GCCA+
THE GLOBAL CLIMATE CHANGE ALLIANCE PLUS INITIATIVE

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Caribbean Community Climate Change Centre

Notes for policymakers

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ACRONYMS TABLE

CCCCC	Caribbean Community Climate Change Centre
CCORAL	Caribbean Climate Online Risk and Adaptation tooL
CDM	Clean Development Mechanism
CARiDRO	Caribbean Assessment of regional drought
CARICOM	Caribbean Community
CariSAM	Portal of the Caribbean Society for Agro-Meteorology
CCA	Climate Change Adaptation
CDKN	Climate and Development Knowledge Network
CERMES	Centre for Resource Management and Environmental Studies
CIMH	Caribbean Institute for Meteorology and Hydrology
COP24	24th UNFCCC Conference of Parties
CSGM	Climate Studies Group Mona, University of West Indies
CSO	Civil Society Organization
DG DEVCO	Directorate-General for Development and Cooperation
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ECHAM	European Centre for Medium-Range Weather Forecasts, Hamburg
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EbA	Ecosystem-based Adaptation
ENSO	El Nino Southern Oscillation
EU	European Union
EDF	European Development Fund
FAO	Food and Agriculture Organization
GCCA+	Global Climate Change Alliance Plus, EU
GCM	Global Climate Model
HadCM	Hadley Centre Coupled Model
INSMET	Institute of Meteorology, Cuba
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
PICSA	Participatory Integrated Climate Services for Agriculture
RECCC	Review of the Economics of Climate Change in the Caribbean
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
SLR	Sea Level Rise
SMASH	Simple Model for the Advection of Storms and Hurricanes
UNDP-JCCCP	UNDP Japan Caribbean Climate Change Partnership
UNFCCC	United Nations Framework Convention on Climate Change
UWI	University of the West Indies

1. EXECUTIVE SUMMARY

Climate change poses a serious threat to sustainable development, impacting negatively on livelihoods, ecosystems, infrastructure, health and the productive sectors. For the Small Island Developing States (SIDS) of the Caribbean sub-region, the threat is even more severe due to the biophysical and socio-economic characteristics of these countries which make them especially vulnerable to these impacts. This is a result of the geographic location of many of these States in the hurricane belt, and the concentrations of their populations and economic infrastructure in coastal zones. Additionally, the sub-region is dependent on a narrow range of economic activities, including agriculture and tourism, which are intimately linked to the environment, making them highly susceptible to external shocks (ECLAC, 2010a). Thus, climate change is of direct relevance to economic development planning in these countries.

Recent scientific analysis (IPCC 2014) shows that the Caribbean region climate is shifting to a new climate regime, dominated by increased variability and erratic and more extreme events. For example, the recent hurricanes Irma and Maria fit this pattern, as at no point in the historical records, dating back to the late 1800s, have two category five storms made landfall in the small Caribbean island chain of the eastern Antilles in a single year. As a consequence of this climatic shift in the region, estimates of the economic cost of climate change to Caribbean economies are useful in developing adaptation and mitigation strategies within the context of national and sub-regional development policies and plans. Apart from obvious costs, such as those related to the replacement value of infrastructure due to increased intensity of tropical cyclones, real costs include productivity loss, potential relocation of persons living near coastlines, and increased resources for dealing with frequent flooding. Indeed, the range of anticipated impacts on key economic sectors in the Caribbean will have implications for overall quality of life in the Caribbean sub-region, and more so among poor and vulnerable groups.

Given such climate and socio-economic context, and under the framework of the Global Climate Change Alliance Plus (GCCA+) flagship initiative of the European Union, the Caribbean Community Climate Change Centre (CCCCC) and the European Commission Directorate-General for International Cooperation and Development (DG-DEVCO)[1] jointly organised an international conference titled **"Integrating Climate Variability and Change information into Adaptation and Mitigation actions in the Caribbean Region"** in Port-of-Spain, Trinidad and Tobago from October 9th to 12th, 2017. With the support of the EU GCCA+, the Caribbean Development Bank, UNDP Japan Caribbean Climate Change Partnership (UNDP-JCCCP), the Food and Agriculture Organisation (FAO) and CCCCC coordinated this joint international climate change conference for the Caribbean. This

[1] The EC DG-DEVCO is responsible for the management of the EU GCCA+ flagship initiative

conference addressed the role of climate information (from global, regional and local models) into shaping and implementing climate policy and programmes in the Caribbean region. The various sessions addressed the crucial nexus of science-policy for building the required resilience capacity and programmes in the Caribbean region, based on available climate information, highlighting how theories translate into research and how these research findings are and can be used to formulate actions and policies which are critical to building resilience in the Caribbean and can be transferable to other regions.

This conference addressed the current global climate change landscape, providing specifically an overview of the expected challenges in the Caribbean region: higher temperatures, lower rates of precipitation, rising sea surface temperatures, more intense extreme events and sea level rise. The conference aimed at evaluating the role of climate information in shaping climate policies and programmes in the Caribbean region, and at discussing the integration of climate variability and change risks into national and regional development planning. The main expected results were fostering the interaction and knowledge sharing amongst regional scientists and wider community of policy makers and development partners.

The conference was organised under three thematic areas: (i) Current and Future Climate Scenarios in the Caribbean Region, (ii) Climate Change impacts on key development sectors and socio-economic dynamics; and (iii) Climate Change Policy and Programme Management.

2. SUMMARY OF FINDINGS

Current and Future Climate Scenarios in the Caribbean Region

The conference sessions addressing local and regional climate change research, highlighted these main findings:

1. Outputs from various modelling groups in the region (Institute of Meteorology in Cuba - INSMET, CCCCC in Belize, Climate Studies Group Mona of the University of the West Indies - CSGM, University of Suriname) have significantly improved climate change science, leading to development of New Analytical and Forecasting Tools used in vulnerability and impact studies, such as the Caribbean Weather Generator, the CARiWIG project[2], the Caribbean Assessment of regional drought (CARiDRO), the Simple Model for the Advection of Storms and Hurricanes (SMASH), and for the development of country-specific, socio-economic scenarios for climate threats;
2. Recent modelling studies show: (i) a dramatic (> 30% of present climate) increase in warm days and warm nights, (ii) a reduction (~ 15%) in cold nights and cool days, and (iii) the increased frequency of heavy rainfall events and duration of dry spells;
3. The predicted warming in the region will be between 1.7°and 3.5 °C. In the near future (in the next 15-20 years), warm days will be the new average condition, coupled with a significantly less (30-40% decrease) precipitation across the Caribbean region, resulting in increased drought;
4. The number of hurricanes in this region will be increasing, as well as their intensity, rainfall and wind-speeds and sea level rise.
5. Even with the full implementation of the Paris Agreement, a 1.5°C increase in the region may occur much sooner than 2050. The regional-led 1.5°C project shows that 2.0° C warming in the region will result in increasing frequency and number of dramatic climate threats, leading to significant financial, management and technical adaptation challenges for various countries;
6. The region has led globally in flash-flood and heat-wave forecasts, by building fine-tuned regional models integrating satellite and in-situ data.

[2] The project was funded by the Climate and Development Knowledge Network (CDKN) and work was carried out as a partnership between the Newcastle University (UK), the Caribbean Community Climate Change Centre (Belize), University of East Anglia (UK), University of the West Indies (Jamaica) and the Institute of Meteorology (Cuba).

More detailed results regarding the various climate variables in the Caribbean were also presented:

TEMPERATURE

Projections for mean annual temperature change show that by 2050, mean temperatures are expected to rise between 1.52°C and 2.64°C above the base period average, with a mean increase of 1.78°C for the sub-region. By 2070, temperatures would have risen by 2.36°C in Turks and Caicos Islands; by 3.85°C in Guyana; and by an average of 2.78°C across the sub-region (Bonilla 2015).

By 2030, the maximum temperature is forecasted to increase by between 0.95°C and 1.85°C (depending on the country), with a regional average increase of 1.20°C. By 2070, maximum temperatures are expected to increase by 2.86°C on average, with a range of 2.33°C (Turks and Caicos Islands) to 4.47°C (Guyana). By 2090, the maximum temperature is forecasted to increase by 3.72°C on average across the sub-region.

Visual plots of the variation over time of average annual temperatures - using the average of the two Global Climate Models (GCM) ECHAM4 and HadCM3 - show that there is little variation between the forecasts for high emissions scenario (A2) and low emissions scenario (B2) in the first half of the twenty-first century. By 2050, mean and maximum temperatures are forecasted to increase by about 1.8°C on average, compared to the base period averages, irrespective of the scenario; but by 2090 the mean annual temperature change can be as much as 3.55°C under the high emissions scenario (A2) or 2.40°C under the low emissions scenario (B2). Maximum temperature change will range somewhere between 2.77°C and 3.72°C depending on the scenario, by 2090.

PRECIPITATION

Under the A2 scenario (IPCC 2017), by 2030, precipitation will increase in some countries by 7.76% (Haiti) and decline by as much as 12.59% in others are predicted, with a mean precipitation decline of 3.05% across the sub-region; and by 2090, the mean precipitation change is forecast to decline in most countries, with the sub-region projected to experience an overall drastic decline in rainfall of about 25.33% on average by 2090. Meanwhile, under the B2 scenario, by 2030, mean precipitation changes of between -22.93% and 18.60% are projected depending on the country, with a 3.69% decrease on average for the sub-region; and by 2090, the mean precipitation change would be between -71.57% and 85.47%, with an average decline of 14.05% for the sub-region.

The Caribbean region is projected to experience progressive declines in the total annual rainfall under both scenarios, with the A2 scenario predicting a more precipitous decline

than the B2 scenario after 2060. Under the A2 scenario, by 2090 the sub-region will experience an average of approximately 25% less rainfall for the year, while under the B2 scenario the sub-region can expect a 14% average reduction in total annual rainfall.

SEA LEVEL RISE (SLR)

Continued growth of GHG emissions and associated global warming could well promote sea-level rise (SLR) of 1-3 m in the twenty-first century in the Caribbean region, with the possibility of a 5 m increase if there is an unexpectedly rapid breakup of the Greenland and West Antarctic ice sheets (Dasgupta and others, 2007). In the Review of the Economics of Climate Change in the Caribbean (RECCC) studies, an estimated SLR of 2m corresponds to the high emissions scenario (A2) and a SLR of 1m corresponds to the low emissions scenario (B2).

EXTREME WEATHER EVENTS

Historical data indicate that, since 1995, there has been an increase in the intensity and distribution of hurricanes in the Caribbean. The number of Category 4 and 5 hurricanes in the North Atlantic have also increased from 16 in the period of 1975-1989 or 1.1 per year, to 25 in the period of 1990-2004 or 1.6 per year, a rise of 56% (Webster and others, 2005). There was only one outlier year in the early twentieth century when the average speed for storms was 130 mph due to a storm with winds of more than 150 mph passing through the sub-region. It is likely that some increase in tropical cyclone intensity will occur if the climate continues to warm. Another phenomenon that may be linked to changes in climate is the El Nino Southern Oscillation (ENSO) which has been responsible for inter-annual variability in the climate of the southern Caribbean.

Based on a range of models, the Intergovernmental Panel on Climate Change (IPCC) suggests that future hurricanes of the north tropical Atlantic are likely to become more intense, with larger peak wind speeds and heavier near storm precipitation. It is projected that there will be an increase in the frequency of hurricanes in Categories 3 to 5 in the Caribbean region, and also it is most likely that a tropical storm will develop into a Category 5 hurricane within a very short time span, such as within 24 hours.

Climate Change impacts on key development sectors and socio-economic dynamics

The conference sessions addressing climate change impacts on key development sectors (agriculture, water, health, coastal infrastructure) and socio-economic dynamics, highlighted the following main findings:

1. Regional livestock are already stressed under current climate conditions. It is forecasted that livestock mortality will increase under a 1.5°C scenario for the region, and productivity will significantly decrease through a 2°C or more climate condition;
2. The state of water resources (including water quality, flux, human consumption) is not being monitored at spatial and temporal scales necessary to quantitatively evaluate the current and future climate change impacts;
3. Insurance schemes for agriculture and fisheries sectors are promoting climate-smart practices and early warning systems, to implement Ecosystem-based Adaptation (EbA) strategies as fish stocks and agriculture production have been declining, and very vulnerable (decrease in 30-40 % of yield) to large climate events in the region (hurricanes, storms) (Jones *et al.* 2015);
4. Increasing and maintaining current agriculture and fisheries production appears no longer possible under the current and future climate change scenarios in the region;
5. Catastrophic multi-island impacts (recent ones by the recent passage of three hurricanes in the region over a period of 2 months), highlighted the upper adaptive capacity limit of regional governments, institutions, and communities to implement effective Regional Response Mechanism and Adaptation Strategies;
6. Climate variability (combined effects temperature, precipitation, local climate) in the region has been identified as the main threat to socio-economic dynamics, and the main vulnerability factors for key development sectors (Agriculture, Infrastructure, Tourism, Water Management);
7. There is overwhelming scientific evidence (IPCC 2017) that the projected SLR in the region represents a serious and chronic threat to the sustainable management of the coastal zone in the Caribbean Community (CARICOM) Member States.

Climate Change Policy and Programme Management

The conference sessions addressing climate change's programmes and policies, highlighted the following main findings:

1. Barriers (financial, management and technical) to the effective delivery of climate services in the regions were identified, namely: (i) lack of funding and staffing for key climate services institutions (e.g. Meteorology and Hydrological departments); (ii) additional institutional responsibility to provide climate services; and (iii) technical challenges to integrate climate information in regional and national policy;
2. Climate projections indicate that extreme events are expected to increase in the region. Integrated and holistically Adaptation and Disaster Risk Reduction (DRR) tools must monitor the evolution of these events, aiming at determining key physical and economic variables as adaptive proxy for regional and local programmes.
3. The region suffers for lack of weather stations, required for climate monitoring and analysis of local climate trends; furthermore, the region lacks long (> 40 years) time-series of climate data, leading to limited regional & national training of technicians to develop a range of climate tools;
4. More site-specific climate scenarios are required to evaluate the region, country and community vulnerability, and, in turn, to developing capacity to develop climate policy;
5. Extensive training activities throughout all the CARICOM Member States in the use of tools (Caribbean Climate Online Risk and Adaptation tool, CCORAL) to integrate climate risks have focused on personnel of Ministries of Planning and Finance;
6. Management and Policy Barriers to climate change adaptation in the region include: (i) weak networking across government agencies to utilize various climate services tools, (ii) weak involvement of senior level personnel in regional climate discussions, (iii) overlapping of mandates across various technical institutions addressing climate and climate-related programs.
7. Inadequate use of climate risks research findings into national and local development programmes and action actions

A key factor influencing the sub-region's vulnerability to the impact of extreme weather events is the fragility of agriculture-based economies which are heavily dependent on their natural environment to sustain livelihoods. Large-scale losses are not unusual, as more than half of the countries in the sub-region depend on one or two commodities for export revenues. In 2017, hurricanes Maria and Irma destroyed all of Jamaica's major export crops (coffee, papaya and coconut), and the food-growing areas of the southern part of the island suffered major dislocation; Haiti lost large portions of its banana, bean, and yam crops to high winds and salt water intrusion on its southern coast, and there was extensive damage to the agricultural sectors in Dominica and Saint Lucia. Many countries have discontinued the production of bananas for export, partly due to frequent crop devastation from intense hurricanes (and partly due to loss of preferential access to European markets). Some countries ceased other agricultural operations due to diseconomies caused by severe weather conditions including extreme droughts, floods and storms as well as variations in temperature. In Guyana and Suriname, where most of the arable land is at sea level, sea walls are built for protection against flooding.

3. CONCLUSION

This conference confirmed the existence of high-quality, climate science-based research and work in the Caribbean region, addressing current and future climate threats across various spatial and time scales. This climate research includes most recent hurricanes and other challenges, clearly highlighting the high financial cost of climate inaction. The Caribbean region is no longer 5-7 years behind other world scientific communities in terms of its capacity to generate high-quality climate information. The '1.5°C -Stay Alive Study" (presented at this conference) clearly showcases the effort of forty-five regional scientists, spanning six countries, working in a coordinated way to answer the vital question: "*What will the 1.5°C change mean for the region, and how does this compare with a world that is 2.0°C or 2.5°C warmer?*". Given a Business as Usual scenario, the Caribbean region will suffer dramatic and extreme climate events, with significant, dire consequences on regional and local socio-economic fabrics.

The Caribbean community is in need for greater, global political support to keep global temperature rise at 1.5°C or less. Otherwise, the Caribbean region will experience significant decreases in precipitation, increase in intense rainfall events, and more dry, hot and warm spells. This international support should consist in further harmonising technical and policy support within all SIDS (Small Island Developing States) countries to keep the global warming threshold of 1.5° C during the preparation of the United Nations Framework Convention on Climate Change (UNFCCC) 24th Conference of Parties (COP24), through sponsoring the relevant technical and negotiation workshops.

Communication of the region's scientific and management information is key and strategic for the successful implementation and development of regional climate change policy and programmes. **Regional climate change vulnerability, threats and solutions should be tailored to the end-users, being decision-makers, community, the grassroots level-farmers and fishermen, and those outside our normal- technical realm.** The high-quality climate knowledge generated by this conference and decades of climate research in the region, should then be translated into accessible information for use by the general public and decision-makers.

Main regional challenges include: (i) availability of climate finance and ad-hoc funding streams for DRR and Climate Change Adaptation (CCA) joint programmes, (ii) uneven regional political support for climate actions, (iii) ad-hoc streamlining of various institutions' arrangements, strategies, conceptual approaches, assessment methodologies and frameworks for climate change policy, (iv) imbalance of human and financial resource allocation for climate programmes, and (v) inadequate of dedicated resources for systematic integration of climate change and DRR into national development plans and budgeting systems at central and local level, as well as need for stronger involvement of local authorities and Civil Society Organizations (CSO), and the scientific community.

Conversely, this conference also identified a range of strategic opportunities over the medium and long-tem for the region. These opportunities include, among others: (i) harmonising DRR/CCA/Sustainable Development Goals (SDG) for all countries, (ii) re-allocating savings from Renewables Solutions to support CCA/Disaster Risk Management (DRM)/Clean Development Mechanisms (CDM) Investments, and (iii) facilitating access of various stakeholders to climate services and new climate financing mechanisms.

4. RECOMMENDATION FOR POLICYMAKERS

The stated objective of the international community is to contain the global temperature rise to 2.0°C above pre-industrial levels by 2100 through concerted global action. Collaborating with the international community to stabilize the global climate system must be the preeminent recommendation to policy-makers in CARICOM.

Nevertheless, even if this important target should be achieved, sea level rise (SLR) and temperature will continue to rise in the region, and extreme weather events will likely become more frequent. Recognising this, the following recommendations reinforce the need for serious, comprehensive and urgent action to be taken to address the challenges of adapting to SLR in the islands and coastal states of the Caribbean:

1. Enhancing Operational Readiness for Climate and Disaster Response (Nationally and Regionally);
2. Supporting Community Resilience Building – National Community Based CCA and DRM Programmes;
3. Supporting Community Climate Risk Profiles, and identifying the most vulnerable communities to Climate Change and Climate Vulnerability;
4. Advancing the Caribbean Safe Schools Programmes to include climate and DRR vulnerabilities and adaptive plans;
5. Establishing a coordinated Climate Change Adaptation and Disaster Risk Information System;
6. Supporting the government and technical institutions to integrate climate information into planning, budgeting and policy development;
7. Regional stakeholders should place emphasis on ANTICIPATION rather than REACTION at the level of policy planning and adaptation strategies;
8. Enhancing technical and management coordination among regional bodies to improve the information-base with regard to the risks posed by climate change impacts in the Caribbean and the capacity of adaptation options to cope with different levels of climate change, so as to enable greater evidence-based adaptation assistance from the international community;
9. Considering implementation of such an adaptation strategy for SLR takes time. Previous coastal defence projects have shown that implementing coastal protection infrastructure typically has a lead-time of 30 years or more. Therefore, to have such structural protection systems in place shortly after mid-century would require the planning and financing of these major infrastructure projects to commence within the next 10 to 15 years. The costs of such coastal protection schemes are beyond the financial capacity of local governments and may exceed the capabilities of some small island nations. The urgency for the international community to negotiate adaptation funding therefore cannot be understated;

10. Local level studies should be undertaken to better understand the potential impacts of SLR for communities and facilitate the engagement of local governments and vulnerable stakeholders in the development of adaptation plans;
11. Improving the spatial detail and reduce uncertainties in climate change scenarios for the Caribbean Basin. Further examination of both GCM and Regional Climate Model (RCM) projections for the Caribbean is recommended to advance understanding of the regional manifestations of global climate change, particularly with respect to changes in precipitation and extreme climate events (e.g., heavy rainfall, tropical storms). Downscaling of the various projections to higher resolutions should be a key focus of climate scenario work in the region.
12. Assessing the adaptive capacity of wetlands and mangroves to SLR. Wetlands and mangroves provide highly valued ecosystem services to the islands and coastal regions of the Caribbean and have been shown to be vulnerable to SLR. More detailed analysis of the impacts of SLR for the size, integrity and function of wetlands and mangroves is needed to accurately assess the implications for flood and erosion protection, water purification, and habitat protection.
13. Commencing coastal projection adaptation planning early. The development of coastal project systems has been shown to take 30 years or more. The detailed local level planning for coastal protection needs to begin within next 15 years if the environmental assessments, financing, land acquisition, and construction is to be completed by mid-century, so that the economic benefits of damage prevention are optimised.
14. Integrating SLR into government insurance policies. Insurance policies that account for the long-term risks of SLR will enable landowners to properly assess coastal protection and retreat options. Government subsidies, for example, can insure coastal properties that suffer repeated losses or are at high risk of SLR inundation and erosion and encourage maladaptive decisions by property owners and a continued expense to national economies.
15. Reviewing and developing policies and legal framework to support coordinated retreat from high-risk coastal areas. Existing policy and legal frameworks should be reviewed to assess the responsibilities of the state and landowners for the decommissioning of coastal properties damaged by the impacts of SLR.
16. Incorporating SLR into local and regional land use development plans as well as tourism master plans. Undertake national-level consultation with government ministries responsible for land use planning and tourism planning to utilize the broad scale results of this study and higher-resolution local scale studies to guide reviews and updates of official land use plans.
17. Reviewing and developing policies and legal framework to support coordinated retreat / relocations from high-risk coastal areas. Existing policy and legal frameworks should be reviewed to assess the responsibilities of the state and

landowners for the decommissioning of coastal properties damaged by the impacts of SLR.

18. Prioritising adaptations to the impacts associated with future SLR, including coastal inundation and inland flooding, greater storm surge damage, and increased erosion, will involve considerable revisions to development plans and major investment decisions.
19. Completing a focused analysis of the vulnerability of tourism dependent small island economies and develop adaptation strategies. A critical finding of this analysis (Ramkissoon and Kahwa 2015) was that while the absolute size of economic losses is generally much greater in the larger CARICOM economies, the proportional impacts (losses compared to the size of the national economy) are generally higher in the smaller economies of St. Kitts and Nevis, Antigua and Barbuda, Barbados, St. Vincent and the Grenadines and Grenada.
20. Adopting a risk management approach consistent with actual science best practice of the Caribbean region. The framework proposed by CARICOM (CARICOM 2017) should be further developed, by taking into account best practice and research in risk management and actual science. This would give a full risk mapping of climate change impacts, which would be a powerful tool for policymakers.
21. Improve the spatial detail and reduce uncertainties in climate change scenarios for the Caribbean Basin. Further examination of both GCM and Regional Climate Model (RCM) projections for the Caribbean is recommended to advance understanding of the regional manifestations of global climate change, particularly with respect to changes in precipitation and extreme climate events (e.g., heavy rainfall, tropical storms). Downscaling of the various projections to higher resolutions should be a key focus of climate scenario work in the region.
22. Engaging the participation of middle and senior policy-makers, along with the private sectors, to future climate change conferences at regional and global level.