

The Caribbean Public Health Agency is the Caribbean Region’s collective response to strengthening and reorienting our health system approach so that we are equipped to address the changing nature of public health challenges, which threaten development.

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Preface

The people of and visitors to the Caribbean region are surrounded by a wealth of culture and diversity in the broadest sense. However, our region of small island and low-lying developing states (SIDS) is facing a plethora of threats affecting all sectors. Climate change (CC) is recognized as one of the greatest global threats to human health, the environment and economies. While emissions of greenhouse gases from the Caribbean region are negligible, the Region is impacted by these emissions from other countries outside of the region resulting in a disproportionate impact on our region. Regional climate change, including the rise of sea levels, threatens the economies of several Caribbean countries and even the existence of some.

Recent events make the impact of climate on the health of Caribbean nations more obvious, especially category four and five storms such as Hurricane Matthew in 2016, and Hurricanes Maria and Irma in 2017. Countries such as Guyana and Trinidad and Tobago have experienced unprecedented floods since the turn of the 21st century. Fragile health systems and public health infrastructures make Caribbean countries especially vulnerable to the consequences of climate change. According to the Intergovernmental Panel on Climate Change (IPCC), “The actual health impacts are strongly influenced by local environmental conditions and socio-economic circumstances, and by the range of social, institutional, technological, and behavioral adaptations taken to reduce the full range of threats to health”. Climate change will have the most profound effects on the most vulnerable sectors of society.

Globally, there is an abundance of information related to climate and climate science. There is also information at our hands on how climate change will manifest in the Caribbean region. However, there is a critical component missing: a more data-driven assessment of the impact of climate on *health*. Within the region, the Caribbean Public Health Agency (CARPHA) is, in collaboration with its member states and partners like the Caribbean Community Climate Change Center and the PAHO/WHO, is exerting a leadership role in creating a strategic road map to address this gap.

Among the priorities are: raising awareness of climate change and health through information, communication and education; strengthening community resilience; integrating multi-sectoral data and decision-making; enhancing regional sustainability and resilience for health facilities; maximizing the benefits of the built environment and climate change resilience, and coordinating resources to address climate change impacts on health. The urgency of resource coordination and prioritizing investments in climate and health should be our collective responsibility.

Not acting on this unfolding threat would be ignoring a preventable problem of a magnitude greater than any epidemic that has faced our region to date. Building on the data presented in this report, and together with our stakeholders in agencies on both climate and health, and policy makers from all Caribbean member states, we must boldly act to counter the climate threats facing our paradise.

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An Oversight Committee of international and regional climate and health experts guided the content and methodology of this report. They met on six occasions from January 2018 to March 2019 to review and approve plans and drafts and provide technical advice and sources of information. Following are the members of the Oversight Committee:

Chair: Dr David Johnson - Chief Medical Officer, Commonwealth of Dominica.

Deputy Chair: Dr John Balbus, Senior Advisor for Public Health/ Director, NIEHS-WHO Collaborating Centre for Environmental Health Sciences

Other external experts

- Dr Adrian Cashman - Director, Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies
- Dr Rudolph Cummings - Programme Manager, Health, CARICOM Secretariat
- Ms Sharon Lindo - Policy Adviser, Caribbean Community Climate Change Centre
- Ms Amrikha Singh - Programme Manager, Environment Sustainable Development, CARICOM Secretariat
- Dr Georgiana Gordon-Strachan - Deputy Dean/ Professor, Department of Physics, Faculty of Pure and Applied Sciences, Mona Campus, Jamaica
- Mr Adrian Trotman - Chief of Applied Meteorology and Climatology, Caribbean Institute for Meteorology and Hydrology
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CARPHA Staff

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- Ms Avril Isaac - Communications Officer (Technical Lead: Communications)
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Other members of CARPHA’s Sub-Technical Advisory Committee and Expert Panel on Climate and Health also participated in the last two meetings of the Oversight Committee, providing valuable information and advice, including:

- Dr Peter Berry - Health Canada
- Mr John Bodden - Ministry of Health, Belize
- Dr A Cabral - Health Canada
- Dr Simone Keizer-Beache – Chief Medical Officer, St. Vincent and the Grenadines
- Dr John Kirton - Munk School of Global Affairs and Public Policy, University of Toronto
- Dr Madeline Koch - Global Governance Programme, University of Toronto
- Prof Maureen Lichtveld – Department of Global Environmental Health Sciences, Tulane University School of Public Health and Tropical Medicine
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- Mr David Ramkelawan – Ministry of Health, Grenada

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The report is dedicated to the people of the Caribbean, in the hope and expectation that their extraordinary resilience and creativity can be brought to bear in addressing the health consequences of climate change.

Acronyms

ACP	African, Caribbean and Pacific
AIMS	Africa, Indian Ocean, Mediterranean and South China Sea
AOSIS	Alliance of Small Island States
APHA	American Public Health Association
AR	(IPCC) Assessment Report
AST	Atlantic Standard Time
BRRS	Belize Barrier Reef Reserve System
BPOA	Barbados Programme of Action
BRCCC	Building Regional Climate Capacity in the Caribbean
CARDI	Caribbean Agricultural Research and Development Insitutie
CariCOF	Caribbean Climate Outlook Forum
CARICOM	Caribbean Community
CARIFORUM	Forum of the Caribbean Group of African, Caribbean and Pacific (ACP) States
CARIWIN	Caribbean Water Initiative
CARPHA	Caribbean Public Health Agency
CATS	Caribbean Aqua-Terrestrial Solutions (Programme)
CC	Climate Change
CCA	Climate Change Adaptation
CCCCC/ 5Cs	Caribbean Community Climate Change Centre
CCH	Caribbean Cooperation in Health
CCRIF SPC	Caribbean Catastrophe Risk insurance Facility Segregated Portfolio Company
CDAC	CARICOM Disaster Assessment and Coordination
CDB	Caribbean Development Bank
CDRRF	Community Disaster Risk Reduction Fund
CDC	Centers for Disease Control and Prevention
CDD	Continuous Dry Days
CDEMA	Caribbean Disaster Emergency Management Agency
CDERA	Caribbean Disaster Emergency Response Agency
CDM	Comprehensive Disaster Management
CDRMP	Caribbean Disaster Risk Management Program
CDPMN	Caribbean Drought and Precipitation Monitoring Network
CDRU	CARICOM Disaster Relief Unit
CERMES	Centre for Resource Management and Environmental Studies
CFC	Chlorofluorocarbon
CH ₄	Methane
CIF	Climate Investment Funds
CIMH	Caribbean Institute for Meteorology and Hydrology
CMHT	Community Mental Health Team
CMI	Caribbean Meteorological Institute
CMIP	Coupled Model Intercomparison Project
CMO	Caribbean Meteorology Organization
CMS	CARPHA Member States
CO ₂	Carbon dioxide
COHI	Caribbean Operational Hydrological Institute
COHSOD	Council for Human and Social Development

COP	Conference of Parties
COST	CARICOM Operational Support Team
CRCC	Caribbean Regional Climate Centre
CRFM	Caribbean Regional Fisheries Mechanism
CRIS	Caribbean Risk Information System
CSDH	Commission on the Social Determinants of Health
CSG	Climate Studies Group
CTF	Clean Technology Fund
CTO	Caribbean Tourism Association
DoWASCO	Dominica Water and Sewerage Company
DRM	Disaster Risk Management
DSWMC	Dominica Solid Waste Management Corporation
EA	Enabling Activities
ECU	Environmental Coordinating Unit
EDF	European Development Fund
EHD	Environmental Health Department
EHSD	Environmental Health and Sustainable Development
EIA	Environmental Impact Assessment
ENSO	El Nino-Southern Oscillation
EOC	Emergency Operations Centre
EWS	Early Warning Systems
EU	European Union
FBDs	Food-borne diseases
GCF	Green Climate Fund
GCM	Global Climate Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFCS	Global Framework for Climate Services
GHG	Greenhouse Gas(es)
HDI	Human Development Index
IAS	Invasive Alien Species
ICCCC	International Caribbean Climate Change Conference
IDB	Inter-American Development Bank
IMPACS	Implementation Agency for Crime and Security
INSMET	Institute of Meteorology in Cuba
IPCC	Intergovernmental Panel on Climate Change
IVCM	Integrated Vector Control Model
IWEco	Integrating Water, Land and Ecosystems (Management)
IWRM	Integrated Water Resource Management
JRCC	Joint Regional Communication Centre
kmh	Kilometres per hour
MDB	Multilateral Development Bank
MoHE	Ministry of Health and the Environment
mph	Miles per hour
MDTF	Multi-Donor Trust Fund
N ₂ O	Nitrous oxide
NAO	North Atlantic Oscillation
NCDs	Non-communicable diseases
NDRM	National Disaster Risk Management

NEPO	National Emergency Planning Organisation
NGO	Non-governmental organisation
NHC	National Hurricane Center
NIH	National Institutes of Health
NMHS	National Meteorological and Hydrological Services
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
OECS	Organisation of Eastern Caribbean States
OHGN	One Health Global Network
PAHO	Pan American Health Organization
PDNA	Post-disaster needs assessment
PDO	Pacific Decadal Oscillation
PHAC	Public Health Agency of Canada
PM	Particulate matter
PPCR	Pilot Program for Climate Resilience
ppm	Parts per million
PS	Participating States
PTSD	Post Traumatic Stress Disorder
RCC	Regional Coordinating Centre
RCM	Regional Climate Model
RCMHS	Regional Coordinating Mechanism on Health Security
RCP	Representative Concentration Pathways
RIFC	Regional Intelligence Fusion Centre
RNAT	Rapid Needs Assessment Team
RPG	Regional Public Goods
RRM	Regional Response Mechanism
RSART	Regional Search and Rescue Team
SCF	Strategic Climate Fund
SDG	Sustainable Development Goal
SDH	Social Determinants of Health
SHFI	Smart Health Facilities Initiative
SLM	Sustainable Land Management
SLR	Sea Level Rise
SPCR	Strategic Program for Climate Resilience
SPHR	State of Public Health Report
SREP	Scaling Up Renewable Energies Programme in Low Income Countries
SRES	Special Report on Emissions Scenarios
SWFDP	Severe Weather Forecasting Demonstration Project
UCL	University College London
UKOTs	United Kingdom Overseas Territories
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change (Secretariat)
UNICEF	United Nations Children's Programme
UN-OCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
USGCRP	United States Global Change Research Program
UV	Ultraviolet

UWI	University of the West Indies
VBD	Vector-borne disease
WASH	Water, Sanitation and Hygiene
WDF	World Diabetes Foundation
WINDREF	Windward Islands Research and Education Foundation
WHO	World Health Organization
WMO	World Meteorological Organization
WMORCC	World Meteorological Organization Regional Climate Center
WPI	Water Poverty Index

Glossary

Adaptation

The process of adjustment to actual or expected *climate* and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected *climate* and its effects.

Adverse side effects

The negative effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Adverse side effects are often subject to *uncertainty* and depend on local circumstances and implementation practices, among other factors.

Biodiversity

The variability among living organisms from terrestrial, marine and other *ecosystems*. Biodiversity includes variability at the genetic, species and *ecosystem* levels.

Carbon tax

A levy on the carbon content of fossil fuels. Because virtually all of the carbon in fossil fuels is ultimately emitted as carbon dioxide (CO₂), a carbon tax is equivalent to an emission tax on CO₂ emissions.

Climate

Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the *climate system*.

Climate change

Climate change refers to a change in the state of the *climate* that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or *external forcings* such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in *land use*. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: ‘a change of *climate* which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural *climate variability* observed over comparable time periods’. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and *climate variability* attributable to natural causes.

Climate projection

A climate projection is the simulated response of the *climate system* to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using *climate models*. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions

concerning, for example, future socio-economic and technological developments that may or may not be realized.

Climate variability

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the *climate* on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system (internal variability)*, or to variations in natural or anthropogenic *external forcing* (external variability).

Confidence

The validity of a finding based on the type, amount, quality and consistency of evidence (e.g., mechanistic understanding, theory, data, models, expert judgment) and on the degree of agreement.

Deforestation

Conversion of forest to non-forest.

Drought

A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term; therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or *ecosystem* function in general (due to soil moisture drought, also termed agricultural drought) and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation. A period with an abnormal precipitation deficit is defined as a meteorological drought. A megadrought is a very lengthy and pervasive drought, lasting much longer than normal, usually a decade or more.

Early warning system (EWS)

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a *hazard* to prepare to act promptly and appropriately to reduce the possibility of harm or loss.

Ecosystem

An ecosystem is a functional unit consisting of living organisms, their non-living environment and the interactions within and between them. The components included in a given ecosystem and its spatial boundaries depend on the purpose for which the ecosystem is defined: in some cases they are relatively sharp, while in others they are diffuse. Ecosystem boundaries can change over time. Ecosystems are nested within other ecosystems and their scale can range from very small to the entire biosphere. In the current era, most ecosystems either contain people as key organisms, or are influenced by the effects of human activities in their environment.

Emission scenario

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases (GHGs), aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change, energy and *land use*) and their key relationships. Concentration scenarios, derived from emission scenarios, are used as input to a *climate model* to compute *climate projections*.

Flood

The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods and glacial lake outburst floods.

Food security

A state that prevails when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life.

Global warming

Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of *radiative forcing* caused by anthropogenic emissions.

Heat wave

A period of abnormally and uncomfortably hot weather.

Impacts (consequences, outcomes)

Effects on natural and human systems. In this report, the term *impacts* is used primarily to refer to the effects on natural and human systems of *extreme weather and climate events* and of *climate change*. Impacts generally refer to effects on lives, livelihoods, health, *ecosystems*, economies, societies, cultures, services and infrastructure due to the interaction of *climate changes* or hazardous climate events occurring within a specific time period and the *vulnerability* of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of *climate change* on geophysical systems, including *floods*, *droughts* and sea level rise, are a subset of impacts called physical impacts.

Industrial Revolution

A period of rapid industrial growth with far-reaching social and economic consequences, beginning in Britain during the second half of the 18th century and spreading to Europe and later to other countries including the United States. The invention of the steam engine was an important trigger of this development. The industrial revolution marks the beginning of a strong increase in the use of fossil fuels and emission of, in particular, fossil carbon dioxide (CO₂). In this report the terms *pre-industrial* and *industrial* refer, somewhat arbitrarily, to the periods before and after 1750, respectively.

Land use and land-use change

Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term *land use* is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction and conservation). In urban settlements it is related to land uses within cities and their hinterlands. Urban land use has implications on city management, structure and form and thus on energy demand, greenhouse gas (GHG) emissions and mobility, among other aspects.

Likelihood

The chance of a specific outcome occurring, where this might be estimated probabilistically.

Mitigation (of climate change)

A human intervention to reduce the sources or enhance the *sinks* of greenhouse gases (GHGs). This report also assesses human interventions to reduce the sources of other substances which may contribute directly or indirectly to limiting *climate change*, including, for example, the reduction of particulate matter emissions that can directly alter the radiation balance (e.g., black carbon) or measures that control emissions of carbon monoxide, nitrogen oxides, Volatile Organic Compounds and other pollutants that can alter the concentration of tropospheric ozone which has an indirect effect on the *climate*. A mitigation scenario is a plausible description of the future that describes how the (studied) system responds to the implementation of *mitigation* policies and measures.

Ocean acidification

Ocean acidification refers to a reduction in the *pH* of the ocean over an extended period, typically decades or longer, which is caused primarily by uptake of carbon dioxide (CO₂) from the atmosphere, but can also be caused by other chemical additions or subtractions from the ocean. *Anthropogenic ocean acidification* refers to the component of *pH* reduction that is caused by human activity.

Poverty

Poverty is a complex concept with several definitions stemming from different schools of thought. It can refer to material circumstances (such as need, pattern of deprivation or limited resources), economic conditions (such as standard of living, inequality or economic position) and/or social relationships (such as social class, dependency, exclusion, lack of basic security or lack of entitlement).

Radiative Forcing

The strength of drivers (for example, modulations of solar cycles, volcanic eruptions and changes in greenhouse gases) is quantified as radiative forcing in units watts per square meter (W/m²). Radiative forcing is the change in energy flux caused by a driver and is calculated at the tropopause or at the top of the atmosphere.

Reforestation

Planting of *forests* on lands that have previously contained *forests* but that have been converted to some other use.

Representative Concentration Pathway

Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios. Extended Concentration Pathways (ECPs) describe extensions of the RCPs from 2100 to 2500 that were calculated using simple rules generated by stakeholder consultations and do not represent fully consistent scenarios. Four RCPs produced from Integrated Assessment Models were selected from the published literature and are used in the Fifth IPCC Assessment.

RCP2.6

One pathway where radiative forcing peaks at approximately 3 W/m² before 2100 and then declines (the corresponding ECP assuming constant emissions after 2100).

RCP4.5 and RCP6.0

Two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W/m² and 6.0 W/m² after 2100 (the corresponding ECPs assuming constant concentrations after 2150).

RCP8.5

One high pathway for which radiative forcing reaches >8.5 W/m² by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250).

Resilience

The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for *adaptation*, learning and *transformation*.

Risk

The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or *likelihood* of occurrence of hazardous events or trends multiplied by the *impacts* if these events or trends occur. In this report, the term *risk* is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, *ecosystems* and species, economic, social and cultural assets, services (including environmental services) and infrastructure.

Sink

Any process, activity or mechanism that removes a greenhouse gas (GHG), an aerosol or a precursor of a GHG or aerosol from the atmosphere.

SRES scenarios

SRES scenarios are *emission scenarios* developed by IPCC (2000a) and used, among others, as a basis for some of the *climate projections* shown in the IPCC Working Group I Assessment Report 5.

Storm surge

The temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions (low atmospheric pressure and/or strong winds). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place.

Sustainable development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability is a dynamic process that guarantees the persistence of natural and human systems in an equitable manner.

Transformation

A change in the fundamental attributes of natural and human systems. A transformation pathway is the trajectory taken over time to meet different goals for greenhouse gas (GHG) emissions, atmospheric concentrations, or global mean surface temperature change that implies a set of economic, technological and behavioural changes. This can encompass changes in the way energy and infrastructure are used and produced, natural resources are managed and institutions are set up and in the pace and direction of technological change.

Uncertainty

A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts)

Vulnerability

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.