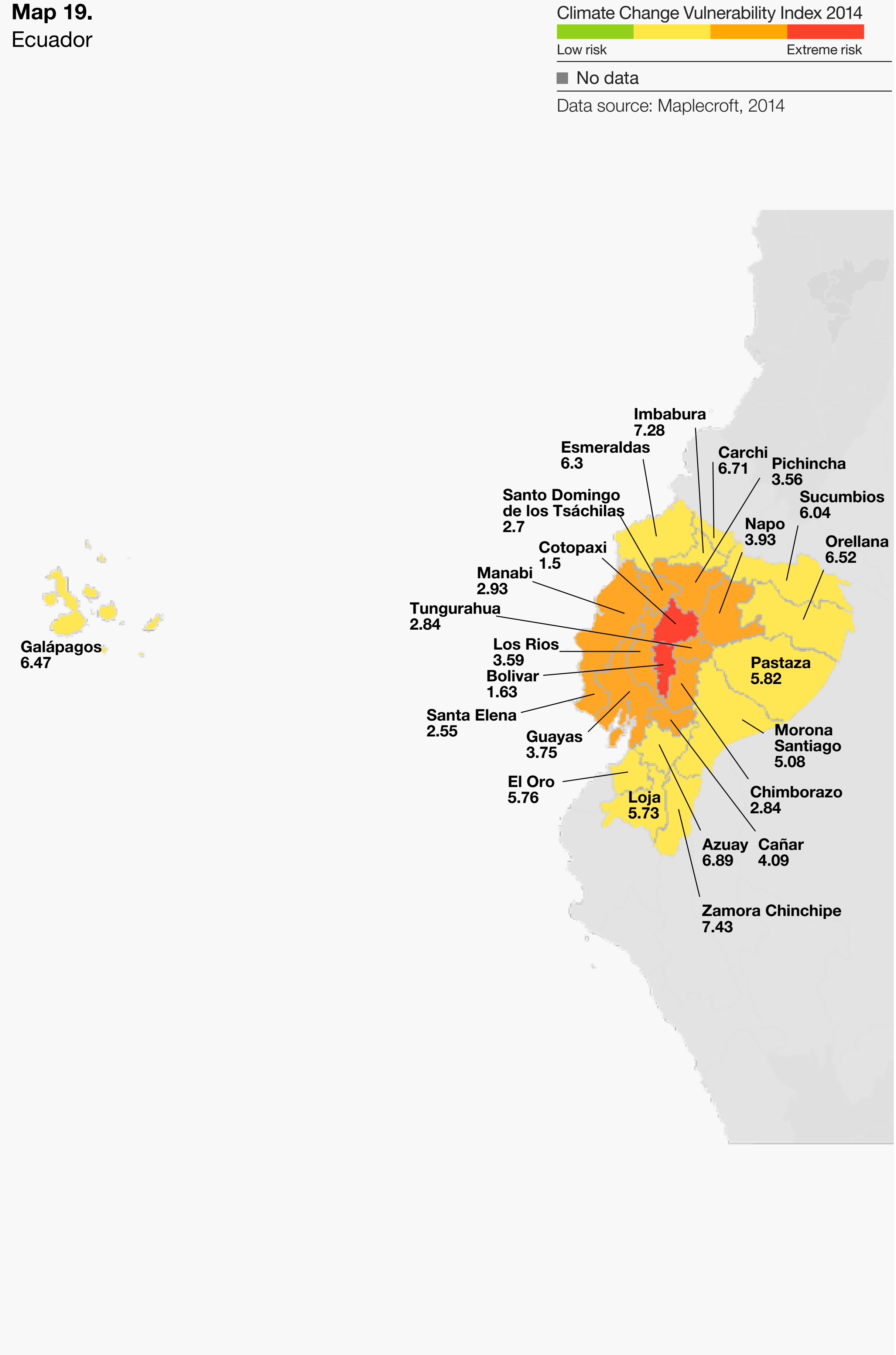


Dominican Republic

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
1.01	2.28	0.76	2.31

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Azua	0.82	1.57	1.92	2.31	Azua	0.80	2.41	2.44	2.31
Bahoruco	1.95	2.31	2.08	2.31	Neyba	0.67	1.26	3.19	2.31
Barahona	3.55	5.35	2.26	2.31	Barahona	2.04	4.13	3.16	2.31
Dajabón	0.45	2.43	1.77	2.31	Dajabon	0.89	3.51	1.22	2.31
Distrito Nacional	0.85	0.90	2.08	2.31	Santo Domingo	0.55	1.31	1.42	2.31
Duarte	0.47	2.97	1.94	2.31	San Francisco De Macoris	0.93	3.13	2.56	2.31
El Seybo	2.38	3.87	2.83	2.31	El Seybo	1.09	2.90	4.01	2.31
Espaillat	0.53	4.32	1.58	2.31	Moca	1.03	3.82	1.70	2.31
Hato Mayor	0.83	2.78	2.54	2.31	Hato Mayor del Rey	1.27	2.75	4.58	2.31
Independencia	3.24	3.19	3.08	2.31	Jimani	2.52	4.54	3.86	2.31
La Altagracia	3.19	5.45	2.70	2.31	Higuey	3.20	5.89	2.90	2.31
La Estrelleta	0.40	0.84	2.23	2.31	Comendador	0.88	1.99	4.22	2.31
La Romana	1.80	4.60	2.06	2.31	La Romana	0.92	3.12	2.18	2.31
La Vega	0.42	1.68	1.99	2.31	La Vega	0.80	2.02	3.14	2.31
María Trinidad Sánchez	1.30	4.02	1.89	2.31	Nagua	0.49	0.60	2.37	2.31
Monseñor Nouel	0.38	0.64	2.87	2.31	Bonao	0.57	1.21	2.08	2.31
Monte Cristi	0.60	2.02	1.66	2.31	Monte Cristi	0.63	0.88	3.47	2.31
Monte Plata	0.41	1.36	2.02	2.31	Monte Plata	0.80	1.74	3.82	2.31
Pedernales	3.82	5.65	4.34	2.31	Pedernales	no data	no data	no data	2.31
Peravia	2.14	2.75	2.87	2.31	Bani	0.81	2.71	1.97	2.31
Puerto Plata	0.61	3.46	1.77	2.31	Puerto Plata	0.67	0.88	4.02	2.31
Salcedo	0.53	4.55	1.59	2.31	Salcedo	1.37	4.06	2.35	2.31
Samaná	2.10	3.12	2.27	2.31	Samana	no data	no data	no data	2.31
San Cristóbal	0.86	1.43	1.38	2.31	San Cristobal	0.60	1.88	1.17	2.31
San José de Ocoa	0.40	1.33	2.07	2.31	San Josedeocoa	0.79	1.69	3.78	2.31
San Juan	0.40	1.38	2.12	2.31	San Juan	0.80	2.28	2.71	2.31
San Pedro de Macorís	1.33	2.41	1.94	2.31	San Pedro de Macoris	0.62	1.80	1.49	2.31
Sánchez Ramírez	0.40	1.81	2.08	2.31	Cotui	0.80	2.24	2.77	2.31
Santiago	0.41	2.12	1.67	2.31	Santiago	0.70	2.21	1.66	2.31
Santiago Rodríguez	0.43	2.15	2.63	2.31	Sabaneta	0.83	2.67	2.26	2.31
Santo Domingo	0.88	1.60	1.48	2.31	-	-	-	-	-
Valverde	0.41	2.18	1.54	2.31	Mao	0.82	2.36	2.84	2.31

Map 19.
Ecuador



Ecuador

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
3.76	5.82	3.47	4.44

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Azuay	6.89	7.82	3.45	4.44	Cuenca	3.38	5.23	2.65	4.44
Bolivar	1.63	3.03	2.70	4.44	Guaranda	2.13	2.58	4.82	4.44
Cañar	4.09	5.48	3.10	4.44	Azogues	3.42	4.80	3.54	4.44
Carchi	6.71	7.97	4.06	4.44	Tulcan	5.44	7.49	3.98	4.44
Chimborazo	2.84	4.20	3.28	4.44	Rio Bamba	1.49	2.85	2.89	4.44
Cotopaxi	1.50	2.46	2.79	4.44	Latacunga	0.99	2.03	2.82	4.44
El Oro	5.76	6.70	2.56	4.44	Machala	4.72	7.85	1.95	4.44
Esmeraldas	6.30	7.23	3.69	4.44	Esmeraldas	1.94	3.61	2.34	4.44
Galápagos	6.47	7.07	8.38	4.44	Puerto Baquerizo Moreno	no data	no data	no data	4.44
Guayas	3.75	5.13	2.65	4.44	Guayaquil	1.14	1.74	1.98	4.44
Imbabura	7.28	8.29	3.68	4.44	Ibarra	4.94	7.59	3.31	4.44
Loja	5.73	7.99	3.03	4.44	Loja	4.32	6.46	3.34	4.44
Los Rios	3.59	5.35	2.10	4.44	Babahoyo	2.75	4.10	3.20	4.44
Manabi	2.93	5.05	2.34	4.44	Portoviejo	1.31	2.67	2.13	4.44
Morona Santiago	5.08	4.93	7.34	4.44	Macas	1.81	2.15	4.99	4.44
Napo	3.93	4.18	6.33	4.44	Tena	1.20	2.19	3.61	4.44
Orellana	6.52	7.16	7.65	4.44	Puerto Francisco-deorellana	4.12	5.49	4.40	4.44
Pastaza	5.82	6.31	8.00	4.44	Puyo	2.12	2.35	5.28	4.44
Pichincha	3.56	4.84	2.93	4.44	Quito	0.90	2.41	1.53	4.44
Santa Elena	2.55	3.20	3.06	4.44	Santa Elena	1.38	2.99	2.41	4.44
Santo Domingo de los Tsáchilas	2.70	3.07	2.29	4.44	Santo Domingo	0.97	2.27	1.75	4.44
Sucumbios	6.04	6.59	6.58	4.44	Nueva Loja	2.40	3.42	3.74	4.44
Tungurahua	2.84	4.83	3.04	4.44	Ambato	1.94	3.44	2.68	4.44
Zamora Chinchipe	7.43	8.05	6.30	4.44	Zamora	3.65	4.04	5.62	4.44

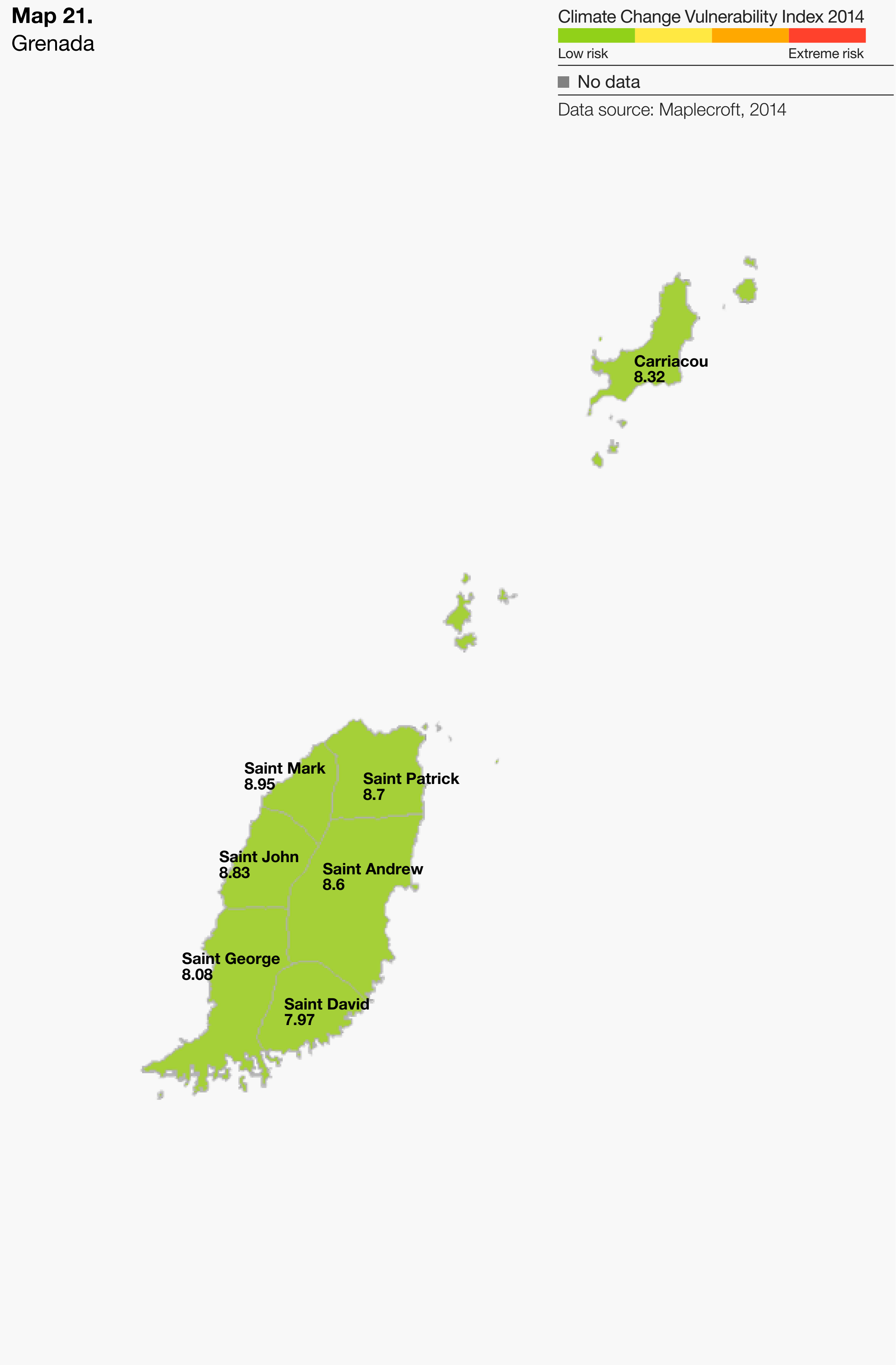
Map 20.
El Salvador

El Salvador

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
0.79	2.68	0.93	1.44

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Ahuachapán	0.61	3.32	2.24	1.44	Ahuachapán	0.85	2.74	3.28	1.44
Cabañas	0.40	2.47	1.74	1.44	Sensuntepeque	0.80	2.17	3.86	1.44
Chalatenango	0.46	2.37	2.34	1.44	Chalatenango	0.79	2.42	3.23	1.44
Cuscatlán	0.40	3.30	1.65	1.44	Cojutepeque	0.72	2.91	1.43	1.44
La Libertad	0.98	4.00	1.90	1.44	Santa Telca	0.83	2.99	2.48	1.44
La Paz	0.91	2.96	1.76	1.44	Zacatecoluca	0.69	2.19	2.51	1.44
La Unión	1.15	2.24	1.95	1.44	La Unión	0.71	1.92	3.22	1.44
Morazán	0.35	0.98	1.67	1.44	San Francisco	0.61	1.69	2.55	1.44
San Miguel	0.39	2.24	1.85	1.44	San Miguel	0.76	2.49	2.65	1.44
San Salvador	0.40	3.43	1.39	1.44	San Salvador	0.74	2.70	1.73	1.44
San Vicente	0.44	2.32	1.88	1.44	San Vincente	0.71	2.26	2.60	1.44
Santa Ana	0.87	4.73	2.64	1.44	Santa Ana	1.06	3.37	3.23	1.44
Sonsonate	1.26	3.60	1.74	1.44	Sonsonate	0.83	3.23	2.02	1.44
Usulután	1.60	3.01	2.70	1.44	Usulután	0.78	2.65	2.64	1.44

Map 21.
Grenada



Grenada

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
9.58	9.79	4.12	7.26

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Carriacou	8.32	8.37	7.38	7.26	-	-	-	-	-
Saint Andrew	8.60	9.30	2.82	7.26	-	-	-	-	-
Saint David	7.97	8.37	4.93	7.26	-	-	-	-	-
Saint George	8.08	8.68	3.02	7.26	Saint George's	3.48	3.88	2.94	7.26
Saint John	8.83	9.70	4.62	7.26	-	-	-	-	-
Saint Mark	8.95	9.73	5.40	7.26	-	-	-	-	-
Saint Patrick	8.70	9.42	5.34	7.26	-	-	-	-	-

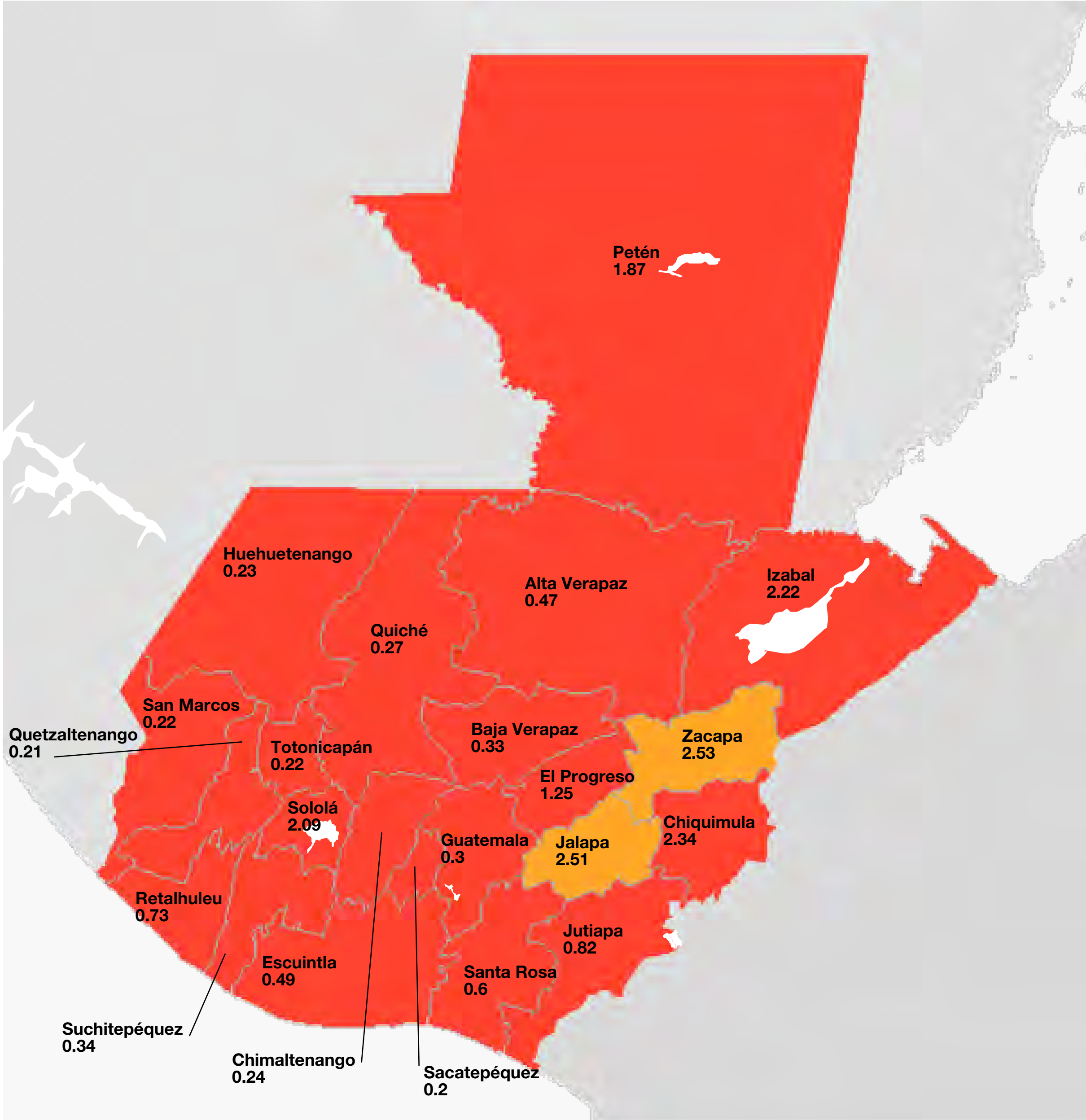
Map 22.
Guatemala

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

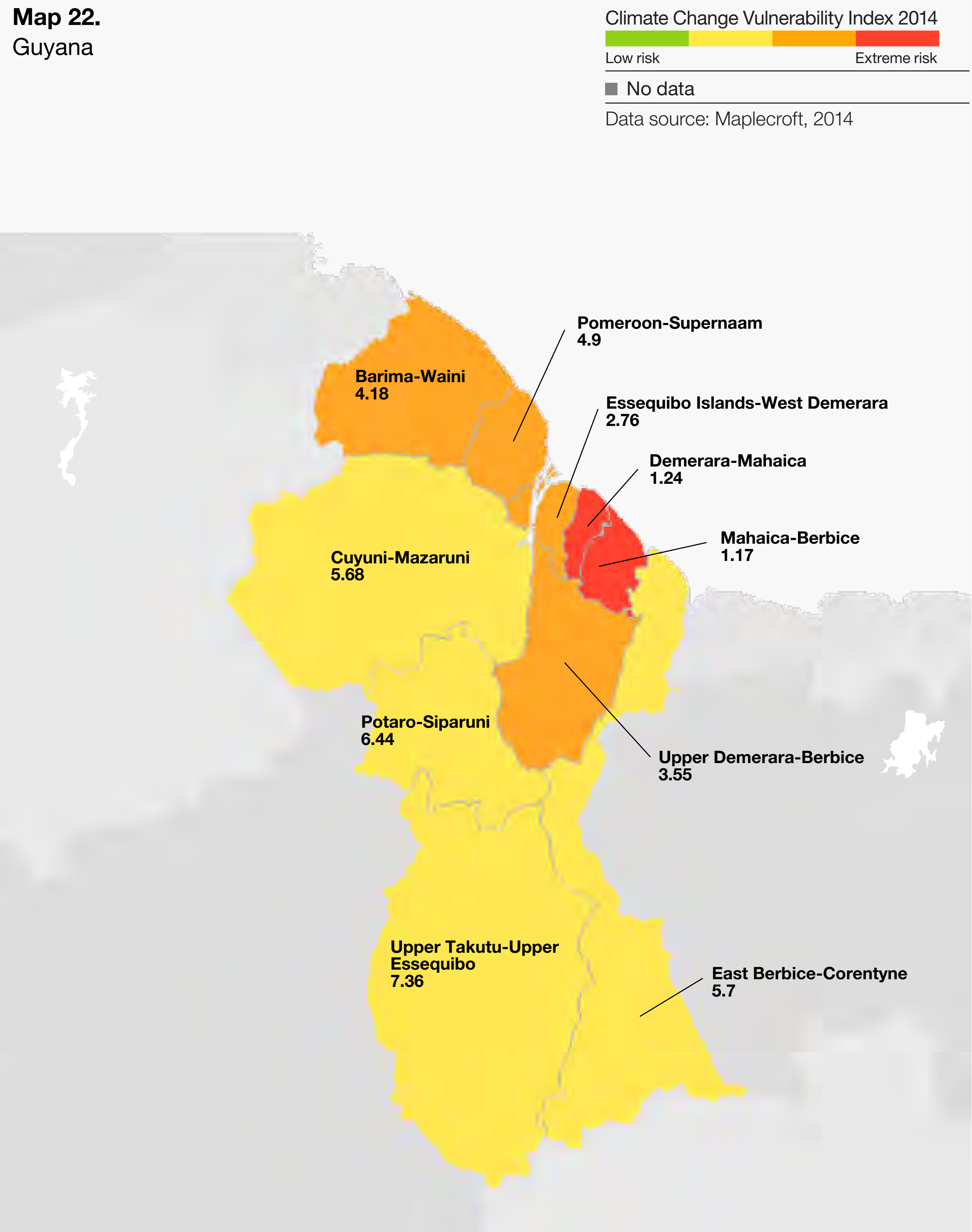


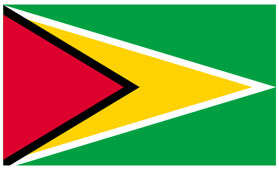
Guatemala

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
0.75	1.66	1.38	0.64

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Alta Verapaz	0.47	1.93	1.90	0.64	Coban	0.62	1.89	2.99	0.64
Baja Verapaz	0.33	1.24	2.28	0.64	Salama	0.48	1.41	2.31	0.64
Chimaltenango	0.24	0.55	1.33	0.64	Chimaltenango	0.39	1.31	1.38	0.64
Chiquimula	2.34	6.58	1.76	0.64	Chiquimula	3.85	7.94	2.35	0.64
El Progreso	1.25	4.51	2.09	0.64	Guastatoya	1.13	4.24	3.15	0.64
Escuintla	0.49	0.71	1.63	0.64	Escuintla	0.30	0.57	1.81	0.64
Guatemala	0.30	2.09	1.35	0.64	Guatemala City	0.39	1.27	1.45	0.64
Huehuetenango	0.23	0.48	1.61	0.64	Huehuetenango	0.47	1.33	2.29	0.64
Izabal	2.22	3.27	2.91	0.64	Puerto Barrios	2.85	5.90	3.71	0.64
Jalapa	2.51	5.20	1.64	0.64	Jalapa	2.18	5.86	2.15	0.64
Jutiapa	0.82	4.09	1.66	0.64	Jutiapa	0.94	4.14	2.30	0.64
Petén	1.87	2.06	3.79	0.64	Flores	0.65	1.46	4.23	0.64
Quetzaltenango	0.21	0.46	1.23	0.64	Quetzaltenango	0.36	0.85	2.03	0.64
Quiché	0.27	0.57	1.91	0.64	San Tacruzdelquiche	0.38	1.32	1.32	0.64
Retalhuleu	0.73	1.18	1.88	0.64	Retalhuleu	0.40	1.11	1.97	0.64
Sacatepéquez	0.20	0.42	1.23	0.64	Antigua Guatemala	0.34	1.12	1.17	0.64
San Marcos	0.22	0.46	1.25	0.64	San Marcos	0.38	0.76	2.36	0.64
Santa Rosa	0.60	0.80	2.00	0.64	Cuilapa	0.60	1.43	3.70	0.64
Sololá	2.09	0.46	1.45	0.64	Solola	0.36	0.88	1.87	0.64
Suchitepéquez	0.34	0.69	1.46	0.64	Mazatenango	0.42	1.01	2.40	0.64
Totonicapán	0.22	0.55	1.23	0.64	Totonicapan	0.44	1.04	2.62	0.64
Zacapa	2.53	3.48	2.26	0.64	Zacapa	3.35	7.37	1.99	0.64

Map 22.
Guyana





Guyana

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
4.23	7.58	7.17	0.66

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Barima-Waini	4.18	6.51	7.88	0.66	Mabarama	4.64	8.28	4.61	0.66
Cuyuni-Mazaruni	5.68	7.53	8.36	0.66	Bartica	no data	no data	no data	0.66
Demerara-Mahaica	1.24	2.81	3.29	0.66	Georgetown	0.56	1.21	3.65	0.66
East Berbice-Corentyne	5.70	7.35	7.62	0.66	New Amsterdam	0.38	0.73	2.43	0.66
Essequibo Islands-West Demerara	2.76	3.72	4.96	0.66	Vreed en Hoop	0.49	1.10	3.04	0.66
Mahaica-Berbice	1.17	2.63	4.22	0.66	Fort Wellington	0.43	0.78	2.97	0.66
					Mahaica	0.51	0.66	4.12	0.66
Pomeroon-Supernaam	4.90	6.78	5.00	0.66	Anna Regina	3.71	1.73	4.71	0.66
Potaro-Siparuni	6.44	8.57	8.23	0.66	-	-	-	-	-
Upper Demerara-Berbice	3.55	5.61	8.27	0.66	Linden	0.90	2.39	5.31	0.66
					Paradise	1.89	3.38	6.48	0.66
Upper Takutu-Upper Essequibo	7.36	9.06	8.29	0.66	Lethem	5.88	5.87	6.40	0.66

Map 24.
Haiti

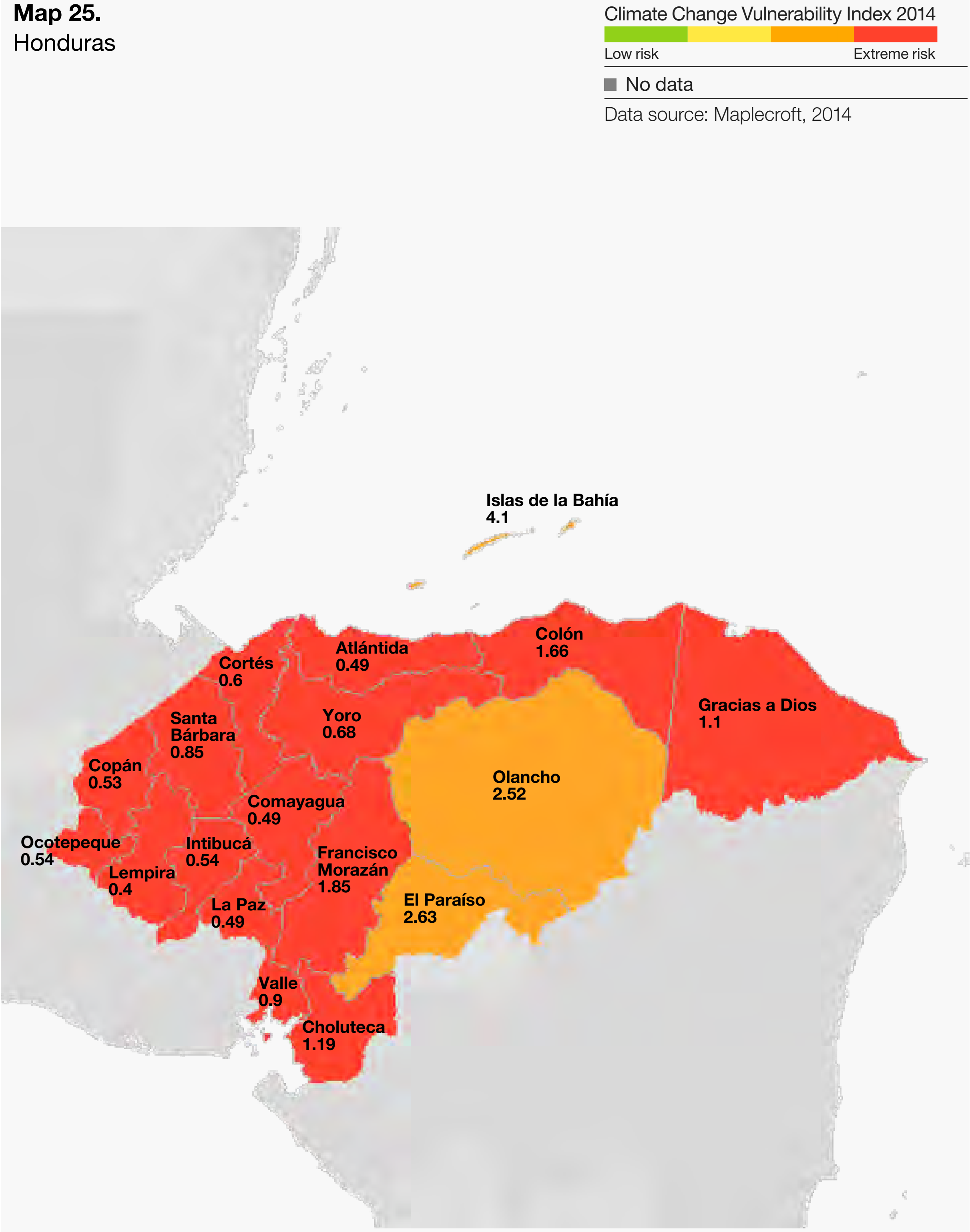

Climate Change Vulnerability Index 2014
Low risk
Extreme risk
No data
Data source: Maplecroft, 2014
Nord-Ouest
1.14
Nord
0.57
Nord-Est
0.42
L'Artibonite
0.57
Centre
0.19
Ouest
0.82
Grand'Anse
0.56
Nippes
0.36
Sud
1.39
Sud-Est
1.74

Haiti

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
0.58	2.14	0.22	0.00

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Centre	0.19	0.86	0.38	0.00	Hinche	0.32	1.61	0.62	0.00
Grand'Anse	0.56	1.20	0.52	0.00	Jeremie	0.47	2.47	0.69	0.00
L'Artibonite	0.57	2.50	0.53	0.00	Gonaives	0.27	1.36	0.50	0.00
Nippes	0.36	1.18	0.38	0.00	Miragoâne	0.41	2.15	0.62	0.00
Nord	0.57	4.24	0.35	0.00	Cap-Haitien	0.42	2.42	0.20	0.00
Nord-Est	0.42	2.76	0.43	0.00	Fortliberte	0.27	1.31	0.67	0.00
Nord-Ouest	1.14	5.65	0.67	0.00	Port-De-Paix	0.53	2.99	0.39	0.00
Ouest	0.82	2.20	0.61	0.00	Port-Au-Prince	0.42	2.39	0.24	0.00
Sud	1.39	2.21	0.95	0.00	Les Cayes	0.21	0.87	0.79	0.00
Sud-Est	1.74	2.76	1.05	0.00	Jacmel	0.23	1.10	0.58	0.00

Map 25.
Honduras



Honduras

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
0.92	2.73	2.43	0.50

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Atlántida	0.49	2.01	3.57	0.50	La Ceiba	0.58	1.30	3.91	0.50
Choluteca	1.19	2.30	2.15	0.50	Choluteca	0.54	1.40	3.20	0.50
Colón	1.66	3.03	3.46	0.50	Trujillo	0.82	1.71	5.88	0.50
Comayagua	0.49	3.30	2.81	0.50	Comayagua	0.78	3.08	2.65	0.50
Copán	0.53	4.73	2.55	0.50	Santa Rosa de Copán	0.88	3.53	2.95	0.50
Cortés	0.60	2.42	3.02	0.50	San Pedro Sula	0.69	2.96	1.90	0.50
El Paraíso	2.63	5.76	2.53	0.50	Yuscarán	1.22	4.15	3.67	0.50
Francisco Morazán	1.85	3.21	2.59	0.50	Tegucigalpa	0.63	2.70	1.63	0.50
Gracias a Dios	1.10	1.94	6.76	0.50	Puerto Lempira	0.52	0.51	4.74	0.50
Intibucá	0.54	2.98	2.37	0.50	La Esperanza	0.84	2.79	3.99	0.50
Islas de la Bahía	4.10	4.56	5.99	0.50	Roatán	2.86	0.58	4.12	0.50
La Paz	0.49	3.52	2.29	0.50	La Paz	0.74	2.73	2.88	0.50
Lempira	0.40	2.70	2.37	0.50	Gracias	0.88	3.57	2.94	0.50
Ocotepeque	0.54	3.54	2.82	0.50	Nueva Ocotepeque	0.81	3.27	2.74	0.50
Olancho	2.52	4.83	4.47	0.50	Juticalpa	1.22	4.11	3.75	0.50
Santa Bárbara	0.85	4.52	2.85	0.50	Santa Bárbara	0.88	2.80	4.43	0.50
Valle	0.90	1.49	2.35	0.50	Nacaome	0.63	1.82	3.38	0.50
Yoro	0.68	2.18	3.50	0.50	Yoro	0.71	1.76	4.55	0.50

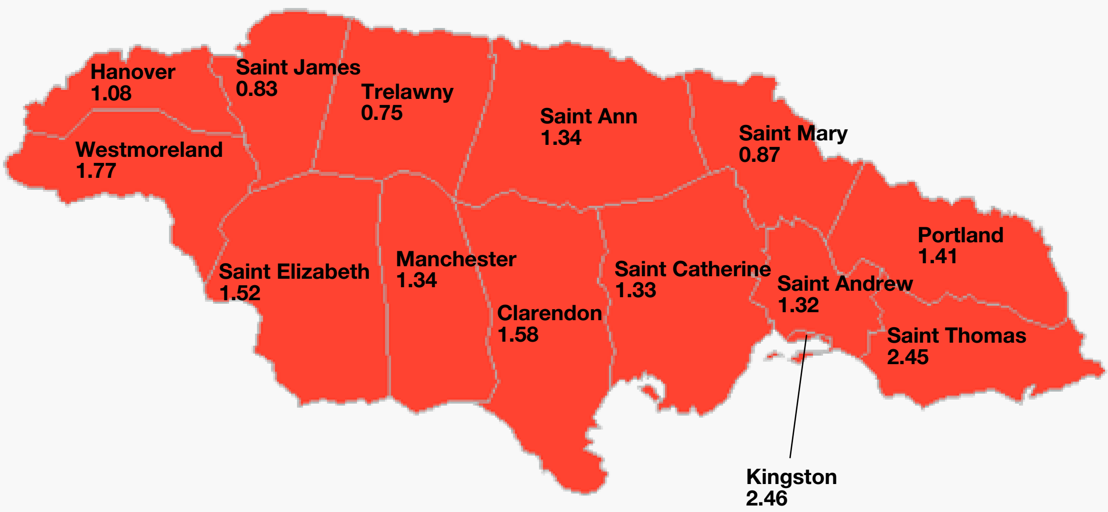
Map 26.
Jamaica

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

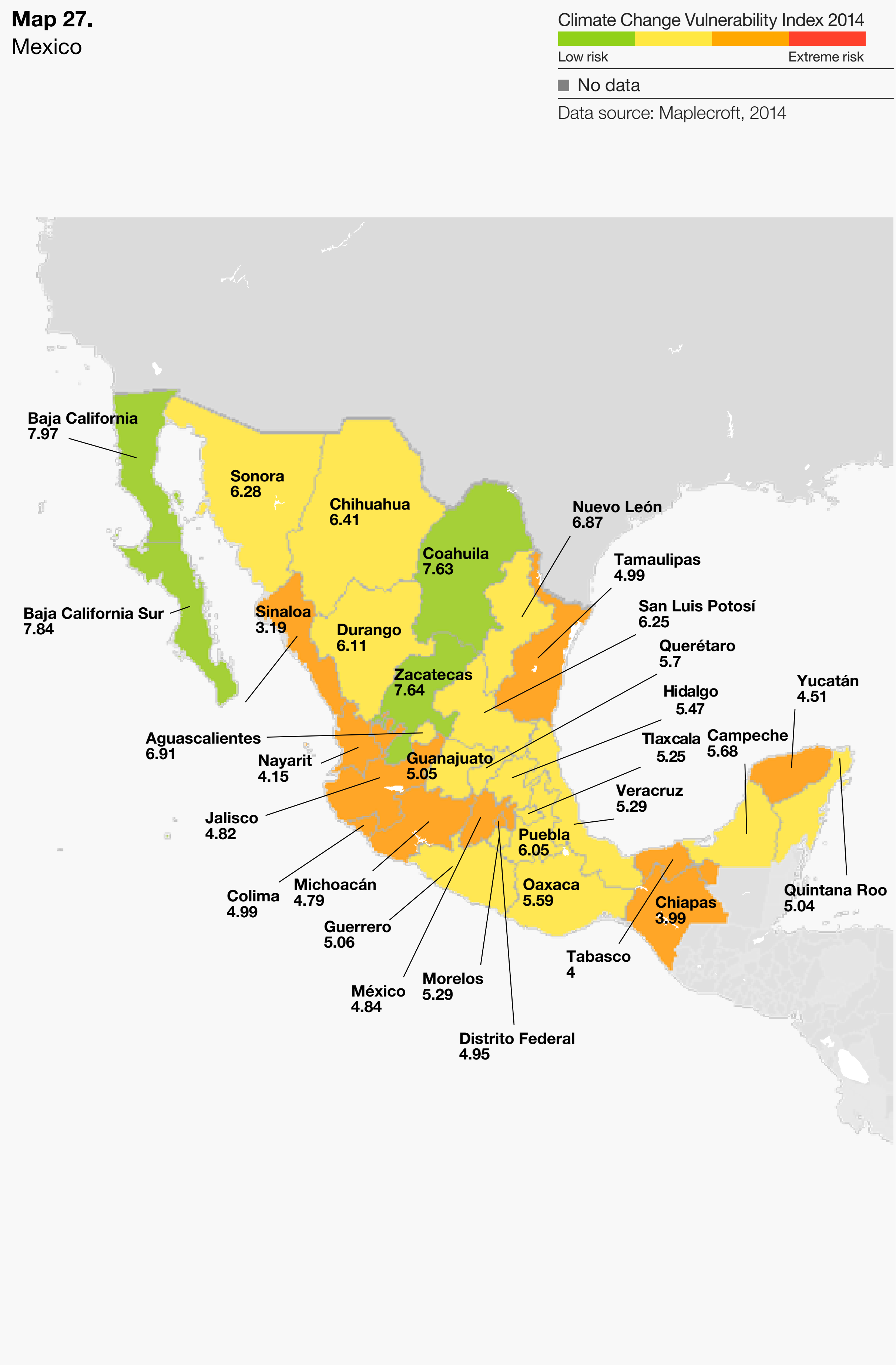


Jamaica

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
1.50	0.84	2.11	6.15

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Clarendon	1.58	0.94	2.69	6.15	May Pen	0.85	1.08	1.85	6.15
Hanover	1.08	0.72	2.81	6.15	Lucea	1.57	1.06	4.76	6.15
Kingston	2.46	2.65	4.66	6.15	-	-	-	-	-
Manchester	1.34	0.92	2.34	6.15	Mandeville	0.87	0.88	2.53	6.15
Portland	1.41	0.87	3.69	6.15	Port Antonio	1.72	1.56	4.26	6.15
Saint Andrew	1.32	0.94	2.84	6.15	Kingston	1.14	1.22	3.04	6.15
Saint Ann	1.34	0.60	3.32	6.15	Saint Anns Bay	1.26	0.73	4.38	6.15
Saint Catherine	1.33	0.79	2.79	6.15	Spanish Town	1.19	1.91	1.82	6.15
Saint Elizabeth	1.52	0.93	2.99	6.15	Black River	no data	no data	no data	6.15
Saint James	0.83	0.53	2.57	6.15	Montego Bay	0.89	0.72	3.00	6.15
Saint Mary	0.87	0.68	2.58	6.15	Port Maria	0.93	1.22	2.04	6.15
Saint Thomas	2.45	1.42	3.19	6.15	Morant Bay	1.74	2.13	3.16	6.15
Trelawny	0.75	0.41	3.89	6.15	Falmouth	0.99	0.41	4.88	6.15
Westmoreland	1.77	0.93	2.58	6.15	Savanna La Mar	0.84	0.44	3.02	6.15

Map 27.
Mexico



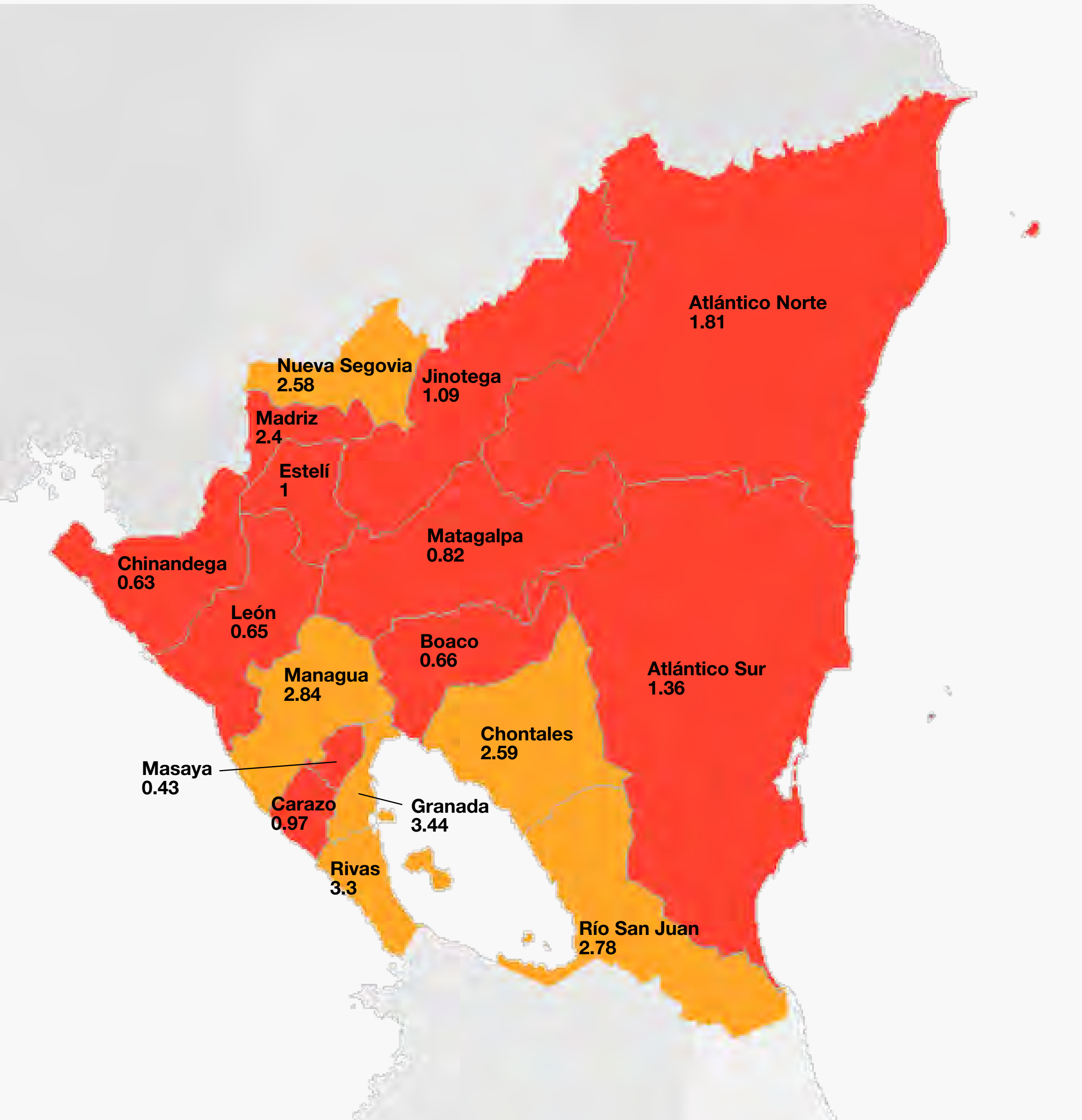
Mexico

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
4.47	3.35	5.32	7.66

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Aguascalientes	6.91	5.51	3.38	7.66	Aguascalientes	3.08	3.06	2.94	7.66
Baja California	7.97	6.70	7.47	7.66	Mexicali	3.74	3.77	3.96	7.66
Baja California Sur	7.84	6.57	8.25	7.66	La Paz	3.26	1.90	5.88	7.66
Campeche	5.68	2.71	8.12	7.66	Campeche	2.67	1.42	5.20	7.66
Chiapas	3.99	1.43	5.59	7.66	-	-	-	-	-
Chihuahua	6.41	5.83	7.13	7.66	Chihuahua	4.37	4.65	3.79	7.66
Coahuila	7.63	5.83	7.86	7.66	Saltillo	3.18	3.01	3.31	7.66
Colima	4.99	1.60	6.36	7.66	Colima	3.06	2.61	3.77	7.66
Distrito Federal	4.95	4.87	2.56	7.66	Mexico City	3.38	4.07	1.85	7.66
Durango	6.11	4.69	7.30	7.66	Durango	3.06	2.62	3.72	7.66
Guanajuato	5.05	3.42	2.98	7.66	Guanajuato	2.64	2.14	3.66	7.66
Guerrero	5.06	2.11	5.50	7.66	Chilpancingo-delosbravo	3.00	2.03	4.80	7.66
Hidalgo	5.47	4.27	3.48	7.66	Pachuca de Soto	4.04	4.48	2.98	7.66
Jalisco	4.82	1.65	5.37	7.66	Guadalajara	1.96	1.98	2.47	7.66
México	4.84	3.68	2.85	7.66	Toluca	2.83	3.25	1.95	7.66
Michoacán	4.79	1.15	5.53	7.66	Morelia	1.93	1.71	2.92	7.66
Morelos	5.29	4.66	2.71	7.66	Cuernavaca	2.78	3.04	2.26	7.66
Nayarit	4.15	0.94	6.34	7.66	Tepic	2.43	1.74	3.98	7.66
Nuevo León	6.87	4.15	7.15	7.66	Monterrey	2.25	2.45	2.19	7.66
					San Tiago	2.06	0.84	4.94	7.66
Oaxaca	5.59	2.61	5.77	7.66	Oaxaca	2.51	2.32	3.02	7.66
Puebla	6.05	4.35	3.92	7.66	Puebla de Zaragoza	2.80	3.06	2.28	7.66
Querétaro	5.70	4.72	3.31	7.66	Queretaro	2.01	2.33	1.87	7.66
Quintana Roo	5.04	1.55	8.17	7.66	Chetumal	6.19	0.57	6.46	7.66
San Luis Potosí	6.25	4.87	6.11	7.66	San Luispotosi	3.92	4.40	2.72	7.66
Sinaloa	3.19	0.65	5.00	7.66	Culiacan	1.45	0.95	3.29	7.66
Sonora	6.28	4.99	7.24	7.66	Hermosillo	2.48	1.80	4.01	7.66
Tabasco	4.00	2.21	4.33	7.66	Villahermosa	2.77	2.54	3.33	7.66
Tamaulipas	4.99	2.10	6.24	7.66	Ciudad Victoria	2.46	1.99	3.57	7.66
Tlaxcala	5.25	2.93	2.83	7.66	Tlaxcala	2.31	2.46	2.26	7.66
Veracruz	5.29	2.93	3.93	7.66	Xalapa	2.62	2.80	2.29	7.66
Yucatán	4.51	0.65	7.31	7.66	Mérida	1.58	1.39	2.78	7.66
Zacatecas	7.64	6.05	6.26	7.66	Zacatecas	5.14	6.14	3.62	7.66

Map 28.
Nicaragua

Climate Change Vulnerability Index 2014
Low risk
Extreme risk
No data
Data source: Maplecroft, 2014



Nicaragua

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
1.19	3.81	2.01	0.13

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Atlántico Norte	1.81	3.38	4.12	0.13	Puerto Cabezas	no data	1.03	no data	0.13
Atlántico Sur	1.36	3.52	2.81	0.13	Bluefields	3.86	2.33	4.92	0.13
Boaco	0.66	2.85	2.15	0.13	Boaco	0.46	1.47	2.44	0.13
Carazo	0.97	1.41	1.53	0.13	Jinotepe	0.48	1.80	1.99	0.13
Chinandega	0.63	2.18	2.05	0.13	Chinandega	0.68	3.01	1.97	0.13
Chontales	2.59	4.29	2.36	0.13	Juigalpa	0.52	1.92	2.23	0.13
Estelí	1.00	5.25	1.65	0.13	Estelí	1.41	5.03	2.34	0.13
Granada	3.44	4.39	2.28	0.13	Granada	no data	no data	no data	0.13
Jinotega	1.09	4.77	2.10	0.13	Jinotega	0.76	2.56	3.85	0.13
León	0.65	2.18	1.87	0.13	León	0.45	1.57	2.09	0.13
Madriz	2.40	5.68	1.43	0.13	Somoto	0.85	3.35	3.34	0.13
Managua	2.84	2.36	2.63	0.13	Managua	0.39	1.54	1.52	0.13
Masaya	0.43	0.95	1.18	0.13	Masaya	0.47	1.79	1.92	0.13
Matagalpa	0.82	4.88	1.90	0.13	Matagalpa	0.93	4.01	3.01	0.13
Nueva Segovia	2.58	7.25	1.62	0.13	Ocotal	2.66	6.25	3.01	0.13
Río San Juan	2.78	5.31	2.87	0.13	San Carlos	no data	no data	no data	0.13
Rivas	3.30	3.59	2.85	0.13	Rivas	1.42	2.27	2.09	0.13

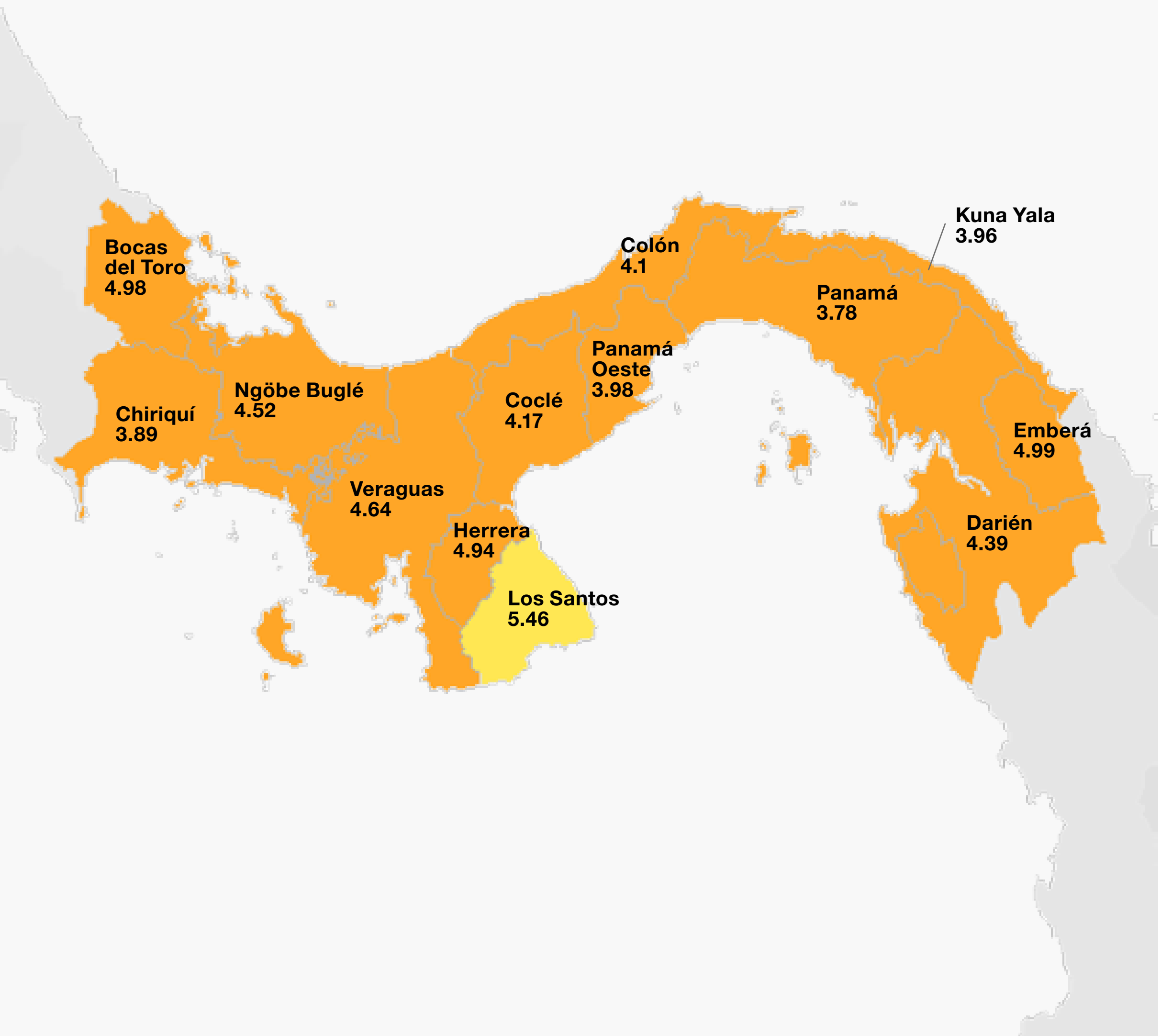
Map 29.
Panama

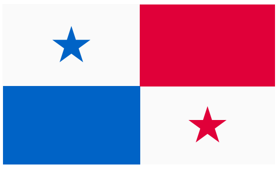
Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014





Panama

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
5.57	5.26	4.61	6.70

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Bocas del Toro	6.19	5.91	6.04	6.70	Bocas del Toro	no data	no data	no data	6.70
Chiriquí	5.40	4.59	4.06	6.70	David	3.80	4.09	3.98	6.70
Coclé	6.37	5.50	4.54	6.70	Penonomé	4.04	5.17	2.95	6.70
Colón	5.67	3.59	6.55	6.70	Colón	2.17	1.56	4.83	6.70
Darién	5.84	5.17	6.85	6.70	-	-	-	-	-
Emberá	7.50	7.06	7.63	6.70	-	-	-	-	-
Herrera	7.47	6.96	4.41	6.70	Chitré	3.92	4.39	3.75	6.70
Kuna Yala	5.39	5.17	5.14	6.70	El Porvenir	no data	0.72	no data	6.70
Los Santos	7.51	6.77	4.38	6.70	Las Tablas	5.28	6.40	4.57	6.70
Ngöbe Buglé	7.00	6.11	3.87	6.70	Chichica	2.89	3.34	2.81	6.70
Panamá	5.15	4.15	5.41	6.70	Panama City	1.37	1.62	2.70	6.70
Panamá Oeste	5.15	4.53	3.94	6.70	La Chorrera	3.61	3.40	3.94	6.70
Veraguas	6.03	5.87	4.98	6.70	Las Palmas	3.76	3.49	4.76	6.70
					Santiago de Veraguas	4.12	4.86	3.80	6.70

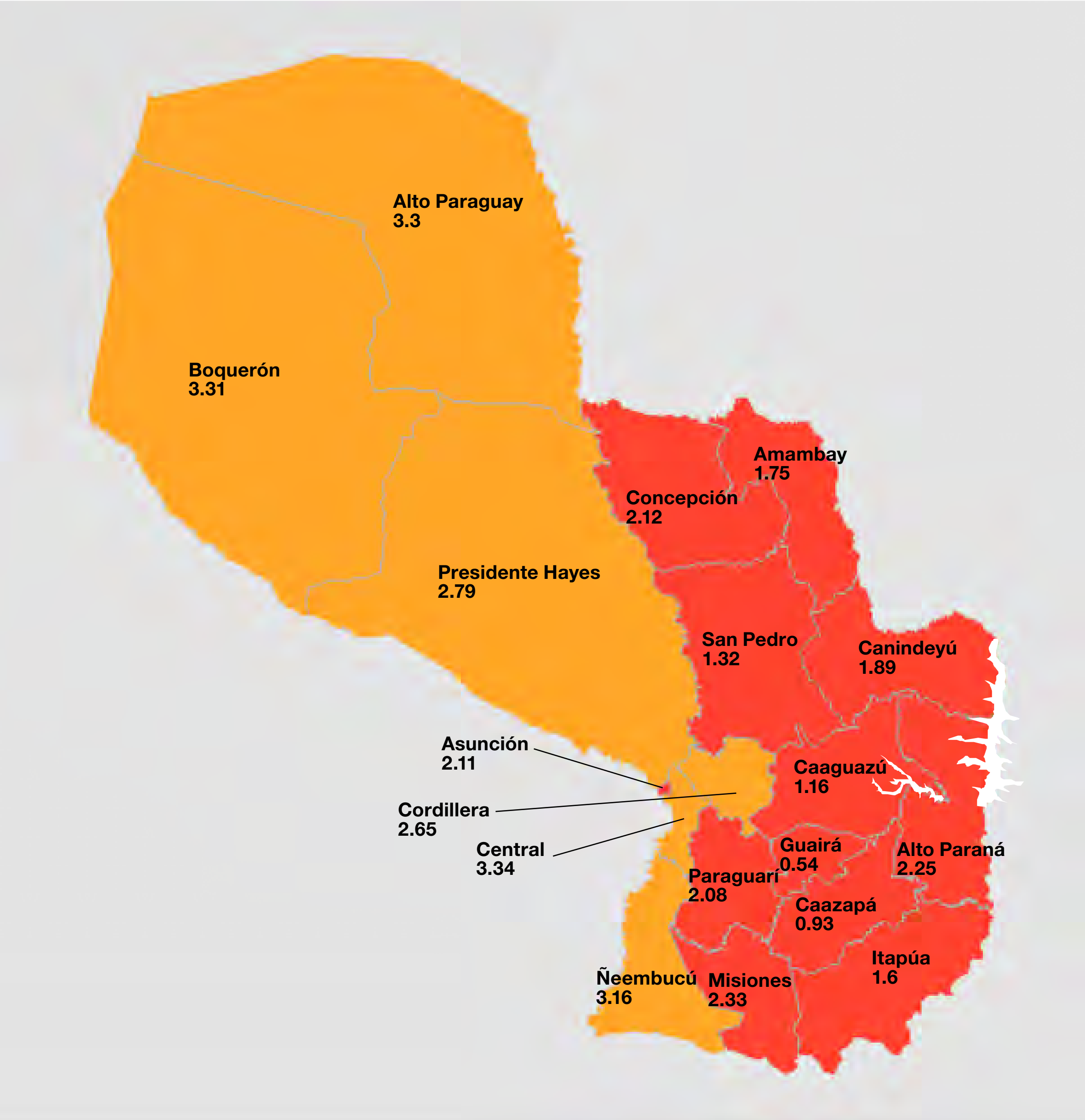
Map 30.
Paraguay

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014



Paraguay

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
1.58	4.30	3.90	0.94

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Alto Paraguay	3.30	4.81	7.88	0.94	Fuerte Olimpo	3.60	1.43	7.29	0.94
Alto Paraná	2.25	3.75	2.45	0.94	Ciudaddeleste	3.65	4.27	2.96	0.94
Amambay	1.75	1.79	3.79	0.94	Pedro Juan Caballero	1.79	1.43	2.98	0.94
Asunción	2.11	4.48	1.21	0.94	-	-	-	-	-
Boquerón	3.31	5.03	6.79	0.94	Filadelfia	0.77	3.13	2.10	0.94
Caaguazú	1.16	3.37	1.95	0.94	Caaguazu	0.72	2.82	2.09	0.94
					Coronel Oviedo	0.74	2.25	3.40	0.94
Caazapá	0.93	3.39	2.71	0.94	-	-	-	-	-
Canindeyú	1.89	2.44	2.58	0.94	Saltodelguaira	2.46	1.22	4.79	0.94
Central	3.34	5.62	2.86	0.94	Aregua	2.80	6.15	2.78	0.94
					Asuncion	2.63	5.91	1.66	0.94
Concepción	2.12	3.42	4.78	0.94	Concepcion	1.07	2.47	4.63	0.94
Cordillera	2.65	5.51	2.71	0.94	Caacupe	3.32	7.22	2.03	0.94
Guairá	0.54	3.00	1.98	0.94	Villa Rrica	0.87	2.98	3.50	0.94
Itapúa	1.60	3.17	2.68	0.94	Encarnacion	1.00	1.82	2.61	0.94
Misiones	2.33	4.64	4.70	0.94	San Juan Bautista	1.00	3.35	4.35	0.94
Ñeembucú	3.16	4.81	7.42	0.94	Pilar	3.72	4.77	4.89	0.94
Paraguarí	2.08	3.67	3.27	0.94	Paraguari	1.95	4.78	3.52	0.94
Presidente Hayes	2.79	4.77	7.64	0.94	Villa Hayes	0.87	3.12	3.21	0.94
San Pedro	1.32	3.11	2.76	0.94	San Pedro	0.96	2.55	5.47	0.94

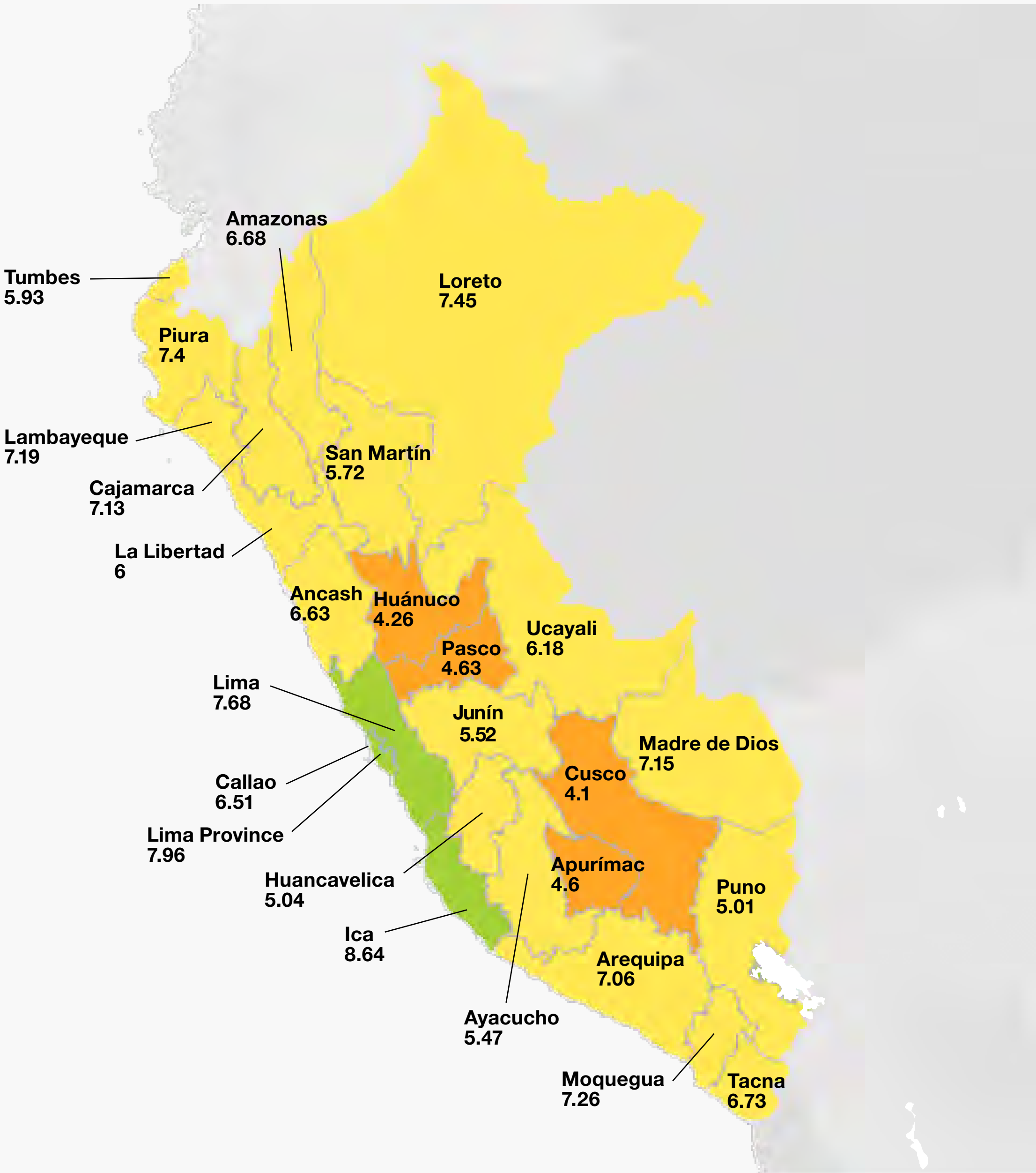
Map 31.
Peru

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

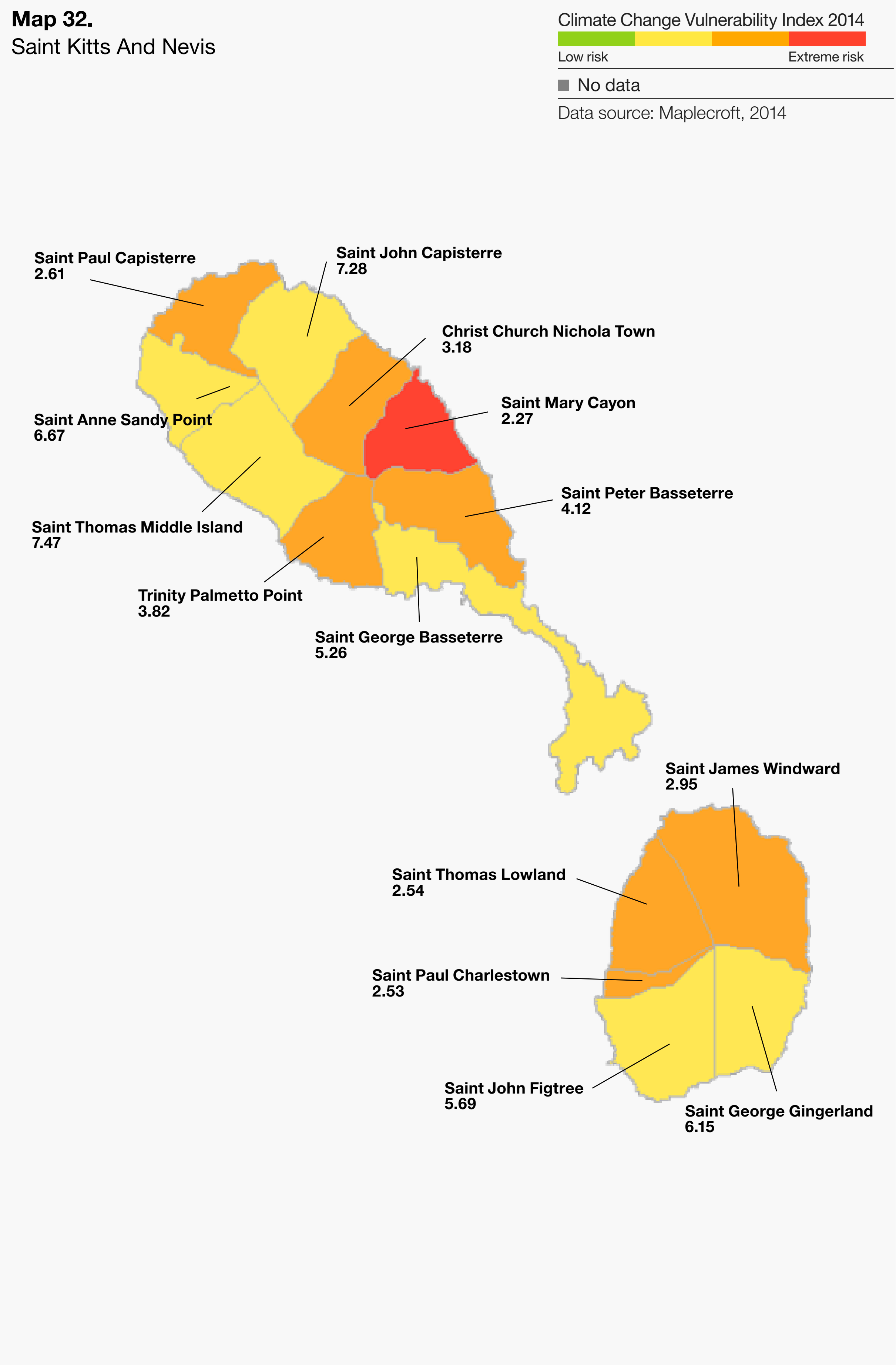


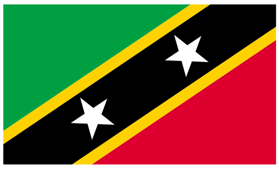
Peru

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
4.98	6.69	4.50	5.32

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Amazonas	6.68	6.00	5.31	5.32	Chachapoyas	4.19	5.91	2.93	5.32
Ancash	6.63	7.88	3.45	5.32	Huaráz	4.76	7.03	2.90	5.32
Apurímac	4.60	4.65	4.12	5.32	Abancay	2.97	3.36	4.41	5.32
Arequipa	7.06	6.85	6.47	5.32	Arequipa	3.63	5.37	2.31	5.32
Ayacucho	5.47	5.74	4.47	5.32	Ayacucho	2.75	3.45	3.65	5.32
Cajamarca	7.13	8.23	2.45	5.32	Cajamarca	5.16	7.58	3.23	5.32
Callao	6.51	9.26	2.57	5.32	Callao	4.96	8.16	1.24	5.32
Cusco	4.10	3.74	5.05	5.32	Cuzco	3.94	5.58	3.13	5.32
Huancavelica	5.04	6.01	3.29	5.32	Huancavelica	3.78	4.40	4.40	5.32
Huánuco	4.26	4.26	4.37	5.32	Huánuco	2.99	3.90	3.35	5.32
Ica	8.64	9.71	5.51	5.32	Ica	6.47	9.74	2.76	5.32
Junín	5.52	5.74	4.37	5.32	Huancayo	3.60	4.65	3.62	5.32
La Libertad	6.00	7.06	3.02	5.32	Trujillo	5.69	8.81	2.41	5.32
Lambayeque	7.19	9.37	2.83	5.32	Chiclayo	1.80	3.15	2.09	5.32
Lima	7.68	8.47	3.72	5.32	-	-	-	-	-
Lima Province	7.96	9.50	2.72	5.32	Lima	5.51	8.89	1.65	5.32
Loreto	7.45	7.53	8.01	5.32	Iquitos	3.74	4.34	4.64	5.32
Madre de Dios	7.15	6.54	8.25	5.32	Puerto Maldonado	4.07	5.31	3.75	5.32
Moquegua	7.26	6.90	5.15	5.32	Moquegua	3.80	3.74	5.96	5.32
Pasco	4.63	4.10	6.41	5.32	Cerro de Pasco	3.09	3.56	4.27	5.32
Piura	7.40	8.56	2.42	5.32	Piura	5.73	9.05	2.10	5.32
Puno	5.01	5.41	5.17	5.32	Puno	2.19	1.97	3.48	5.32
San Martín	5.72	5.76	5.58	5.32	Moyobamba	4.91	5.92	5.68	5.32
Tacna	6.73	6.79	6.33	5.32	Tacna	6.04	9.09	2.85	5.32
Tumbes	5.93	6.98	3.34	5.32	Tumbes	1.93	3.41	1.88	5.32
Ucayali	6.18	6.45	7.93	5.32	Pucallpa	4.72	6.56	3.61	5.32

Map 32.
Saint Kitts And Nevis





Saint Kitts And Nevis

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
6.24	2.36	8.68	7.50

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Christ Church Nichola Town	3.18	1.06	7.51	7.50	-	-	-	-	-
Saint Anne Sandy Point	6.67	6.25	8.65	7.50	-	-	-	-	-
Saint George Basseterre	5.26	3.06	8.83	7.50	Basseterre	5.26	3.06	8.83	7.50
Saint George Gingerland	6.15	5.74	8.13	7.50	-	-	-	-	-
Saint James Windward	2.95	0.56	6.38	7.50	-	-	-	-	-
Saint John Capisterre	7.28	2.70	7.52	7.50	-	-	-	-	-
Saint John Figtree	5.69	1.92	7.73	7.50	-	-	-	-	-
Saint Mary Cayon	2.27	0.59	6.06	7.50	-	-	-	-	-
Saint Paul Capisterre	2.61	0.62	6.78	7.50	-	-	-	-	-
Saint Paul Charlestown	2.53	0.62	6.54	7.50	-	-	-	-	-
Saint Peter Basseterre	4.12	3.47	6.75	7.50	-	-	-	-	-
Saint Thomas Lowland	2.54	0.62	6.55	7.50	-	-	-	-	-
Saint Thomas Middle Island	7.47	3.07	8.00	7.50	-	-	-	-	-
Trinity Palmetto Point	3.82	2.10	7.61	7.50	-	-	-	-	-

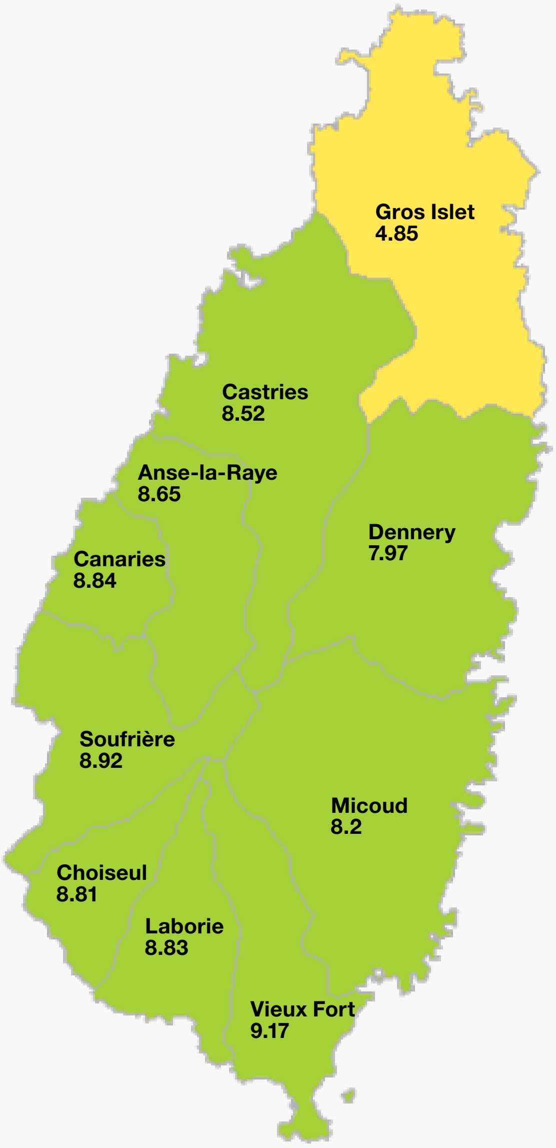
Map 33.
Saint Lucia

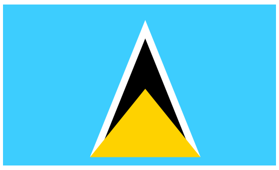
Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014



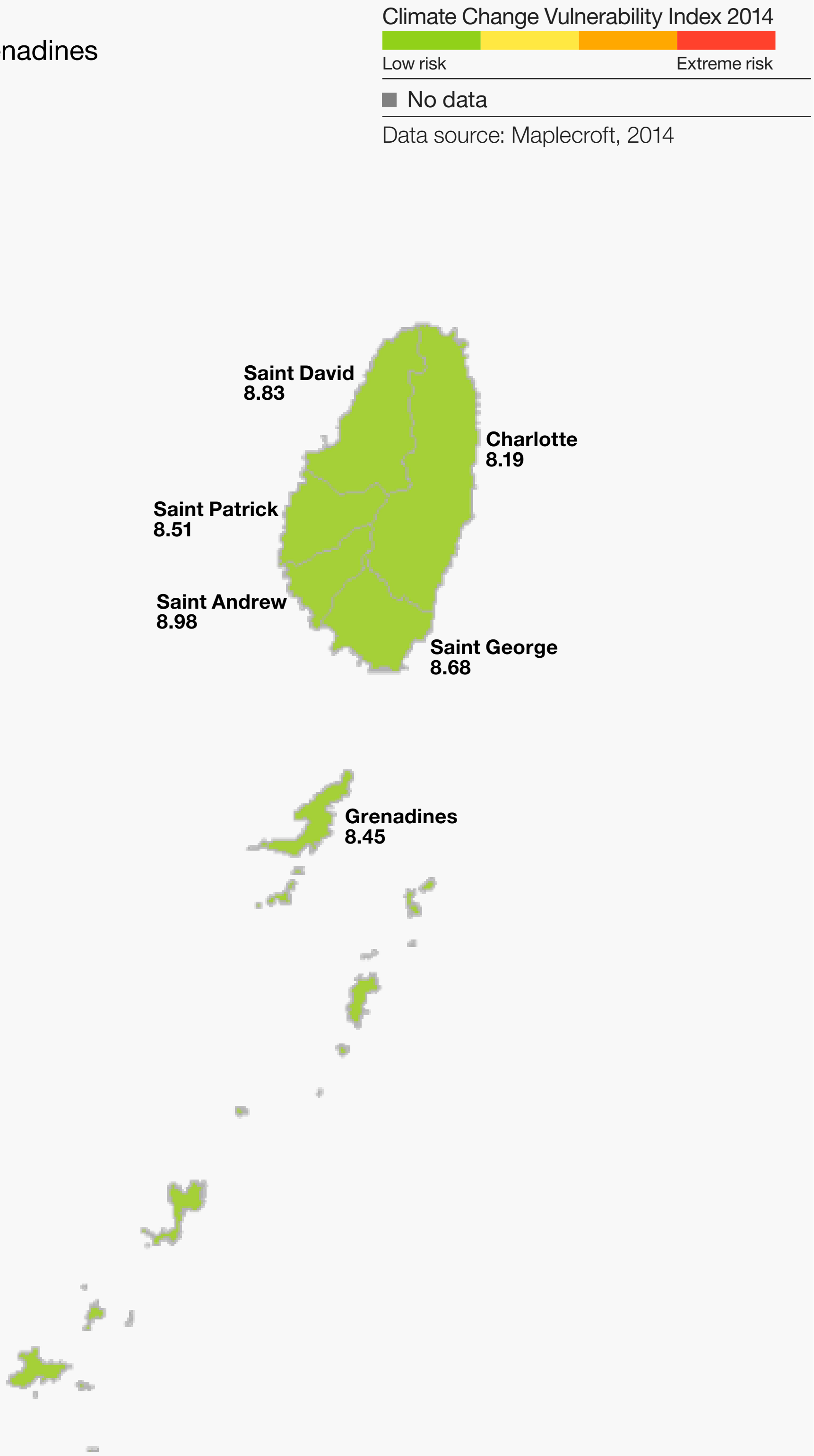


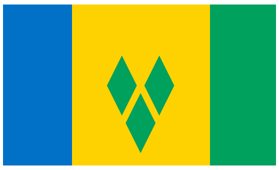
Saint Lucia

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
8.25	8.70	5.45	6.31

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Anse-la-Raye	8.65	9.64	4.86	6.31	Anse La Raye	6.64	8.98	3.79	6.31
Canaries	8.84	9.74	5.54	6.31	Canaries	7.49	9.45	4.77	6.31
Castries	8.52	9.32	4.43	6.31	Castries	6.47	7.81	5.13	6.31
Choiseul	8.81	9.80	5.40	6.31	Choiseul	7.01	9.48	3.64	6.31
Dennery	7.97	8.42	5.18	6.31	Dennery	4.50	4.56	5.85	6.31
Gros Islet	4.85	4.94	4.38	6.31	Gros Islet	4.68	5.99	3.69	6.31
Laborie	8.83	9.78	5.54	6.31	-	-	-	-	-
Micoud	8.20	8.91	3.91	6.31	Micoud	3.37	3.04	5.04	6.31
Soufrière	8.92	9.79	6.04	6.31	Soufriere	7.53	9.47	4.98	6.31
Vieux Fort	9.17	9.83	7.65	6.31	Laborie	no data	no data	no data	6.31
					Vieux Fort	no data	no data	no data	6.31

Map 34.
Saint Vincent and the Grenadines





Saint Vincent and the Grenadines

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
9.63	9.85	4.69	6.74

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Charlotte	8.19	9.00	2.41	6.74	Georgetown	7.27	9.49	3.76	6.74
Grenadines	8.45	8.65	7.71	6.74	Port Elizabeth	3.41	3.46	3.88	6.74
Saint Andrew	8.98	9.82	5.85	6.74	Layou	7.43	9.50	4.11	6.74
Saint David	8.83	9.44	8.06	6.74	Chateaubelair	7.73	9.50	5.15	6.74
Saint George	8.68	9.57	5.50	6.74	Kingstown	5.69	8.20	2.28	6.74
Saint Patrick	8.51	9.17	5.49	6.74	Barroualie	4.84	5.56	4.27	6.74

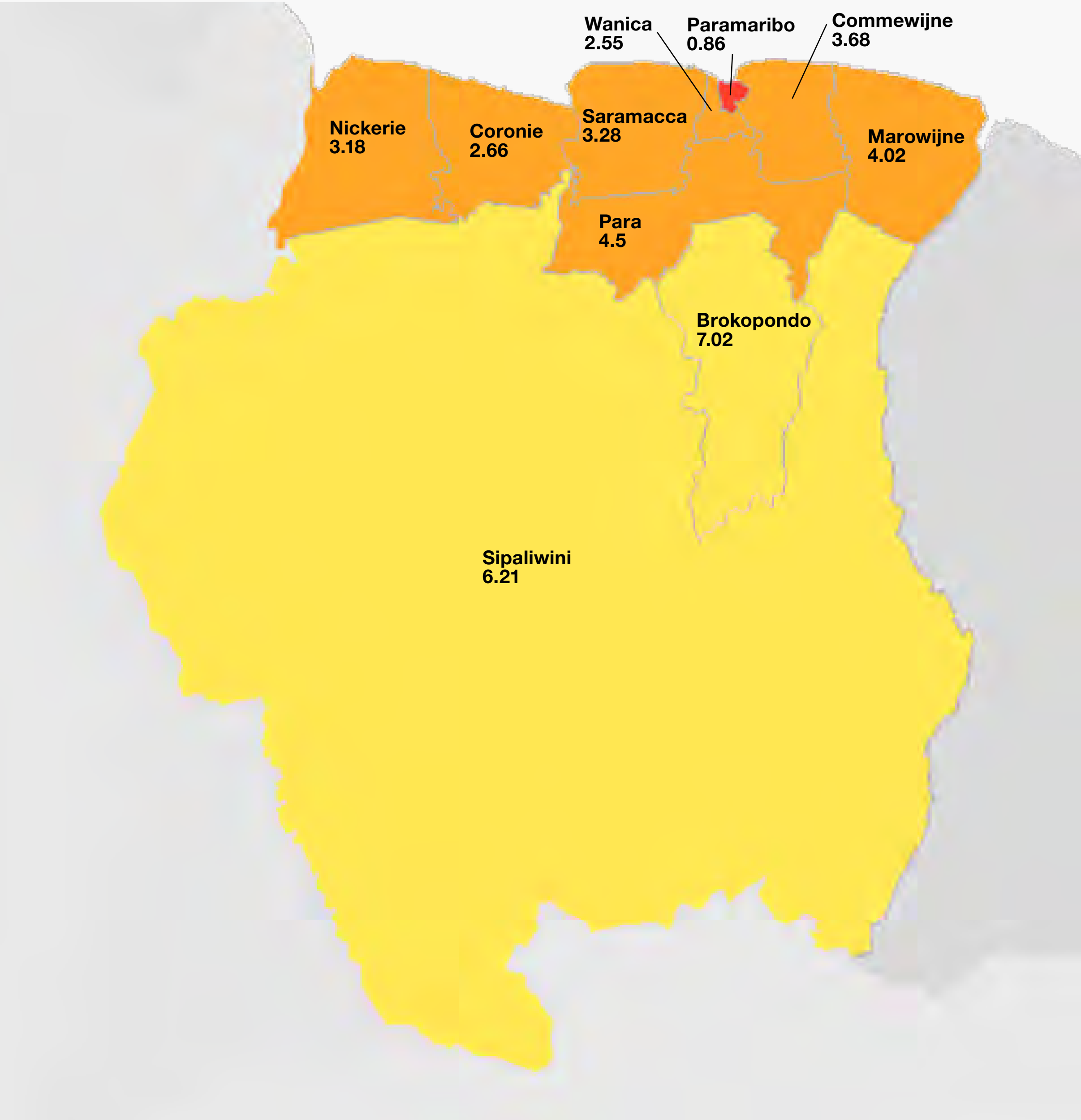
Map 35.
Suriname

Climate Change Vulnerability Index 2014

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

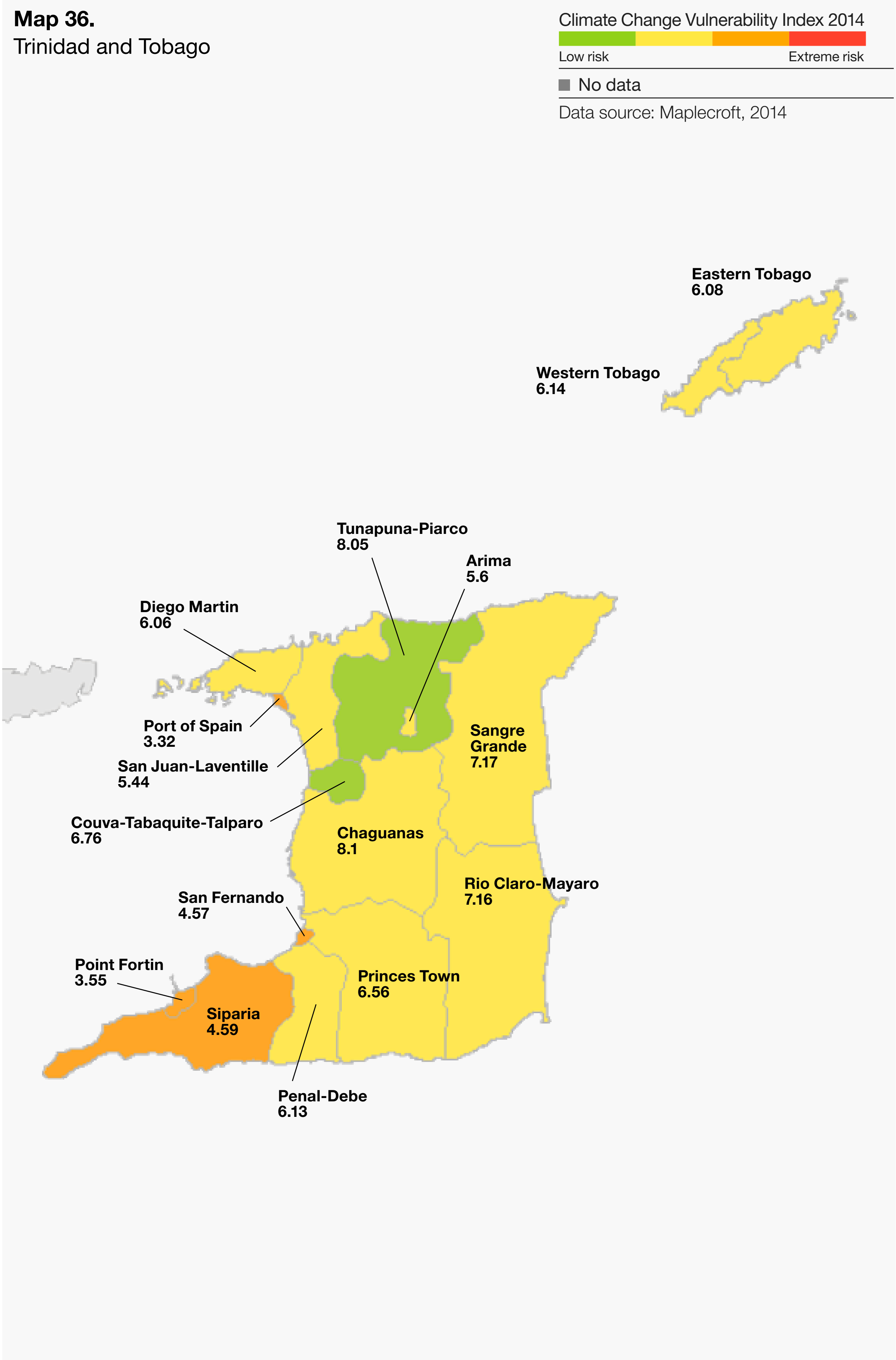


Suriname

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
5.85	7.99	8.89	3.31

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Brokopondo	8.51	9.18	8.89	3.31	Brokopondo	4.69	5.90	6.86	3.31
Commewijne	3.98	4.25	8.06	3.31	Nieuw Amsterdam	1.13	1.12	6.22	3.31
Coronie	3.36	3.12	8.48	3.31	Totness	1.15	0.77	7.46	3.31
Marowijne	4.38	5.06	8.51	3.31	Albina	2.66	2.96	7.27	3.31
Nickerie	3.68	3.85	7.88	3.31	Nieuw Nickerie	0.72	0.67	4.02	3.31
Para	7.12	7.70	8.53	3.31	Onverwacht	4.02	4.73	6.68	3.31
Paramaribo	0.43	0.81	2.30	3.31	Paramaribo	1.35	2.10	4.14	3.31
Saramacca	4.01	4.42	8.48	3.31	Groningen	3.92	4.19	7.37	3.31
Sipaliwini	8.07	9.12	8.47	3.31	-	-	-	-	-
Wanica	3.21	4.42	3.66	3.31	Lelydorp	3.30	4.26	5.71	3.31

Map 36.
Trinidad and Tobago



Trinidad and Tobago

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
7.22	7.02	5.75	6.78

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Arima	5.60	7.83	2.68	6.78	Arima	5.64	7.95	2.58	6.78
Chaguanas	8.10	9.03	2.85	6.78	Chaguanas	6.25	8.41	3.43	6.78
Couva-Tabaquite-Talparo	6.76	7.40	4.83	6.78	Couva	3.28	3.86	3.48	6.78
Diego Martin	6.06	6.56	3.83	6.78	Petit Valley	4.44	5.59	3.08	6.78
Eastern Tobago	6.08	5.01	6.44	6.78	Roxborough	no data	no data	no data	6.78
Penal-Debe	6.13	6.30	3.79	6.78	Penal	7.15	8.85	4.74	6.78
Point Fortin	3.55	2.92	5.44	6.78	Point Fortin	3.79	2.81	6.17	6.78
Port of Spain	6.12	6.88	6.33	6.78	Port Of Spain	3.32	4.08	3.04	6.78
Princes Town	6.56	6.84	5.79	6.78	Princes Town	6.94	8.85	4.34	6.78
Rio Claro-Mayaro	7.16	7.23	8.20	6.78	Rio Claro	7.58	8.85	5.86	6.78
San Fernando	4.57	5.00	5.24	6.78	San Fernando	2.73	2.74	3.60	6.78
San Juan-Laventille	5.44	5.54	5.02	6.78	Laventille Laventille	1.49	1.68	2.90	6.78
Sangre Grande	7.17	6.89	6.76	6.78	Sangre Grande	6.68	8.47	4.41	6.78
Siparia	4.59	3.87	6.55	6.78	Siparia	5.96	6.90	5.18	6.78
Tunapuna-Piarco	8.05	8.62	4.57	6.78	Tunapuna	5.77	7.73	3.33	6.78
Western Tobago	6.14	5.37	5.25	6.78	Scarborough	2.00	1.90	3.56	6.78

Map 37.
Uruguay

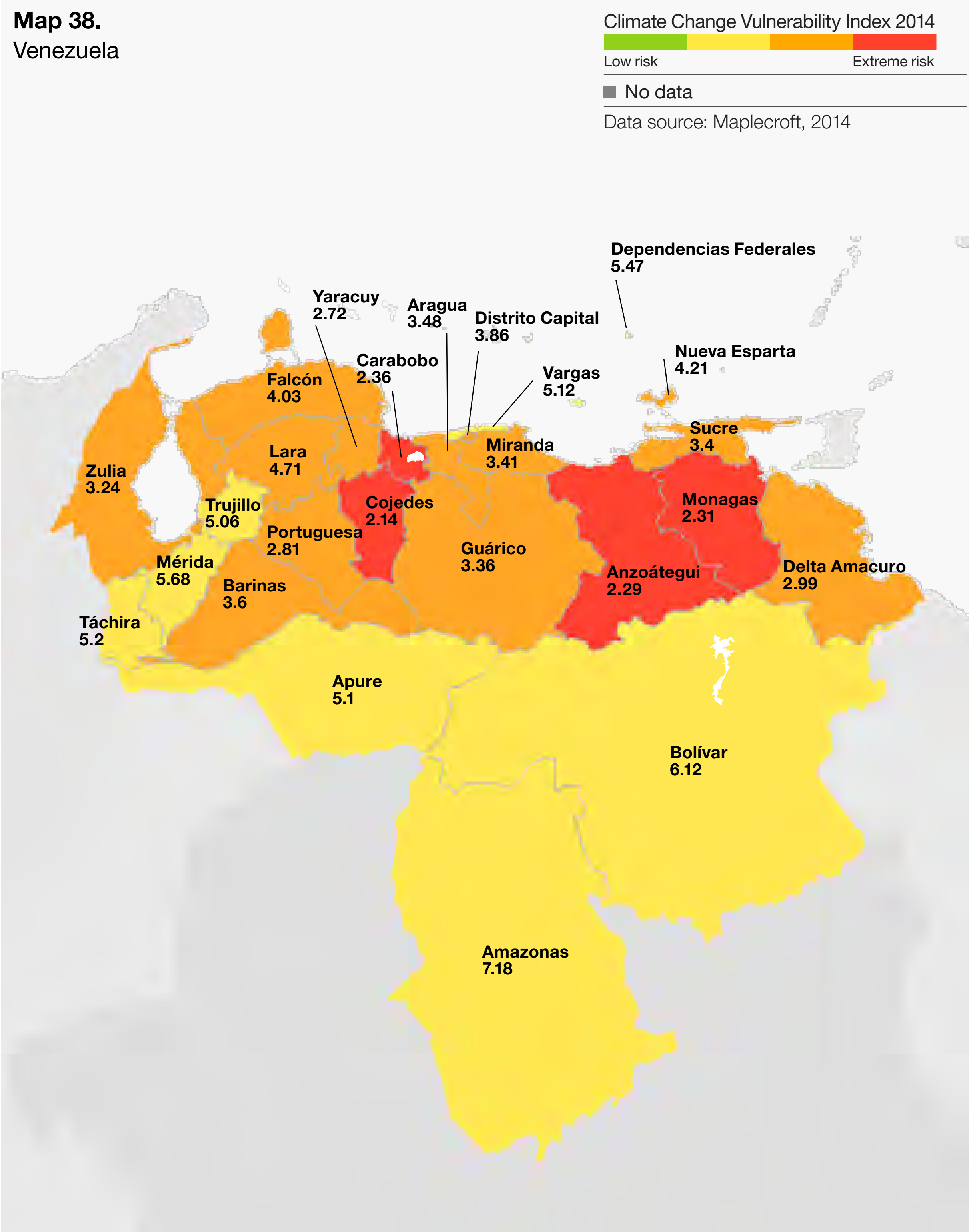
Climate Change Vulnerability Index 2014
Low risk — Extreme risk
No data
Data source: Maplecroft, 2014

Uruguay

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
8.33	7.27	8.61	8.18

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Artigas	7.61	6.52	8.48	8.18	Artigas	4.50	3.35	6.71	8.18
Canelones	7.79	6.31	4.87	8.18	Canelones	4.60	4.39	4.91	8.18
Cerro Largo	8.11	7.87	8.54	8.18	Melo	4.60	3.55	6.31	8.18
Colonia	7.93	6.12	8.21	8.18	Colonia	3.05	1.30	5.81	8.18
Durazno	8.50	8.01	8.68	8.18	Durazno	5.79	6.39	4.74	8.18
Flores	8.47	8.22	8.60	8.18	Trinidad	6.00	6.55	4.97	8.18
Florida	8.55	8.25	8.57	8.18	Florida	5.86	6.52	4.62	8.18
Lavalleja	8.70	8.10	8.53	8.18	Minas	7.49	7.71	6.43	8.18
Maldonado	8.63	7.20	8.18	8.18	Maldonado	4.40	2.02	5.18	8.18
Montevideo	5.19	4.95	2.85	8.18	Montevideo	3.38	3.65	2.91	8.18
Paysandú	7.96	6.64	8.56	8.18	Paysandu	2.82	2.58	4.99	8.18
Río Negro	8.11	6.66	8.60	8.18	Fray Bentos	4.34	3.68	6.56	8.18
Rivera	7.98	6.68	8.73	8.18	Rivera	3.64	2.91	4.68	8.18
Rocha	8.15	5.76	8.65	8.18	Rocha	5.60	5.51	5.63	8.18
Salto	7.79	6.51	8.56	8.18	Salto	3.59	3.44	5.10	8.18
San José	7.88	5.95	8.40	8.18	San José de Mayo	4.71	3.90	5.75	8.18
Soriano	8.25	6.73	8.52	8.18	Mercedes	4.51	3.74	5.66	8.18
Tacuarembó	8.24	7.92	8.61	8.18	Tacuarembo	5.74	6.37	4.63	8.18
Treinta y Tres	8.40	6.99	8.47	8.18	Treinta Y Tres	6.28	6.30	6.12	8.18

Map 38.
Venezuela



Venezuela

Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
3.64	5.07	6.25	3.62

Administrative Area	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index	City	Climate Change Vulnerability Index	Exposure Index	Sensitivity	Adaptive Capacity Index
Amazonas	7.18	7.86	8.37	3.62	Puerto Ayacucho	2.51	2.76	4.72	3.62
Anzoátegui	2.29	1.96	7.10	3.62	Barcelona	0.81	1.60	2.62	3.62
Apure	5.10	5.81	7.80	3.62	-	-	-	-	-
Aragua	3.48	4.83	4.41	3.62	Maracay	1.63	3.43	2.62	3.62
Barinas	3.60	4.52	6.08	3.62	Barinas	2.78	4.32	3.80	3.62
Bolívar	6.12	6.88	8.22	3.62	Ciudad Bolivar	0.80	1.09	3.84	3.62
Carabobo	2.36	3.09	3.67	3.62	Valencia	1.19	2.83	2.73	3.62
Cojedes	2.14	1.99	6.77	3.62	San Carlos	1.89	3.19	3.90	3.62
Delta Amacuro	2.99	2.58	8.34	3.62	Tucupita	0.84	0.78	4.56	3.62
Dependencias Federales	5.47	6.26	8.08	3.62	-	-	-	-	-
Distrito Capital	3.86	7.52	1.42	3.62	Caracas	2.56	4.96	1.97	3.62
Falcón	4.03	5.11	6.33	3.62	Coro	1.81	3.25	3.65	3.62
Guárico	3.36	3.44	7.29	3.62	San Fernando	2.73	3.89	4.48	3.62
					San Juan de los Morros	2.26	3.74	3.89	3.62
Lara	4.71	5.62	6.39	3.62	Barquisimeto	2.78	4.84	2.76	3.62
Mérida	5.68	6.96	5.89	3.62	Merida	4.02	5.83	4.41	3.62
Miranda	3.41	4.96	3.43	3.62	-	-	-	-	-
Monagas	2.31	1.81	7.21	3.62	Maturín	1.11	2.05	4.04	3.62
Nueva Esparta	4.21	5.27	3.73	3.62	Laasuncion	3.78	6.75	1.39	3.62
Portuguesa	2.81	3.45	5.23	3.62	Guanare	2.58	4.06	3.69	3.62
Sucre	3.40	3.81	5.16	3.62	Cumana	0.92	2.01	3.08	3.62
Táchira	5.20	6.99	5.60	3.62	San Cristobal	4.26	6.48	3.78	3.62
Trujillo	5.06	6.28	4.69	3.62	San Tiago	2.82	3.67	5.06	3.62
					Trujillo	4.25	6.93	2.85	3.62
Vargas	5.12	7.19	4.43	3.62	La Guaira	3.53	5.36	3.54	3.62
Yaracuy	2.72	3.63	4.15	3.62	San Felipe	1.01	3.22	1.86	3.62
Zulia	3.24	3.42	5.24	3.62	Los Teques	3.38	5.26	3.44	3.62
					Maracaibo	1.75	3.70	1.38	3.62

Appendix 2

Country profile scores

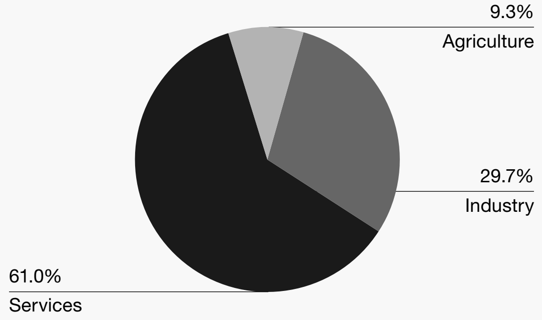
Argentina. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	6.66 (24)
Exposure	7.32 (26)
Sensitivity	7.22 (25)
Adaptive capacity	6.07 (16)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Ciudad de Buenos Aires – 3.10	Santa Cruz – 9.21	Buenos Aires – 3.73
Tucuman - 4.99	Chubut – 9.11	Cordoba – 1.75
Entre Ríos – 5.59	Tierra del Fuego – 8.95	Rosario – 3.01

Institutional framework

Secretary of Environment and Sustainable Development: main contact point for UNFCCC and houses Direction for Climate Change and the National Advisory Commission on Climate Change which have contributed to policy development and aim to integrate climate change mitigation and adaption into planning.

Governmental Committee on Climate Change: formed to develop the National Strategy and set targets for its implementation.

Argentine Carbon Fund: aims to incentivise CDM projects and is run by the Secretary of Environment and Sustainable Development.

Federal Environment Council: represents provincial environmental ministries and includes a group on climate change.

Policy Context

National Strategy for Climate Change: provides a framework for national and sectoral mitigation and adaptation measures. Includes 14 objectives, for which targets are being developed in conjunction with key sectors and state bodies. NAMAs are also being identified through this process. Policies are geared towards low carbon economic growth and sustainable development.

National Program for Rational and Efficient Energy Use: introduced by Decree 140/2007 and implemented by the Energy Secretary, this aims for a 28 million tonne CO_2e reduction between 2006 and 2015. Supported by several enabling laws for renewables and a public education campaign on energy efficiency.

Key sectors at risk

Coastal settlements: including Buenos Aires and agricultural land are at high risk from sea level rise – a World Bank study ranked Argentina 5th highest out of 84 developing countries for the amount of agricultural land that may be submerged with a 1m rise sea levels.

Agriculture: a high percentage of exports are agricultural commodities; production may be negatively affected by rising temperatures and increased intensity of extreme weather events, coupled with fluctuations in water supply from retreating glaciers in some areas and increased river flow in others; there is a large degree of regional variation but the majority of studies show reductions in crop yield overall. Recent floods and storms had a high economic impact (between1999-2008, losses average 0.23% of GDP and damages of US$ 2.1 billion).

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

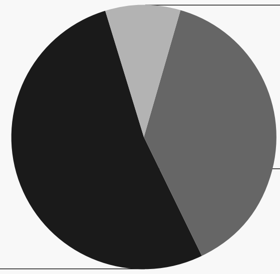
Map 4.
Adaptive capacity

Bolivia. Country profile scorecard 2014

Indices	**Score (rank)**
Climate Change Vulnerability Index	2.48 (10)
Exposure	6.00 (22)
Sensitivity	4.58 (16)
Adaptive capacity	0.80 (6)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	**Lowest risk areas**	**Major cities**
Cochabamba – 2.42	Oruro – 5.66	Santa Cruz De La Sierra – 2.81
El Beni – 2.92	Pando – 5.56	El Alto – 2.52
Tarija – 3.06	Potosí – 4.50	Cochabamba – 1.83

Institutional framework

Ministry of Environment & Water: remit includes climate change.

Ministry of Rural Development: developing an information system for farmers to aid adaptation (e.g. agro-meteorological data).

National Climate Change Programme: has published studies on climate change impacts and adaptation; responsible for National Climate Change Action Plans.

Platform of Social Organisations against Climate Change: dialogue between citizens and state, pressing for and helping formulate national climate change policies.

Local government: some have prepared Adaptation Strategies.

Policy Context

National Mechanism for Adaptation to Climate Change (2007): considers water resources; food security; health; human settlements and risks reduction; and ecosystems, along with transversal programs: scientific research; education; and social aspects. Action to date includes research into future water availability, reforestation, trialling different potato varieties, improving meteorological observation.

2006-2010 National Development Programme: included policies regarding response to climate change impact.

Key sectors at risk

Water supply: current provision from reservoirs sufficient but will need to double in next 10-15 years; glacial retreat accelerating due to temperature rise will affect water and power supplies. Regional variation in likely impacts is considerable, with projections for major flooding and drought in Amazonia, less water in the Altiplano due to glacial retreat, and droughts in the Chaco region.

Agricultural production: vulnerable to unpredictable weather, with potential impacts of food availability and prices; particularly important issue since a large proportion of the population are engaged in small-scale agriculture.

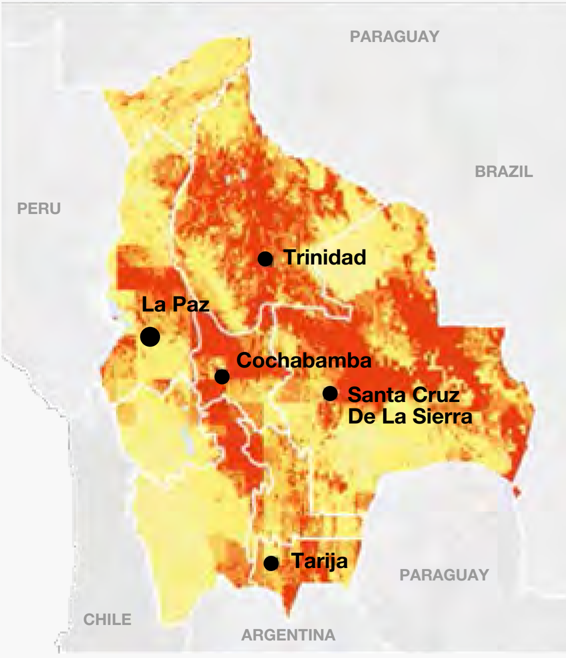
Major urban areas: those located in the upper watersheds of the Altiplano and valley regions (including La Paz) are vulnerable to climate variability and water scarcity including prolonged droughts and changes in seasonality.

Low risk Extreme risk

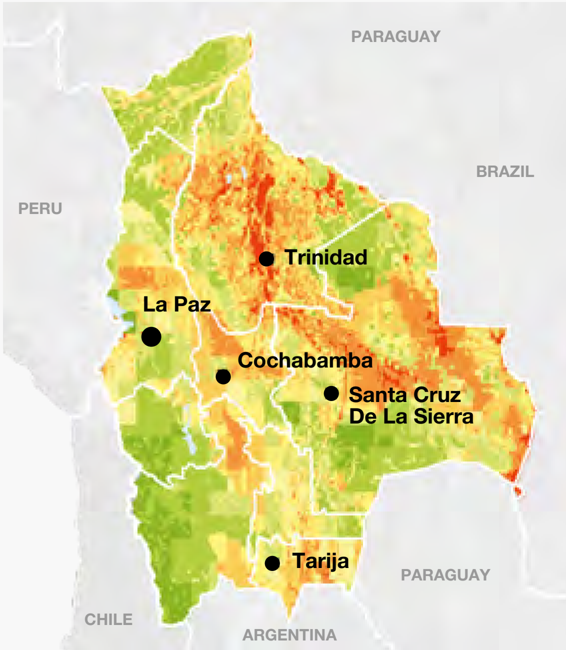
No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability



Map 2.
Exposure



Map 3.
Sensitivity

Map 4.
Adaptive capacity

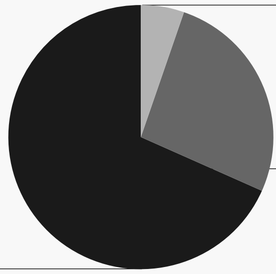
Brazil. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	5.77 (21)
Exposure	5.11 (18)
Sensitivity	6.32 (23)
Adaptive capacity	7.88 (27)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Alagoas – 4.57	Acre – 8.36	São Paulo – 5.53
Rio de Janeiro – 6.01	Amapa – 8.33	Rio De Janeiro – 4.39
Maranhao – 6.09	Roraima – 8.29	Salvador – 3.91

Institutional framework

Inter-ministerial Commission on Climate Change: develops, implements and reviews National Climate Change Plan and approves new policies for inclusion in the plan

Department of Climate Change (Ministry of Environment): duties include monitoring and support for National Climate Change Plan

Brazilian Panel on Climate Change: scientific body which gathers, synthesizes and evaluates information on climate change and conducts national GHG inventory

State / city authorities: some have established climate change policies and reduction targets (e.g. São Paulo, Rio de Janeiro)

Policy Context

National Plan on Climate Change: introduced by the National Policy on Climate Change (Law no. 12187/2009) and further regulated by Decree no. 7390/2010, the Plan is a framework of 25 actions with a focus on reducing deforestation to deliver GHG emissions reduction of 36-39% by 2020. Sets target for 5% biofuels in transport fuel, 80% of power from renewables by 2030 and sectoral emissions reduction. First developing country to set a national emissions cap (2GtCO2 for 2020).

National Energy Efficiency Action Plan to reduce electricity consumption by 10% by 2030.

Brazilian Emissions Reductions Market: for trading credits from CDM, but yet to form cap-and trade scheme.

National Adaption Plan expected 2015, several adaptation activities already underway.

Key sectors at risk

Water and energy supply: rainfall may become less frequent and more variable in the semi-arid northeast, with groundwater recharge diminishing by as much as 70% along with greater erosion and sedimentation of reservoirs, affecting hydropower.

Agriculture: agricultural exports are important to GDP but this is threatened by increased rainfall and floods in southeast damaging crop yields.

Coastal zones: vulnerable to rising sea levels, including several major cities.

Biodiversity loss: likely in the Amazon and northeast as they become drier.

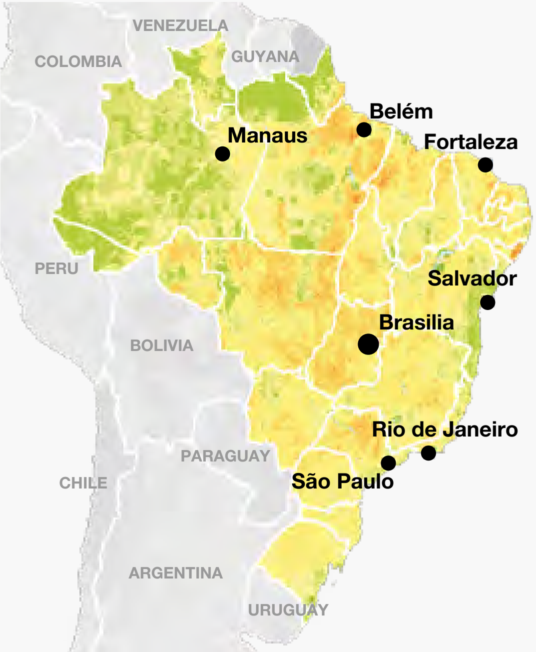
Human health: threatened by spread of infectious diseases favoured by warming climate.

Low risk — Extreme risk

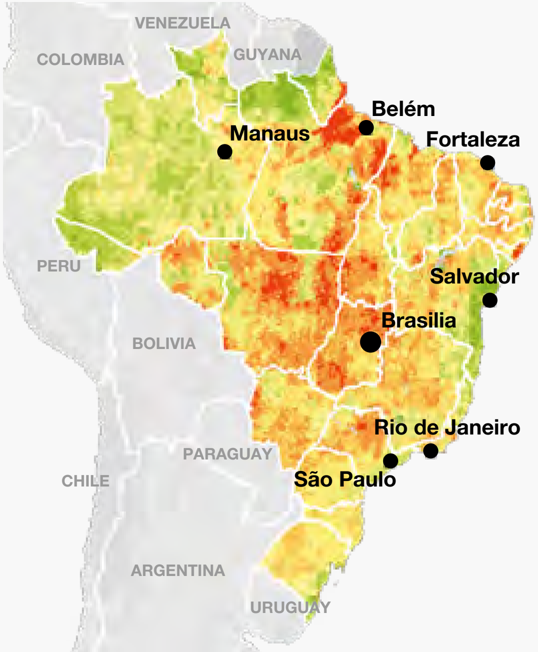
No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability



Map 2.
Exposure



Map 3.
Sensitivity

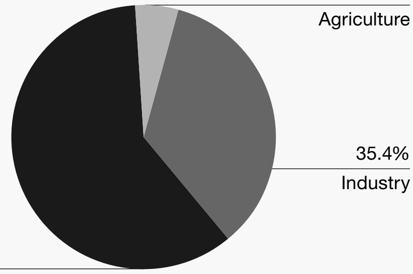
Map 4.
Adaptive capacity

Chile. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	9.54 (30)
Exposure	8.57 (29)
Sensitivity	8.04 (28)
Adaptive capacity	9.40 (31)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector   Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Libertador General Bernardo O'Higgins – 7.86	Atacama – 9.54	Santiago – 5.70
Maule – 8.08	Antofagasta – 9.52	Valparaiso- 6.18
Valparaíso – 8.29	Tarapacá – 9.52	Concepcion – 3.60

Institutional framework

Ministry of the Environment: responsible for national climate change policy

Climate Change Office: research, participation in international communications and negotiations

Inter-Ministerial Committee on Climate Change: set up under National Climate Change Action Plan, dialogue platform between public, private, civil society

Ministry of Energy: governs energy sector, includes Chilean Energy Efficiency Agency

Ministry of Agriculture: comprised of several bodies with remit for climate change, including Climate Change and Agriculture Council

Policy Context

National Climate Change Action Plan 2008-2012 sets out public policy guidelines, to be followed by long term national and sectoral plans for climate change mitigation, adaptation and capacity building. Considers climate change vulnerability, response capacity and impacts for different sectors.

National Energy Strategy 2012-2030 "Energy for the Future" puts energy efficiency and renewable energy as top priorities out of six key areas for action. GHG reduction target of 20% for 2020.

National Energy Efficiency Action Plan 2010-2020 sets 15% energy efficiency improvement target for 2025.

National Adaptation Plans are being prepared by the Climate Change Office for six sectors, for example prioritising research into crop and water resource management for agriculture.

Key sectors at risk

Urban zones and industry: face a double threat to their water supply from retreating glaciers in the Andes (which act as strategic water reserves) and changes in rainfall patterns. The later is expected to cause water shortages in the central region, where 70% of the population lives (mostly in cities).

Agriculture and forestry: water resource management identified as key issue in the sector, with the central and northern regions likely to be particularly vulnerable to impacts of changes in temperature and precipitation, which vary by +/-30% from north to south.

Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity

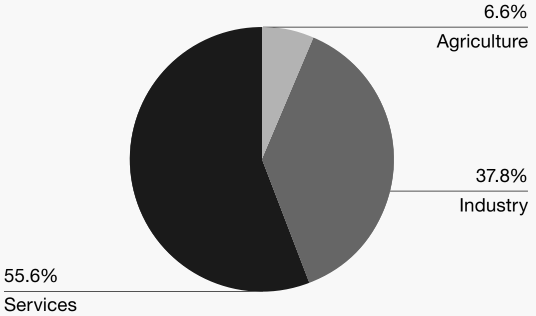
Colombia. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	4.30 (16)
Exposure	5.41 (20)
Sensitivity	3.72 (11)
Adaptive capacity	5.66 (15)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Atlántico – 0.72	San Andrés y Providencia – 8.32	Bogota – 1.28
Caldas – 1.89	Amazonas – 8.10	Medellin – 1.12
Risaralda – 2.01	Guainía – 7.94	Calin – 1.52

Institutional framework	Policy Context	Key sectors at risk
Ministry of Environment and Sustainable Development: overarching body which houses Climate Change Mitigation Office whose role includes CDM promotion & accessing external financial support **National Climate Change System (SISCLIMA**) manages information and finance to facilitate mitigation and adaptation projects **National Council for Economic and Social Policy** responsible for preparing National Plan for Climate Change Adaptation **Institute of Hydrology, Meteorology and Environment Studies of Colombia:** prepares national communications	**National Development Plan 2010-2014:** implemented by Law no. 1450 of 2011, the Plan addresses sustainability and risk reduction and foresees design of National Climate Change System. **Low Carbon Development Strategy** –foresees identification of GHG baseline and sectoral low carbon plans. **National Plan for Climate Change Adaptation (2012)**: aims to improve understanding and management of risks and to mitigate vulnerability. **Programme for a Rational and Efficient use of Energy and of other Non Conventional Energy Sources:** first presented by Law no. 697 of 2001, this programme introduces sectoral energy-efficiency programmes	**Agriculture:** vulnerability of this sector highlighted by La Niña phenomenon 2010-11, with extensive flooding and agricultural losses. Majority of cropland uninsured. Projections indicate huge losses in agricultural production with temperature rise and changes in precipitation. 4.9% of total cropland and pastures on Caribbean Coast is already threatened by floods. **Transport:** vulnerable to extreme weather events, with severe damage to the road system during 2010-11 floods. **Energy**: 84% of Colombia's electricity generated by hydropower (so power sector not one of largest GHG sources), which leaves the country vulnerable to changes in precipitation and river flows.

Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity

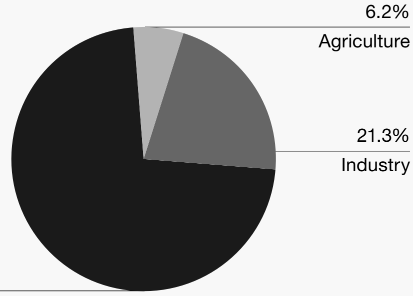
Costa Rica. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	7.70 (26)
Exposure	3.70 (14)
Sensitivity	4.22 (14)
Adaptive capacity	9.23 (30)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Guanacaste – 5.76	Limón – 7.79	San Jose – 3.26
San José – 6.60	Heredia – 7.78	Puerto Limon – 3.83
Puntarenas – 7.10	Alajuela – 7.46	Alajuela – 3.31

Institutional framework

Ministry of Environment and Energy (MINAE): leading entity on climate change, oversees the carbon neutrality programme and climate change strategy

Office of Climate Change: within MINAE, coordinates and formulates public policy on climate change

Ministry of Agriculture has produced a national adaptation plan for the sector; climate change is a key theme in the State Policy for Agriculture Sector and Rural Development 2010-2021

National Meteorological Institute prepares national GHG Inventory and studies on vulnerability and adaptation and houses the Commission for the El Niño Phenomenon

Inter-ministerial Climate Change Committee advisory committee on climate change

Policy Context

National Climate Change Strategy (2008) (and Action Plan): covers mitigation; vulnerability & adaptation; education & behaviour change; capacity building & technology transfer; metrics; financing

National Development Plan 2011-2014: incorporates strategic objectives for achieving carbon neutrality & climate change adaptation. Lack of financial resources has hindered progress and total emissions continue to increase.

Carbon neutrality by 2021: first country to make such a commitment. National Registry for Emissions, Reductions and Compensation set up and "C-Neutral" label for certifying compensation of all GHG emissions by tourism and certain industries.

National Water Policy (2009) includes vulnerability and adaptation actions e.g. monitoring of water resources.

Key sectors at risk

Hydropower: generates majority of electricity (78% in 2009); vulnerable to variation in precipitation volume and regime and sedimentation from floods.

Agriculture: coffee is a key export but sensitive to rainfall patterns and temperature. Poor farmers reliant on agriculture are particularly vulnerable.

Public health: disease-transmitting vectors may proliferate with higher temperatures (as already seen during warmer conditions of El Niño events).

Water supply for industry may be affected by changes in rainfall patterns and increased floods and droughts. Water considered a "high risk" vulnerability indicator for 2020.

Eco-Tourism: most visited country in the region for its natural ecosystems, which are sensitive to climate change.

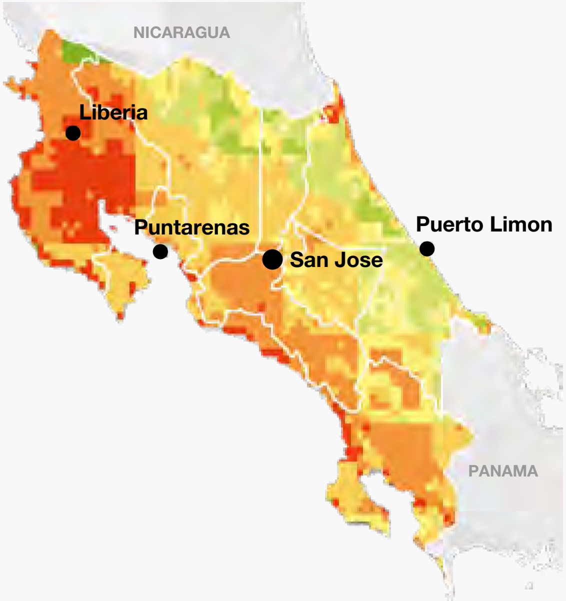
Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure



Map 3.
Sensitivity

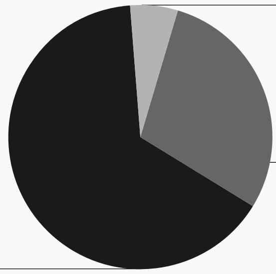
Map 4.
Adaptive capacity

Dominican Republic . Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	1.01 (5)
Exposure	2.28 (6)
Sensitivity	0.76 (2)
Adaptive capacity	2.31 (9)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Monseñor Nouel – 0.38	Pedernales – 3.82	Santo Domingo – 0.55
La Estrelleta, San José de Ocoa, San Juan, Sánchez Ramírez – 0.40	Barahona – 3.55	Santiago – 0.70
	Independencia – 3.24	Puerto Plata – 0.67

Institutional framework

Ministry of Environment: produced NAPA and National Communications to UNFCCC, provides technical support across government on climate change issues.

National Council for Climate Change and the DCM: coordinates the implementation of NAPA among responsible ministries and promotes/enables CDM projects

Secretariat for the Environment and Natural Resources: responsible for environmental policies; houses a sub-secretariat for climate change projects

Dominican Corporation of Government Electric Enterprises: works on programmes, actions and measures to encourage energy conservation and efficiency, and fuel-switch to renewable energy

Policy Context

Constitution: states that responsibility for climate change adaptation and mitigation lies with government and citizens.

National Adaptation Plan of Action: identifies freshwater, agriculture & food security, and coastal & marine systems as priorities due to high vulnerability and importance for economy.

National Development Strategy 2010-2030: (Law 1-12) identifies sustainable environmental management and adaptation to climate change as a strategic area. Commits to reversing deforestation trends and reducing GHG emissions by 25% by 2030 (compared to 2010 levels).

Climate Compatible Development Plan: supports above Strategy with policies for achieving strong economic growth while curbing emissions.

Key sectors at risk

Water supply: groundwater resources which supply one third of fresh water are already under threat from overuse and this may be exacerbated by saltwater intrusion as sea levels rise

Agriculture & food security: threatened by water shortages and sea level rise inundating low-lying areas

Coastal zones: a key concern is an increase in extreme events (particularly hurricanes and tropical storms); coastal communities may be especially vulnerable as sea level rise squeezes coastal margins and defences.

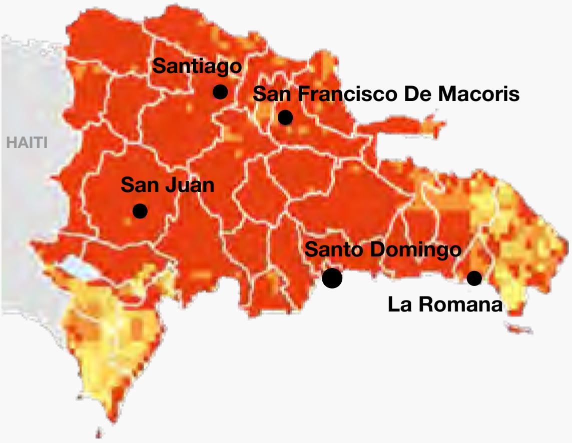
Services: second poorest country in Caribbean and the workforce is highly dependent on the service sector (tourism, transportation, communications, finance industries).

Low risk — Extreme risk

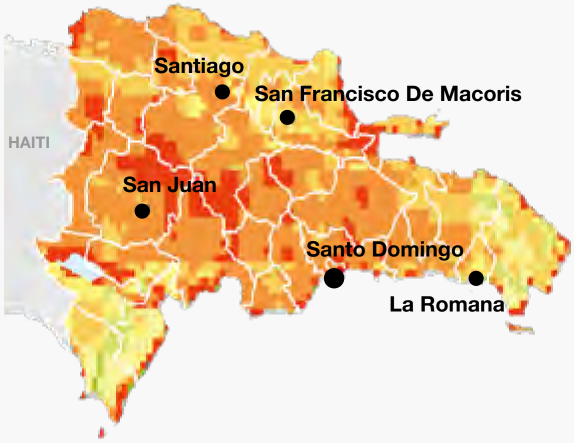
No data

Data source: Maplecroft, 2014

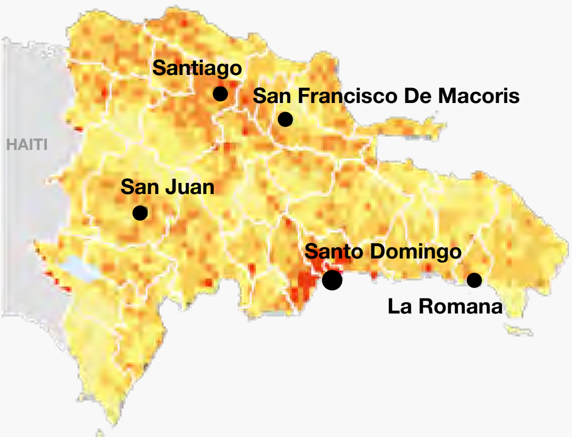
Map 1.
Climate change vulnerability



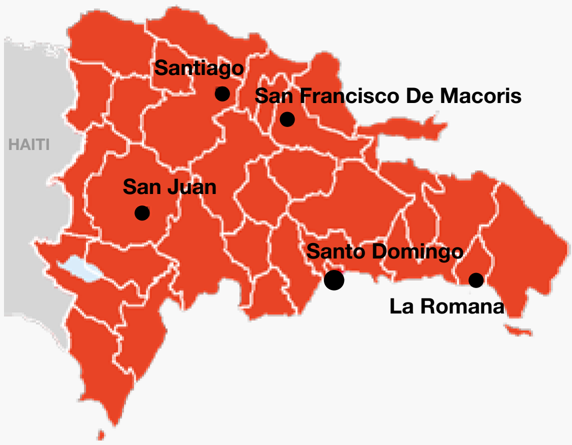
Map 2.
Exposure



Map 3.
Sensitivity



Map 4.
Adaptive capacity



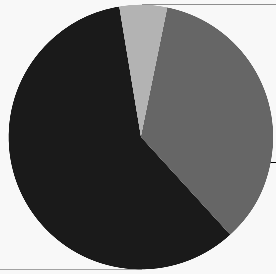
Ecuador. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	3.76 (12)
Exposure	5.82 (21)
Sensitivity	3.47 (10)
Adaptive capacity	4.44 (13)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Cotopaxi – 1.50	Zamora Chinchipe – 7.43	Guayaquil – 1.14
Bolivar – 1.63	Imbabura – 7.28	Quito – 0.90
Santa Elena – 2.55	Azuay – 6.89	Cuenca – 3.38

Institutional framework

Ministry of Environment: has as objectives for 2010-2014 to reduce environmental, social and economic vulnerability to climate change, raise awareness and encourage GHG emissions reductions from industry and society; responsible for National Climate Change Strategy

Inter-Institutional Climate Change Committee and its technical **Under Secretary for Climate Change** -acts as a focal point for climate change communications and CDM; its mission is to lead policy on mitigation and adaptation (including mechanisms for technology transfer, finance, communication)

National Directorates of Climate Change Mitigation and Adaptation: regulates and coordinates policies, strategies, programmes and projects to reduce GHG emissions and promote adaptation.

National Institute of Meteorology and Hydrology- performs research on climate change future scenarios.

Policy Context

Constitution: includes commitments to addressing climate change.

National Plan for Good Living 2009-2013: within environment objectives it recognises importance of mitigating and adapting to climate change; goal to reduce deforestation rate (5th highest in LAC, contributes roughly 70% of GHG emissions) by 30% by 2013.

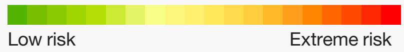
National Climate Change Strategy 2010-2030: the Strategy is an outcome of provisions set out in Executive Decree 1815 No.636; an overarching climate change policy; comprises National Mitigation and Adaptation plans.

Key sectors at risk

Water supply and hydropower: key vulnerability as disappearance of Andean glaciers will seriously affect water supply and electricity generation (50% of which is from hydropower); also, about 25% of the country is already susceptible to drought.

Coastal lowlands: estimated that 1m sea level rise could impact GDP by around 3% due to inundation (considered conservative); already subject to flooding from El Nino.

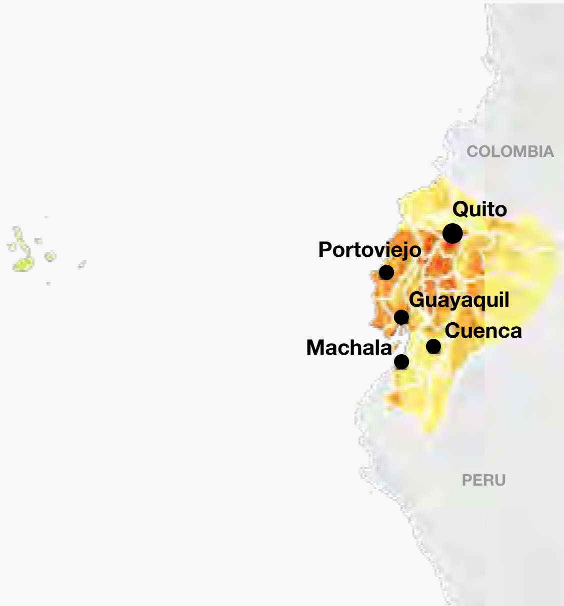
Agriculture: scenarios show deficits in certain key crops (rice, potatoes) with temperature increase (projected 1°C to 2°C by 2030) and precipitation decrease (15% under pessimistic scenario) although uncertainty in rainfall projections (could increase by 20% under optimistic scenarios). Sector also threatened by soil erosion.



No data

Data source: Maplecroft, 2014

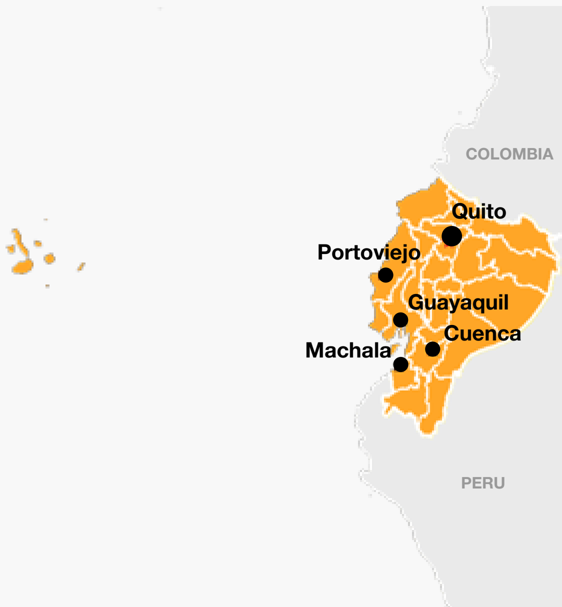
Map 1.
Climate change vulnerability



Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity



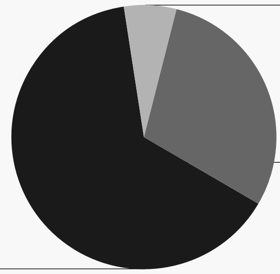
Jamaica. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	1.50 (7)
Exposure	0.84 (1)
Sensitivity	2.11 (6)
Adaptive capacity	6.15 (17)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Trelawny – 0.75	Kingston – 2.46	Kingston – 1.14
Saint James – 0.83	Saint Thomas – 2.45	Montego Bay – 0.89
Saint Mary – 0.87	Westmoreland – 1.77	Spanish Town – 1.19

Institutional framework

Ministry of Water, Land, Environment and Climate Change: Lead ministry for oversight and implementation of climate change policy, strategy and action plan. Will house future Climate Change Department which will oversee climate change initiatives

Ministry of Energy and Mining: governs the National Energy Policy 2009-2030 which includes a National Renewable Energy Policy and the Energy Efficiency & Conservation Programme

Planning Institute of Jamaica: agency in the Ministry of Finance and Planning ; plays important role in climate policy formulation, research and disaster risk management

Focal Point Network: will support goverment implementation of Climate Change Policy Framework and Action Plan; comprised of 27 representatives from across government.

Climate Change Advisory Committee: multi-actor committee serves as a platform for communication and coordination of strategies and collaboration across sectors

Policy Context

Vision 2030 Jamaica: aims to achieve developed country status by 2030. Vision considers climate change a cross-cutting issue and contains national strategies to support adaptation and mitigation. Sets target of 20% energy mix from renewables.

National Climate Change Policy Framework and Action Plan: under development as of April 2014. Outlines strategies to respond to the impacts and challenges of climate change. Creates new institutional mechanisms to facilitate development, coordination and implementation of climate change-related initiatives covering both mitigation and adaptation.

Key sectors at risk

Coastal zone: critical as produces 90% of GDP – population and tourism industry vulnerable to sea level rise, increased intensity of tropical storms and damage to coral reefs from increased sea surface temperature.

Agriculture: vulnerable to overall reduction in water availability and extreme weather events.

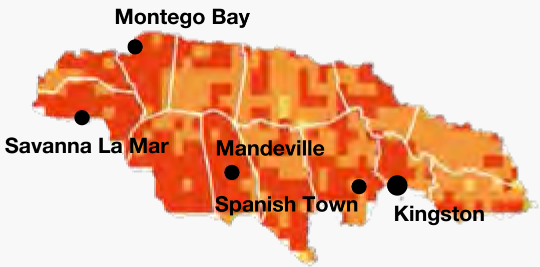
Energy supply: 87% of foreign exchange earnings are spent on fossil fuel imports. The country's reliance on foreign energy resources, which are exposed to climate-related risks, poses a threat to all sectors.

Freshwater resources: face risks from changing rainfall patterns, sea level rise, extreme weather events and rising temperatures. Groundwater provides 84% of water supply and is threatened by salt water intrusion.

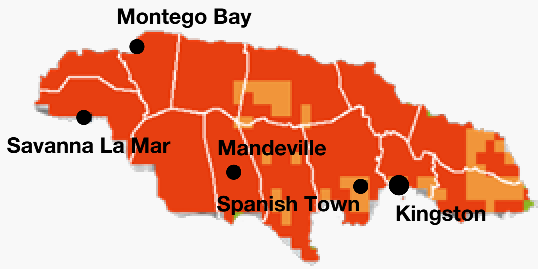
No data

Data source: Maplecroft, 2014

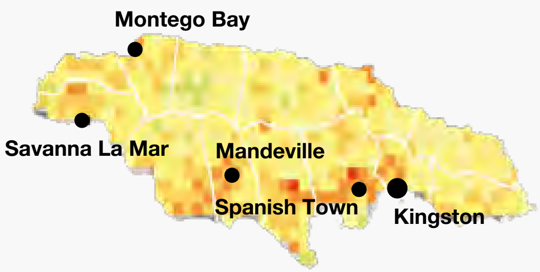
Map 1.
Climate change vulnerability



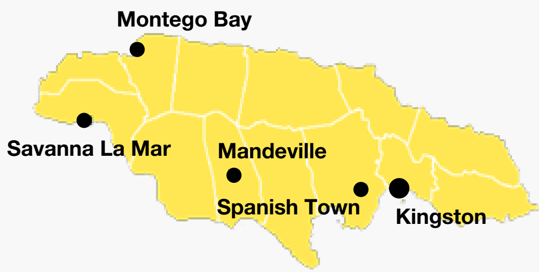
Map 2.
Exposure



Map 3.
Sensitivity



Map 4.
Adaptive capacity



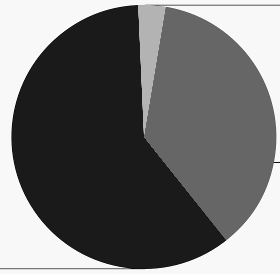
Mexico. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	4.47 (17)
Exposure	3.35 (12)
Sensitivity	5.32 (19)
Adaptive capacity	7.66 (26)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Sinaloa – 3.19	Baja California – 7.97	Mexico City – 3.38
Chiapas – 3.99	Baja California Sur – 7.84	Guadalajara – 1.96
Tabasco – 4.00	Zacatecas – 7.64	Puebla de Zaragoza – 2.80

Institutional framework

National Institute of Ecology Climate Change Program: (within Ministry of Environment and Natural Resources) responsible for compiling national GHG inventory, developing strategies and plans for sustainable development

Inter-Ministerial Commission on Climate Change: coordinates government action on climate change and develops national mitigation and adaptation policies

National Climate Change System coordinates climate change actions at Federal, state and local levels

Climate Change Fund: channels funding to mitigation and adaptation initiatives.

Policy Context

General Law on Climate Change (2012): landmark legislation; sets 30% GHG reduction target by 2020 compared to BAU, subject to financial and technical support. Establishes key institutions and an emissions trading market. Emphasis on adaptation, informed by a ‘Risk Atlas’ of vulnerability scenarios.

Climate Change Special Programme: policy instrument for mitigation and adaptation with no negative impact on economic growth; 105 objectives and 294 goals for mitigation in 2009-12.

Various energy laws: several laws combine to promote the development of renewable energy and improve energy efficiency.

National Development Plan 2007- 2012 specifically includes climate change considerations.

Key sectors at risk

Agriculture: between 40% and 70% of current croplands are projected to undergo declining suitability by 2030 and considerable adaptation measures (e.g. reduced export) may be required to avoid food security issues; in addition sea level rise may submerge productive land in coastal zones.

Water security: already an issue in Mexico and the population exposed to water stress could increase substantially due to climate change, with a general decrease projected in mean precipitation.

Coastal settlements: in particular may be affected by a possible increase in the intensity of tropical cyclones in the Gulf of Mexico and East Pacific.

Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity

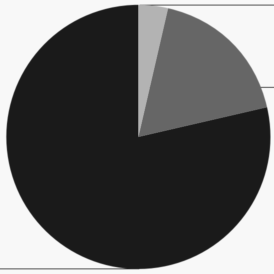
Panama. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	5.57 (19)
Exposure	5.26 (19)
Sensitivity	4.61 (17)
Adaptive capacity	6.70 (19)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Panama – 5.15	Los Santos – 7.51	Panama City – 1.37
Panama Oeste – 5.15	Embera – 7.50	David – 3.80
Kuna Yala – 5.39	Herrera – 7.47	Colon – 2.17

Institutional framework

National Environmental Authority (ANAM): coordinates National Climate Change Policy and National Communications

Climate Change and Desertification Unit: within ANAM, includes the National Climate Change Coordination Technical Unit which was formed for preparation of the second National Communication

National Climate Change Committee: assists with policy implementation and facilitates dialogue between government, private sector, NGOs and academia

Policy Context

National Climate Change Policy (2007): introduced by Executive Decree No. 35; general framework for mitigation and adaptation; requires vulnerability and adaptation to be considered in national environment plans; contains the Strategy for Climate Change Mitigation which aims for emissions reduction from land-use change and forestry, reduced deforestation and degradation, cleaner production, and energy.

National Energy Plan 2009–2023 - plans installation of additional capacity, mostly from hydropower.

National Integrated Water Resource Management Plan: takes vulnerability to climate change into account.

Key sectors at risk

Coastal lowland zones: vulnerable to permanent flooding as sea level rises and coastal erosion increases.

Services sector: the most important economic sector (Panama Canal, banking, tourism, healthcare); may be impacted by increasing variability and intensity of extreme events.

Urban health: urban areas (in which 60% of the population lives) may be particularly sensitive to temperature rise (2.2°C to 3.6°C by 2100 projected) and more frequent heat waves.

Water supply: storage capacity will need to increase to manage the greater variability expected in rainfall.

Energy supply: 49% of electricity generation is hydropower which is vulnerable to variability in precipitation.

Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity

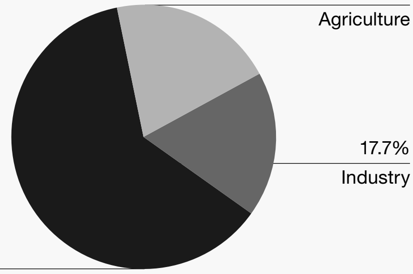
Paraguay. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	1.58 (8)
Exposure	4.30 (16)
Sensitivity	3.90 (12)
Adaptive capacity	0.94 (7)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Guaira – 0.54	Central – 3.34	Asuncion – 2.63
Caazapa – 0.93	Boqueron – 3.31	Ciudad del este – 3.65
Caaguazu – 1.16	Alto Paraguay – 3.30	Encarnacion – 1.00

Institutional framework

National Environmental System (SISNAM): consists of the National Environment Council and the Environment Secretariat (SEAM) which is the focal point for UNFCCC

National Climate Change Program (within SEAM): evaluation and implementation of actions under UNFCCC obligations; produced five year plan for climate change 2008-2012 which preceded current Policy; includes the National Climate Change Office

National Climate Change Commission: part of the above program, role is to coordinate inter-institutional response to climate change (represents government ministries, private sector, civil society and education sector)

Policy Context

National Climate Change Policy (2011): sets out framework for climate change mitigation and adaptation activities to be developed in line with the goal of sustainable development.

Strategic Plan on Climate Change and Communication: awareness raising, environmental education.

National Development Policy 2010-2020: considers climate risks as an obstacle to poverty alleviation and small-scale agricultural development.

Land use change: contributes 95% of GHG emissions; laws are in place to slow deforestation and a National Reforestation Plan has been prepared.

Key sectors at risk

Agriculture: high contribution to GDP and occupies 53% of land; crops are vulnerable to changes in rainfall (high proportion are rainfed) coupled with severe land degradation in places. Livestock affected by temperature rise.

Rural poor: may be disproportionately affected; Paraguay is the most rural South American country and 30% to 40% of the population lives in poverty, many of which rely on agriculture.

Public health: malaria is a concern; increased cases projected in some regions with rising temperatures (1.2°C to 6.2°C rise by 2100 projected).

Water supply: rainfall projections vary considerably, in general studies show a decrease in the west and northeast and an increase in the north, east and southeast. Decreased runoff overall due to increased evapotranspiration.

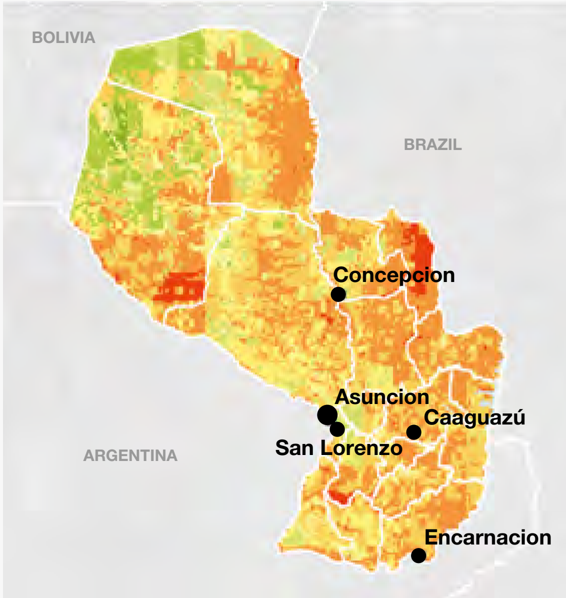
Low risk — Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure



Map 3.
Sensitivity

Map 4.
Adaptive capacity

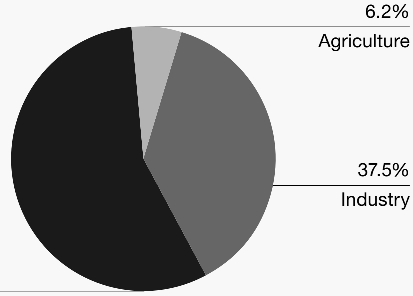
Peru. Country profile scorecard 2014

Indices	**Score (rank)**
Climate Change Vulnerability Index	4.98 (18)
Exposure	6.69 (23)
Sensitivity	4.50 (15)
Adaptive capacity	5.32 (14)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	**Lowest risk areas**	**Major cities**
Cusco – 4.10	Ica – 8.64	Lima – 5.51
Huánuco – 4.26	Lima Province – 7.96	Arequipa – 3.63
Apurimac – 4.60	Lima – 7.68	Trujillo – 5.69

Institutional framework

Ministry of Environment: produced the PACC (see right) and includes a Directorate General for Climate Change, Desertification and Hydrological Resources

National Commission on Climate Change: implements UNFCCC and the National Strategy for Climate Change

Regional Environmental Commissions: due to decentralisation of government, regional commissions are responsible for managing the environment and translating national policy into local mitigation and adaptation strategies

Ministry for Agriculture and **Ministry for Water:** govern climate change-related activities in respective sectors.

Policy Context

National Climate Change Strategy: (Executive Decree No. 086-2003-PCM); aims to reduce impacts by conducting research into vulnerability and action plans for CDM-friendly mitigation.

National Plan of Action on Adaptation and Mitigation and Climate Change (PACC) 2011 – 2021: outlines specific adaptation measures and covers the following themes: reporting mechanisms on GHG emissions, mitigation, adaptation, research and development of technology systems, financing and management, and public education.

2020 pledge: 33% of energy mix from renewables; eliminate deforestation of primary forests (which accounts for more than half of GHG emissions), supported by National Plan for the Conservation of Forests to Mitigate Climate Change.

Promotion of energy efficiency -declared a matter of national interest under Law No. 27345 of 2000 and regulated by Executive Decree No.053-2007-EM.

Key sectors at risk

Agriculture: threatened by Andean glacial retreat (22% lost in last 30 yrs) and reducing precipitation as well as increasing trend in extreme weather events, such as droughts, floods and increased pest plagues from the El Nino phenomenon (caused US$ 613 million damages in 1997-98 event).

Fisheries: important economic sector which may be affected by rising sea surface temperatures on Peruvian coasts (predicted 3-4% rise by 2050).

Coastal cities: more than 59% of the population live on the coastline and 75% in cities, whose sustainability is threatened by retreating glaciers in the Andes affecting water supply and rising sea levels.

Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

Map 4.
Adaptive capacity

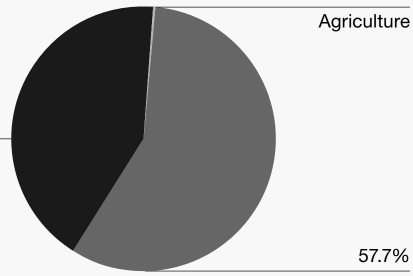
Trinidad & Tobago. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	7.22 (25)
Exposure	7.02 (24)
Sensitivity	5.75 (21)
Adaptive capacity	6.78 (21)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Point Fortin – 3.55	Chaguanas – 8.10	Chaguanas – 6.25
San Fernando – 4.57	Tunapuna-Piarco – 8.05	San Fernando – 2.73
Siparia – 4.59	Sangre Grande – 7.17	Port of Spain – 3.32

Institutional framework

Ministry of the Environment and Water Resources: coordinates climate change related policy, legislation and international activities.

Environmental Management Authority: oversaw preparation of national communication, assists government in implementing UNFCCC ; strategic goals include climate change mitigation and adaptation

Inter-ministerial committee: tasked with monitoring the mainstreaming of climate change in national development

Ministry of Energy and Energy Affairs: developing a Renewable Energy Policy

Policy Context

National Climate Change SNational Climate Change Policy (2011): overarching policy directive for addressing climate change mitigation; seeks to fulfil commitments made under UNFCCC and Kyoto Protocol; aims to provide policy guidance for the development of an appropriate administrative and legislative framework for the pursuit of low carbon development, adaptation & mitigation.

National Environmental Policy (2006): framework for environmental management, provides context for GHG mitigation and adaptation activities.

Carbon Reduction Strategy: initiative to establish GHG baselines and carbon reduction strategies for key sectors (transportation, power, industry).

Renewable Energy Policy: the Government has committed to developing this policy, recognising the importance of developing renewable energy and energy efficiency.

Key sectors at risk

Coastal urban zone: main economic activity is concentrated along the coast and vulnerable to sea level rise (0.13m and 0.56m by 2100); the most densely populated area of Trinidad (Caroni Basin) is vulnerable to flooding and this is expected to increase; the islands may also become increasingly exposed to hurricanes (currently on the edge of the hurricane belt).

Water supply: projections show a long term decrease in precipitation, putting pressure on water resources, particularly in the Caroni Basin.

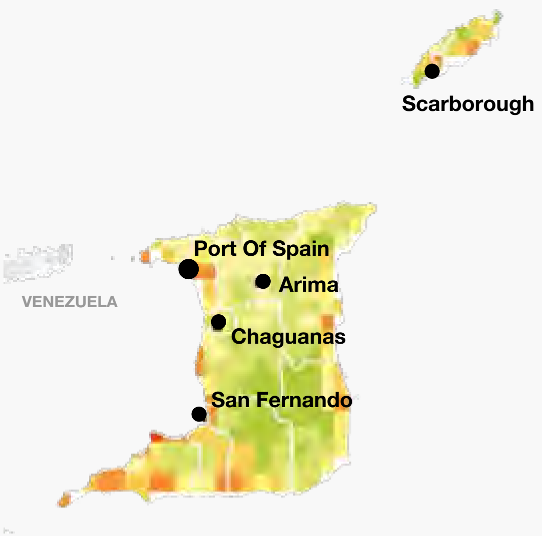
Agriculture: low proportion of GDP compared to industry (oil & gas), but agricultural land is nonetheless vulnerable to projected changes in temperature and rainfall, particularly in central and southern Trinidad.

Low risk Extreme risk

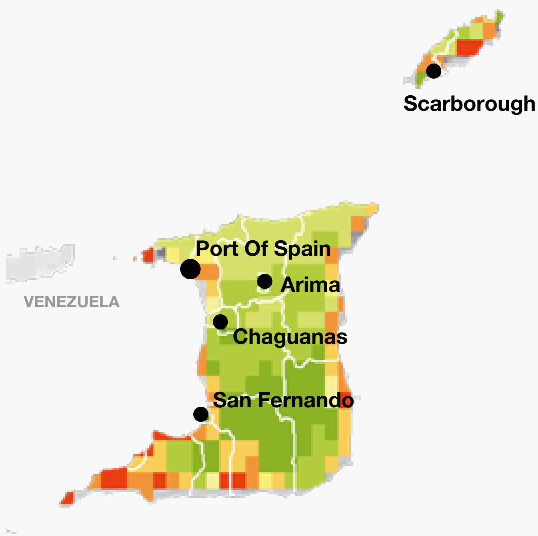
No data

Data source: Maplecroft, 2014

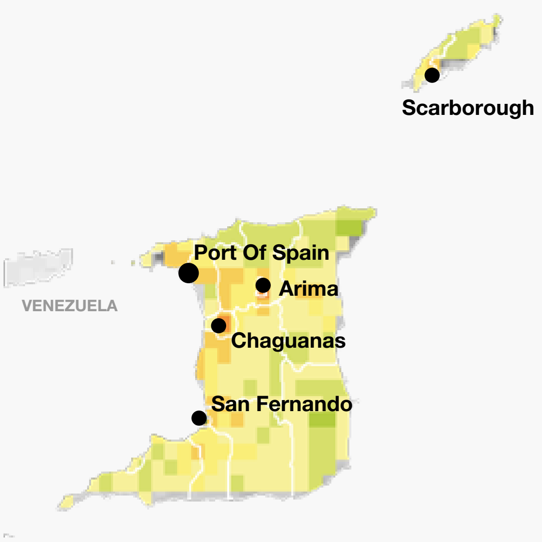
Map 1.
Climate change vulnerability



Map 2.
Exposure



Map 3.
Sensitivity



Map 4.
Adaptive capacity

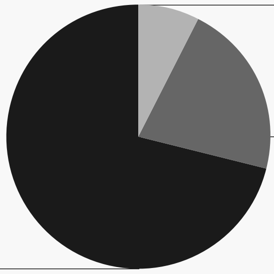
Uruguay. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	8.33 (28)
Exposure	7.27 (25)
Sensitivity	8.61 (30)
Adaptive capacity	8.18 (28)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector

Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Montevideo – 5.19	Lavalleja – 8.70	Montevideo – 3.38
Artigas – 7.61	Maldonado – 8.63	Salto – 3.59
Canelones & Salto – 7.61	Florida – 8.55	Paysandu – 2.82

Institutional framework

Ministry of Housing, Land Planning and Environment: implements the UNFCCC, designs mitigation and adaptation actions, and coordinate roles of related institutions

Climate Change Unit: within National Environment Directorate, conducts national GHG inventory and National Communications

National System to Respond to Climate Change & Variability: coordinates climate change actions among public and private institutions, published National Climate Change Response Plan

Ministry of Industry, Energy & Mining: responsible for preparing a National Energy Efficiency Plan and for implementing the National Energy Policy

Policy Context

National Response Plan to Climate Change (2010): strategic framework with emphasis on adaptation - identifies vulnerability of different sectors and sets actions for society and sectors to adapt to climate change and variability. Mitigation is not a priority line of action but measures are identified for each sector, including implementation of the CDM.

Integrated Water Resources Management National Plan: development of guidelines and cartography of floodable areas and risk maps, and a programme intended to ensure the supply of drinking water to small rural towns.

National Energy Policy 2005-2030: sets short, medium and long term targets e.g. 50% of primary energy from renewable and 15% of electricity from non-conventional renewable by 2015; also promotes energy efficiency.

Key sectors at risk

Agriculture: represents 65% of national export sources but vulnerable to increase in pests and diseases with temperature rise (2°C to 3°C by 2100) and humidity, longer droughts, increased soil erosion, more intense flooding, and changes in distribution of pasture.

Public health: concern that diseases carried by mosquitoes will become more prevalent with a rise in temperature and humidity; vulnerable members of society may be affected by an increase in duration of heat waves.

Tourism: may be negatively affected by sea level rise, more frequent forest fires, and more prolonged rainfall (which is projected to increase by 10% to 20% on average, more so in summer and increase in intensity).

Coastal economy: distribution and abundance of species with commercial value may change with rising sea surface temperatures.

Low risk
Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure

Map 3.
Sensitivity

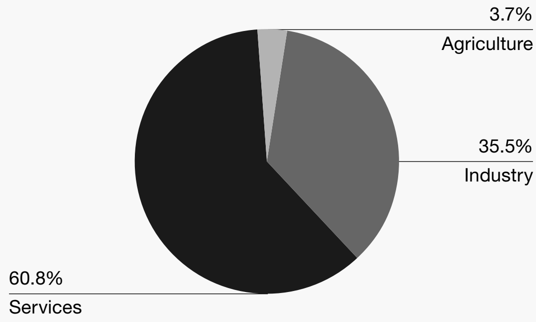
Map 4.
Adaptive capacity

Venezuela. Country profile scorecard 2014

Indices	Score (rank)
Climate Change Vulnerability Index	3.64 (11)
Exposure	5.07 (17)
Sensitivity	6.25 (22)
Adaptive capacity	3.62 (12)

- Extreme risk (0-2.50)
- High risk (2.50-5.00)
- Medium risk (5.00-7.50)
- Low risk (7.50-10.00)

GDP by sector Source: CIA World Factbook, 2013 data



Climate change vulnerability – Sub-national risk

Highest risk areas	Lowest risk areas	Major cities
Cojedes – 2.14	Amazonas – 7.18	Caracas – 2.56
Anzoátegui – 2.29	Bolivar – 7.12	Maracaibo – 1.75
Monagas – 2.31	Merida – 5.68	Valencia – 1.19

Institutional framework

Ministry for Environment (MINAMB): handles climate change issues at national level but lacks a dedicated climate change office

Ministry of External Affairs: focus point for international climate negotiations e.g. UNFCCC

Direction of Hydrographical Basins: coordinated production of first National Communication

National Centre for Agricultural Research: studies climate change impacts for agriculture.

Policy Context

Second National Development Plan 2013-2019 includes a section on the environment and identifies the environment as a global issue; speaks of impelling a world movement to contain the causes of climate change. In 2012 plans were announced to prepare a programme for limiting GHG emissions, however this does not appear to have been implemented and there is so far no national climate change strategy.

Law of Socio-Natural and Technological Risks (2009): identifies climate change as a national priority risk area for action; specifies responsibilities for creating a National Plan of Adaptation to Climate Change, although no plan has been produced to date.

Key sectors at risk

Water supply: most rain falls in the south (Amazonia), while 60% of the population lives in the relatively dry north with a reliance on groundwater; this region is projected to become drier, with decreasing rainfall trends.

Agriculture: strong negative impact on production likely from a combination of factors: vulnerability to weather extremes (e.g. flooding and landslides from heavy rain in 2011 caused a state of emergency in 8 states); projected increase in temperature (1°C to 2°C by 2060s); fall in precipitation (94.3% of agriculture is rainfed); and increase in dry areas prone to desertification (set to cover 47% of the country by 2060).

Energy supply: vulnerable to reliance on hydropower (70% of electricity generation) as it is affected by extreme events (as shown by droughts and excessive rain during El Nino and La Nina).

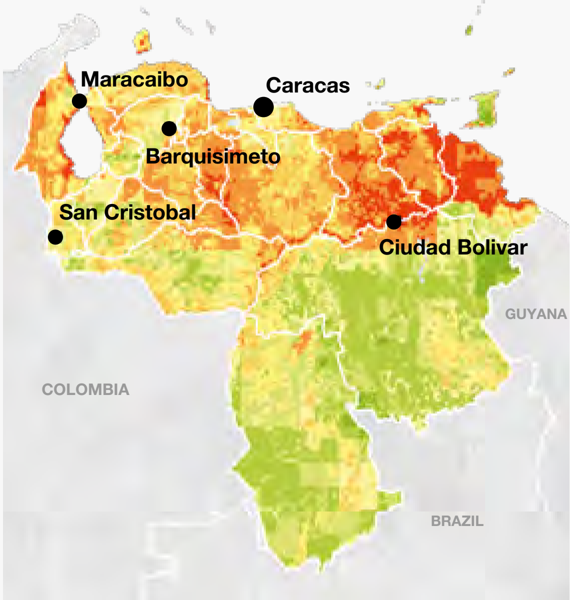
Low risk Extreme risk

No data

Data source: Maplecroft, 2014

Map 1.
Climate change vulnerability

Map 2.
Exposure



Map 3.
Sensitivity

Map 4.
Adaptive capacity

DEVELOPMENT BANK
OF LATIN AMERICA