

The Caribbean Regional Climate Outlook Forum (CariCOF)

Basseterre St. Kitts

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Report

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The 2015 Dry Season CariCOF stakeholder forum came on the heels of the customary pre-CariCOF training session for meteorologists and climatologists. The areas of focus of the pre-CariCOF training were (i) the use and application of the newly developed CariCOF Outlook Generator (CAROGEN); (ii) verification of forecasts; and (iii) media training (follow link for [CariCOF Concept Note](#)). This 2015 Dry Season CariCOF was made possible through collaboration with the World Meteorological Organization (WMO); the National Oceanographic and Atmospheric Administration (NOAA); the United States Agency for International Development (USAID); Department of the Environment, Government of Canada; the International Research Institute for Climate and Society (IRI) and the St Christopher Air & Sea Ports Authority (SCASPA) .

It is the custom at these forums for the meteorologists and climate scientists to communicate climate information to the stakeholders from climate sensitive sectors in the Caribbean – agriculture, water, disaster management, tourism, health and energy (see [Appendix I](#) for attendee list).

Opening Remarks

The Opening Ceremony was Chaired by Mr. Adrian Trotman of CIMH. The key addresses from the formal opening of the 2015 Dry Season CariCOF are as follows:

Mr. Elmo Burke, St. Kitts Meteorological Service

Mr Burke welcomed all participants to St Kitts. He mentioned that this CariCOF brings together some of the smartest minds in meteorology and climate sciences from across the region together with key stakeholders from climate sensitive sectors. This gathering allows us to address the issue of climate change and increasing climate variability via the communication of early warning information. It also paves the way for future tailoring of products to sectors in an attempt to safeguard livelihoods and protect lives. The media training gained during the pre-CariCOF training equipped the scientists with a more effective way of communicating information to stakeholders.

Mr. Lester Arnold, Organization of Eastern Caribbean States (OECS) Commission

Mr Arnold expressed greetings on behalf of the OECS Commission and its Director General, Dr. Didacus Jules. The OECS has been working closely with CIMH over the last few years in an effort to

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build resilience against climate change. This partnership tackled the area of institutional capacity building, where the OECS was able to finance (i) the training of Meteorological Officers in their related discipline; (ii) weather station installation at all OECS member states airports; (iii) installation of hydro-meteorological stations in some of the OECS states; and (iv) installation of early flood warning systems in Dominica and Nevis (on going).

Mr. Arnold posited that Climate change is real and this has heightened the need to form and maintain partnership with CIMH. Climate variability itself is also causing havoc across the region as seen with this year's drought. This is the second time in the history of Antigua that the Potworks dam has gone dry.

Currently on the table is the question of having a drought management workshop in the coming year, where the focus would be to develop the drought management policies of all the OECS member states. This project began under the Brazilian Government grant and will be built upon.

Mr. Tyrone Sutherland, Coordinating Director of the Caribbean Meteorological Organization

Mr Sutherland, in his address, highlighted one of the roles of CIMH as the training arm of the Caribbean Meteorological Organization, which also provides climate services for the region. CIMH is currently in demonstration phase in being a WMO Regional Climate Centre.

A major component of the Global Framework for Climate Services (GFCS) is the hosting of Regional Climate Outlook Forums (RCOF) across the globe – CariCOF being the Caribbean version, which is a vehicle for collaboration across sectors in the region.

Ms. Brenda Boncamper, Permanent Secretary of Ministry of Public Infrastructure, Post, Urban Development and Transport

Ms. Boncamper welcomed this type of forum as she believes it to be timely and relevant for the region, with the assurance of CariCOF of more forecast products to its users. The Caribbean is filled with sharp and brilliant minds and it is heartening to know that we can rely on our own.

Kudos were given to those who were behind the re-establishment of CariCOF in 2010 and with this technology, the region is now equipped to respond to many disasters such as drought, hurricanes etc.

The island of St. Kitts has been in water crisis since earlier in 2015, one which has not been felt in over 30 years and thus has been a challenge for the water department. There is a desire for CariCOF, along with its partners, to continue to grow and remain relevant across the region.

Presentations

Dry Season Climatology of the Caribbean the 2015 Dry Season in the Caribbean, a retrospective (Dr. Cédric Van Meerbeeck, CIMH)

In his very informative presentation, Dr. Meerbeeck put the Caribbean dry season into perspective. Across the Caribbean, the dry season, which is marked by low thunderstorm and rainfall activity, generally extends from December to May. The timing of the dry season varies, however, across the

region with the start and end of the season being one month earlier in the Northern Caribbean compared with the south. The Guianas as well as Aruba, Bonaire and Curacao (ABC Islands) differ in their seasons, with the northern portion of the Guianas having two dry and two wet seasons and the ABC Islands having an extended dry season (with October to January usually wet).

The wet and dry seasons give rise to a marked variability in monthly rainfall totals, and higher temperatures are generally observed during the wet season.

Monitoring of the severity of the dry season is done via the use of Standardized Precipitation Index (SPI). The SPI is a tool for measuring the severity of drought and dry spells, with only rainfall as the input parameter. With the recognition that drought duration results in different impacts across sectors, the Caribbean Drought and Precipitation Monitoring Network (CDPMN) monitors drought at different time scales. For example, 1 and 3-month SPIs are good for monitoring agricultural drought, whereas 6 and 12-month SPIs are better for monitoring hydrological drought. The activity of the CDPMN proved useful during the 2009-2010 drought, alerting and advising Member States. The past dry season began as normal (December 2014 to February 2015) but drier than normal conditions developed in the second half of the season (March to May 2015). Drier than normal conditions persisted well into the traditional wet season, due to El Niño (which essentially leads to drying across the region with the exception of the northwestern Caribbean). This year's El Niño is categorized as one of the strongest on record.

Since El Niño is expected to persist into 2016, drought impacts are expected to worsen, potentially leading to water crises in parts of the Caribbean. Drought relief is likely as the El Niño is expected to weaken as the 2016 wet season approaches. Dr. Van Meerbeeck also cautioned that the drought relief, in itself may likely be accompanied by an increasing risk of flash floods and vector borne diseases.

Dry Season Climate Outlook – rainfall, temperature, drought, wet days/wetspells (Mr Elmo Burke and Ms Vincere Benjamin, St. Kitts Meteorological Service)

Mr. Elmo Burke and Ms. Vincere Benjamin of St Kitts Meteorological Service presented a review of the rainfall patterns of St. Kitts in 2015 as well as the forecasts for the 2015-2016 dry season before engaging in a panel discussion with stakeholders.

The 2015 rainfall patterns showed that St. Kitts received below normal rainfall totals for each month of the year up until October. The rainfall outlook for December 2015 through to February 2016 suggests below normal rainfall totals from the Northern Leeward Islands southward to the Guianas, contrasting the expected conditions from Puerto Rico westward to Belize.

The drought outlook up to the end of May 2016 recommended that the majority of the eastern Caribbean be placed under a drought warning (from the northern Leeward Islands south to Trinidad and Tobago). Most of the Guianas and portions of Hispaniola are also recommended for drought warning for this period. It was also noted that Puerto Rico, by the end of May 2016, could be in a drought emergency.

Some actions were suggested to cope with drought warning/emergency situation, based on the pre-defined action levels of the CariCOF drought outlook (Appendix II):

- Sensitize the public on the drought situation
- Enhance bulletins and public announcements
- Sensitize the public with the laws pertaining to water wastage
- Water services need to implement/intensify their drought management plan
- Water services need to continue to monitor reservoirs

With respect to the wet spells frequency outlook for the dry season, it is expected that the number of wet days will be below normal for the eastern and southern Caribbean but above normal for The Bahamas and Belize. This has implications for fewer disruptions in outdoor activities due to rainfall and an increase in surface dryness with reduced recharge of reservoirs.

The temperature outlook suggests above normal temperatures for the entire region. This would suggest increased evaporation rates, which could exacerbate drought conditions.

Panel discussion (Dr. Cédric Van Meerbeeck, Mr. Elmo Burke, Ms. Vincere Benjamin)

Stakeholder representatives discussed the current dry season outlook and made comments and posed questions to the panel.

Questions/Comments

Dr Neville Trotz (Caribbean Community Climate Change Centre):

- There is a drought watch for northern Guyana, however, recent studies suggest that there is severe drought in the south of the country. The Southern portion of Guyana is where the indigenous people reside and it is also where there is a lot of mining activity.

Dr Meerbeeck:

- We need data-driven evidence-based information services to deliver early warning. Rainfall records are not available to make forecasts for southern Guyana. However, advancements are being made with the Guyana Hydro-Meteorological Service to acquire data for this area.

Representative from Guyana:

- Conditions in southern Guyana are drier than in the north. There are issues with the loss of surface water within the Amerindian society, with a two-foot trail of water left. The south of Guyana is mostly affected by drought conditions.

Dr. Elizabeth Johnson (Inter-American Institute for Cooperation on Agriculture, IICA):

- When do we reach the critical point and how far away are we (in terms of drought crisis)? What are the managers doing?

Ms Veronica Yearwood (APUA, Antigua and Barbuda):

- We have reached a stage (in Antigua) where we no longer panic. We have sat down with the Government to find a solution to the situation. The island is now 90% desalination dependent.

Mr Alex Ifill (BWA):

- Nothing can be done. BWA has been replacing significant infrastructure and the country is 10% desalination dependent. There is a major challenge with saline intrusion, as well as unaccounted water. Most of the BWA current plans are not as a result of drought but rather for infrastructural repairs.

Dr Neville Trotz (CCCCC):

- The CCCCC has worked to install desalination plants in Carriacou, Petite Martinique, Bequia and Barbados using photo-voltaic generation to combat high costs. One issue faced is the changing weather patterns. Increasing rainfall runoff reduces aquifer recharge therefore the question of reconstructing aquifers to deal with these changing patterns might be useful.

Mr Danroy Ballentine (Central Water and Sewerage Authority, St. Vincent and the Grenadines):

- The Central Water and Sewerage Authority of St Vincent and the Grenadines have been increasing their water storage capacity via new tanks and reservoirs.
- There is some effort being made to include in policy for each home to have storage tanks

Mr Tyrone Sutherland (CMO):

- Mr. Sutherland is puzzled as to why water harvesting is not a major mitigation response in the Caribbean

Lester Arnold (OECS):

- Waste water reuse can help in augmenting water supplies as 90 percent of the water received is usually lost.

Lena Dempewolf (GWP-C)

- There is no rainwater harvesting policy in Trinidad and Tobago. Support has been given to start this within the schools. One of the largest challenges is people's perception with the idea of rain water harvesting.

Break out groups per sector Implications of forecasts and outlooks Recommendations

Participants were asked to discuss the forecasts and implications and recommendations as they relate to their sectors. They were grouped into three (water, agriculture and a mixed group with researchers and meteorological personnel). Results from the discussion are in [Appendix III](#).

CariCOF Theatre

CariCOF theatre has become a well anticipated event at CariCOF, where real-time issues are dramatized by some CariCOF members. This dry season's theatre was entitled "Miss the Water Before the Well Runs Dry", with the focus on 2015 and forecasted 2016 drought conditions..

Communicating Forecasts (Shireen Cuthbert, CIMH; Steve Menzies; David Eades)

Mr Adrian Trotman of CIMH and Mr Elmo Burke of St Kitts Meteorological Service along with other sectoral representatives, Mr Kevin Longsworth of the Belize Electricity Limited and Mr. Gusland McCook of the Jamaica Coffee Board, were interviewed by Mr David Eades of the British Broadcasting Corporation on climate services within the Caribbean region.

Towards the Development of Sector-specific Early Warning Information Systems Across Climate Timescales: Progress to Date (Dr Roché Mahon and Dr Dale Rankine, CIMH)

Guided by the Global Framework for Climate Services (GFCS) and financially supported through the The BRCCC program, CIMH and the region are working toward establishing sector-specific early warning systems across the Caribbean.

The presenters identified the GFCS's vision as "...to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to climate-related hazards" The GFCS targets five sectors – Agriculture and Food Security, Water, Health, Energy and Disaster Risk Management. Under the BRCCC program, tourism has been added as a sector of focus due to its sensitivity to climate and economic importance for the Caribbean.

WMO has proposed Climate Risk Management (CRM) to be:

"A systematic and coordinated process in which climate information is used to reduce the risks associated with climate variability and change, and to take advantage of opportunities, in order to improve the resilience of social, economic and environmental systems"

CRM has significant benefits to offer to the Caribbean region in supporting adaptation in both long and short term. CRM fits into the mandate of CIMH as it transitions to being a WMO Regional Climate Centre (RCC). CIMH, through its RCC provides relevant climate information that can benefit sectors.

An Early Warning Information System Across Climate Time Scales (EWISACTs) would generate and disseminate timely and relevant early warning information. This information would enable individuals, communities and organizations threatened by a climate hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. Another concept in EWISACTs is operating across climate timescales from daily, monthly, seasonal, decadal and centuries. It spans a full gamut of climate-related hazards, including extreme events.

The four key characteristics of EWISACTs are knowledge of the risks faced; technical monitoring and warning service; dissemination of meaningful warnings to those at risk; and public awareness and preparedness to act. Caribbean sectoral EWISACTs will contribute to the implementation of the GFCS through monitoring and long-range forecast products produced by CIMH and CariCOF (rainfall, temperature, drought and wet spell frequency - heat wave and flood potential forecasts will be added in the future.)

Sector participants were then invited to fill a survey in capturing sectoral needs.

Invitational Drought Tournament Introduction and Scenario Review (Mr Harvey Hill, AAAS Policy Fellow at IWR, USACE and Ms Shelly-Ann Cox, CIMH)

As the lead author of the peer-reviewed drought tournament article, Dr. Hill reported that the original drought tournament was developed in Canada at Agriculture and Agri-Food Canada and has been applied and further developed in Canada, the United States of America, Nepal and the Czech Republic.

The idea of the drought tournament is to engage persons to think about ways in which they could manage and prepare for drought situations. The structure of the tournament involves i) back-ground information about watersheds to various teams; ii) the game process, where players decide on management options, develop innovative techniques of mitigation and response to drought; and iii) the outcomes, where vulnerabilities and insights realized are used to inform research or potential next steps to proactively manage decisions on drought preparedness.

The CariCOF participants were able to indulge in a shortened version of this tournament. See [Appendix IV](#) for the scenario.

Belize Case of Climate Service to the Energy Sector (Ms Catherine Cumberbatch, Belize National Meteorological Service)

From October 30th to November 1st 2013, The National Meteorological Services of Belize, in collaboration with WMO and CIMH facilitated a National Consultation on a Framework for Climate Services in Belize under the framework of the GFCS. Representatives from the agriculture, energy, health, tourism and fisheries were in attendance. Resulting from this consultation, five priority steps were recognized in charting the way forward:

1. A platform for dialogue and engagement of key stakeholders of climate services
2. Capacity development
3. Demonstration of benefits of climate services
4. National Meteorological Services legislation
5. Inter-institutional co-ordination

Belize has held three successful National Climate Outlook Forums (NCOFs) since the national consultation, where the Meteorological Service provided stakeholders with rainfall, temperature and drought forecasts and discussed with them the implications of the forecasts for their sectors – a nationally downscaled version of the CariCOF.

Belize Electricity Limited (BEL) was one of the national stakeholders that attended the consultation and the NCOFs that followed. BEL uses the three month seasonal rainfall outlook produced by the Belize National Meteorological Service. However, the problems with the outlooks are that they are probabilistic and not site specific to the Chalillo Dam and supply catchment area that supply Belize with electricity through hydropower. The projections of the forecast do not reflect the quantity of rainfall nor do they indicate input flow from the supplying streams into the reservoir. Consultation between the Belize Meteorological Service and BEL lead to the development of a project in 2014 that would build customized products and services to the BEL. This is being made possible through a World Bank funded project, Energy Resilience for Climate Adaptation Project (ERCAP). This project

was designed to leverage climate data to guard against energy shortages and disruptions. The key components of the project are:

- Activity 1: Installation of hydro-meteorological stations and rain gauges in upper Macal catchment
- Activity 2: Upgrade in network of meteorological stations country wide
- Activity 3: Hydro-meteorology capacity building in radar interpretation
- Activity 4: Hydrological modeling of upper Macal Watershed
- Activity 5: Acquisition of a lightning detection system

The Potential for Early Warning System for Livestock – The Thermal Heat Index (THI) (Mr Cicero H. O. Lallo, Faculty of Food and Agriculture, The University of the West Indies St. Augustine Campus Trinidad and Tobago)

The Inter-governmental Panel on Climate Change (IPCC, 2007) has indicated that small island states will be hardest hit by climate change. Heat waves and extended drought periods can have a negative impact on non-adapted animals. The reoccurrence of heat waves must give rise to change in animal management systems and practices to enhance food and protein security in the Caribbean Community (CARICOM).

The direct effect of climate on reduced feed intake, growth rate and reproductive performance are due largely to heat stress. Heat stress also suppresses the immune system and increases animal susceptibility to various diseases. Haematological parameters such as the amount of red blood cells, haemoglobin, erythrocytes and packed cell volume are also affected by heat stress.

In developing an early warning Temperature Humidity Index (THI) system for livestock there is the need to adopt risk management strategies by first considering perceived thermal challenges and the potential consequences and respond accordingly to reduce the impacts of the challenges. Mitigating actions would include modification of the environment by: animal housing, provision of shade, sprinkling or active cooling. The suggested actions for moving forward include:

1. Characterizing and developing a THI zone map for the region based on THI similar to the rainfall pattern map created by meteorological bodies.
2. Developing a system for forecasting THI in an effort to develop an early warning forecast for livestock farmers.
3. Developing educational programs for extension officers (train the trainers workshops) and farmers of what THI numbers mean and what actions can be taken to attenuate the effect and reduce heat stress on the animals. This should also include nutrition and the management of animals at pasture.
4. Develop training program to have farmers adopt methods of forage conservation and how to meet the nutritional needs of their animals in a changing climate.

The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (Henry Reges, Colorado Climate Centre)

CoCoRaHS, established since 1977, is a network of volunteers who collect rainfall, hail and snow information. Mr Reges highlighted some important ingredients to having this type of network.

- It is necessary to have a data management system for the inflow of data
- Have user friendly website for users to ingest information.
- Training of observers so that they know what they are doing and why - observers should be reliable and committed to reporting also when no precipitation has fallen.
- Simple easy to handle low cost equipment.
- Spatial density is important. The more observers the better.

Closing Remarks (Mr Adrian Trotman, CIMH)

CariCOF was re-established in 2010 as result of the 2009-2010 El Niño. This re-establishment was supported by NOAA, WMO and IRI in collaboration with CIMH. CariCOF has since been recognized by WMO for the work done within this small region. Mr Trotman thanks the meteorological services for this achievement, not overlooking the integral collaboration with the sectors who think that we have something to offer. Mr Trotman also thanked all sponsors of this effort.

Mr Trotman announced that the intended focus for CariCOF in May 2016 would be health.

The forum was then closed with the launch and distribution of the first ever Caribbean Climate Models Calendar.

Appendix I: Attendee List

Country	Last Name	First Name	Country	Last Name	First Name
1 Antigua	Destin	Dale	22 CIMH	Cuthbert	Shireen
2 Antigua	Ford	Tammie	23 CIMH	Kirton-Reed	Lisa
3 APUA	Yearwood	Veronica	24 CIMH	Mahon	Roche
4 Aruba	Irausquin	Lothar	25 CIMH	Rankine	Dale
5 Bahamas	King	Arnold	26 CIMH	Scott	Wazita
6 Barbados	Blenman	Rosalind	27 CIMH	Stoute	Shontelle
7 BBC World	Eades	David	28 CIMH	Trotman	Adrian
8 Belize	Cumberbatch	Catherine	29 CIMH	van Meerbeeck	Cedric
9 BVI	Penn	Franklin	30 CIMH	Ward	Shamar
10 BWA	Ifill	Alex	31 CMC	Chance	Kenton
11 BZE Elec	Longsworth	Kevin	32 CMO	Sutherland	Tyrone
12 CaFAN	Abraham	Norville	33 CoCoRaHS	Reges	Henry
13 CARDI	Hall-Hanson	Rasheeda	34 CTO	Layne	Davina
14 Caribbean New Media Group	Wallace	Ean	35 Cuba	Hernandez-Sosa	Marieta
15 CARPHA	Clauzel	Shermaine	36 CWSA	Ballantyne	Danroy
16 Cayman Islands	Gall	Winston	37 Defence force	Comrie	Maj
17 CCCCC	Trotz	Ulric	38 Defence force	Maloney	Jason
18 CDEMA	Pierre	Donna	39 Disaster	Langley-Stevens	Claricia
19 CIMH	Applewhaite	Andrea	40 Dominica	Carrette-Joseph	Annie
20 CIMH	Boyce	Shawn	41 Dominican Republic	Viloria	Cecilia
21 CIMH	Cox	Shellyanne	42 DOWASCO	Williams	Magnus
			43 Energy Division	Williams	Clement

Country	Last Name	First Name	Country	Last Name	First Name
44 Environment	Parry	Eavin	65 MOA Guyana	Fredericks	David
45 Fire	Griffin	Lennox	66 Montserrat	Skerritt	Arlen
46 Flinch Marketing Ltd.	Hunter	Sarah	67 OECS	Arnold	Lester
47 Flinch Marketing Ltd.	McCormick	Hamish	68 Puerto Rico	Martinez	Odalys
48 Flinch Marketing Ltd.	Menzies	Steve	69 SLU MOA	Monero	Faustinus
49 Grenada	Miller	Trisha	70 St. Kitts	Benjamin	Vincere
50 Guyana	Williamson	Thieola	71 St. Kitts	Rohan	Didier
51 GWI	Canterbury	Donna	72 St. Kitts Water Agency	Greenaway	Shawn
52 GWP-C	Dempewolf	Lena	73 St. Kitts Water Agency	Parris	Charles
53 Haiti	Etienne	Emmanuel	74 St. Lucia	Willie	Shem
54 IICA	Johnson	Elizabeth	75 St. Maarten	Etienne-Leblanc	Sheryl
55 IICA	McCook	Gusland	76 St. Vincent	Neverson-Jack	Desiree
56 IICA local	Merchant	Augustine	77 Suriname	Mitro	Sukarni
57 IRI	Gawthrop	Elisabeth	78 Tourism	Morton	Novelette
58 Jamaica	Brown	Glenroy	79 Trinidad & Tobago	Kerr	Kenneth
59 Martinique	Gibier	Florian	80 U.S. Army Corps of Engineers	Hill	Harvey
60 Ministry of Education	Strawn	Olston	81 USA	Markovic	Marco
61 MOA Antigua	Bailey	Gregory	82 USA	Mason	Simon
62 MOA Bdos	Lucas	Charleston	83 UWI Carby	Bedward	Shanice
63 MOA Dom	Brumant	Ricky	84 UWI Taylor	Stephenson	Tannecia
64 MOA GDA	Fletcher	Kenton	85 UWI T'dad	Lallo	Cicero
			86 WRMA SLU	Engeliste	Mervin

Appendix II: CariCOF Drought Outlook Alert Levels and Actions

Alert Level	Meaning	Action Level
No Concern	No drought concern	<ul style="list-style-type: none"> ✓ monitor resources ✓ update and ratify management plans ✓ public awareness campaigns ✓ upgrade infrastructure
Drought Watch	Drought possible	<ul style="list-style-type: none"> ✓ keep updated ✓ protect resources and conserve water ✓ implement management plans ✓ response training ✓ monitor and repair infrastructure
Drought Warning	Drought evolving	<ul style="list-style-type: none"> ✓ protect resources ✓ conserve and recycle water ✓ implement management plans ✓ release public service announcements ✓ last minute infrastructural repairs and upgrades ✓ report impacts
Drought Emergency	Drought of immediate concern	<ul style="list-style-type: none"> ✓ release public service announcements ✓ implement management and response plans ✓ enforce water restrictions and recycling ✓ enforce resource protection ✓ repair infrastructure ✓ report impacts

Appendix III: Group Discussions on Forecasts and Outlook Recommendations

Agriculture

Question

1. **Is there more information that would be useful for agriculture that is not necessarily provided now or in the right format?**
 - a. Are 3 month forecasts enough?
 - i. Too short six month would be better for livestock and forage planting
 - ii. One to month forecasts for short crops
 - iii.
 - b. Can spatial distribution be improved?
 - c. The frequency and distribution of the precipitation
 - d.
2. **What are the implications of this forecast for your sector?**
 - a. The livestock industry needs to know what this information means for pasture management, silage, etc.
 - b. Food Security increased food insecurity
 - c. Fall in production yields lower exports lower lower foreign exchange
 - d. Increased soil erosion
 - e. Less fruits
 - f. More food imports
 - g. Decrease in pests but increased heat stress may decrease resistance implying increased disease
 - h. Irrigators with secure water would benefit
 - i. Livelihoods for rainfed producers will be lowered.
 - j. Increase of cost of production if irrigation needs to be installed but beneficial as amortized over a planning horizon.
 - k. Forecasts will allow for the potential for hedging of crop prices or imports
 - l. Potential Index drought insurance for producers
 - m. Quality of product will be reduced do to heat stress,
 - n. Some islands that are not affected by the drought might be able to increase revenue to export to drought stricken countries,
2. **How can we mitigate and adapt**
 - a. *Larger issue is water deficits are growing due to long term trends in increasing water demand in the Caribbean islands*
 - b. *How can we adapt current agricultural systems to address increasing water demands and shortages to ensure the agricultural sector can remain robust.*
 - c. *Island microclimates can lead to very different adaptation options due the relative precipitation on islands?*
 - d. Must be part of a policy planning systematic
 - e. What efforts are being taken to grow drought resistant crops and practices
 - f. Link the forecasts to production planning and market demand
 - g. Currently the varieties differences and drought
 - h. Water trading
 - i. Comparative advantage of crops may change

- j. Agronomic practices that preserve water
- k. Minimum tillage
- l. Green house technology,
- m. Mulching,
- n. Hydroponics
- o. Reforestation

3. Is there any important in your opinion you wish you could have to help with question 2?

- a. When and how often frequency when and how much
- b. Site specific information and the general island micro niches
- c. Stringent farm plans for water management
- d. Soil hydrology starting conditions
- e. Agromet bulletin for agronomic advice
- f. Yield projections
- g. Need more data for some islands
- h. Data quality, accessibility, and ability to communicate the information varies across the region due to data and institutional constraints,
- i. What do the Ministries use of the forecasts.

4. Are there any research needs in your opinion?

- a. Yes
- b. Research in water consumption
- c. Of the agricultural commodities and livestock and
- d. Water efficiency of unit of nutrition
- e. Cuba would like more weekly forecasts
- f. Not easy to say specific what actual decision options are available that will then inform what types of climate information.
- g. More inter-seasonal forecasts between seasonal and weather forecasts,
- h. Some work on decadal needs to continue
- i. What is stopping the application or use of this information
- j. What are the gaps to transferring the information,
- k. Need more education to the producers and extension officers in contexts that they can relate to.
- l. In programming agriculture development the information needs to be integrated and extension officers trained.
- m. Need to be able to explain how the information is economically useful and is worth adopting
- n. And how to help integrate late technology adopters.

5. How might we be able to mobilize national interests that support better planning for extreme climate events?

- a. The outcomes from these meetings should be conditioned by the participation of policy and planning staff to influence the finance ministry.
- b. A better availability of the information of the losses to livestock due to climate extremes,
- c. Show how this affects the electorate in terms of food prices and food security
- d. Show how it affects macro financial issues such as foreign exchange, exchange rate and import

- e. Need more producer organizations to support information needs identification and information dissemination.

Water

Water is a very diverse area covering surface and groundwater. It also covers northern areas like Belize with excess and countries like Antigua and Barbados with drought

Implications

Drought Declaration across most of the Caribbean

Impacts on tourism and economic impacts

Response

Water rationing

Trucking of water

Increased Desalination

Research

Hydrological Outlook

Belize: has been spilling excess water from dams: +ve for hydropower

1. Need to be careful on management of risk of opposite outcome
2. Have excess rainfall – spilling water from dam
3. How to forecast excess

St. Kitts

1. Water rationing – has caused new leakage
2. Limit water to cruise ships
3. Under forecast rationing continues
4. Increase overtime
5. Less income

Barbados

1. Might to officially declare drought
2. 10% reserve desalination

St. Lucia

1. Stakeholder consultation
2. Has drought committee
3. Drought must be declared by cabinet
4. Water Company may act to reduce usage
5. Produce Agronet bulletins

Antigua

Water storage required to approve building plans

Additional RO plants

Education on conservation –schools and public
Water rationing to population not cruise ships
Increased water rates

Trinidad

Storage tanks from public supply
Recently water rationing

St. Vincent

Two 0.5 million storage tanks
Drought committee to look at drought
Conservation in public buildings responsible for 60% water loss
Can reroute water from catchment to catchment

Need for sub-seasonal forecast

Hydrological outlook hindered by lack of data (physic-graphic data) – need research
Research in social sciences to see how the information is received and understood by stakeholders
Expansion of climate monitoring networks

Guyana

Trucking water has become the norm in parts of the hinterland

Mixed Group with researchers and meteorological personnel

1. Research and delivery.

- Risks need to be communicated using avenues such as the media (e.g. insert a climate forecast into the weather forecast)
- Have a more long-term mainstreaming through the educational sector with respect to risks and how to manage them
- Communication within groups differ, therefore there is a need to research how the stakeholders interpret information
- Research around the direct and indirect linkages between climate and sector productivity or outcomes (i.e. bush fires damaging poles – indirect linkage; CARPHA is pushing rainwater harvesting and storing at the household level and how it relates to vector borne diseases – how to mitigate; and how climate impacts the hotels and the tourist experience)
- Research on access to finance mechanisms (outside of government)

2. National coordination mechanisms for working together on climate issues

- Following a workshop in Barbados a consensus was made to handle climate issues under existing mechanisms due to constraints in resources (human and financial)
- There is no one size fits all. National stakeholders need to come together and decide how such mechanisms would work in their countries.

Appendix IV: The CariCOF Tournament Scenario

At a key meeting of Caribbean Heads of State, the Caribbean Development Bank, External Funders and the private sector signed an agreement to proactively prepare for drought. Three islands have been selected for a proof of concept pilot project: Cariba, Utopia and Elysium. Your goal is to minimize the environmental, economic, and social impacts on the islands given a budget of US\$15,000,000.00. You will present a press release based on the management plan your team develops.

The current drought situation:

- As a result of below-normal rainfall during the previous dry and current wet seasons, water shortages may occur in many portions of the Antilles.
- Nearly all islands are in longer-term drought (except the Bahamas and Eastern Cuba) as well as Western Belize.
- Strong El Niño in place. El Niño often results in a drier wet season and an early end to it (except for the northwestern Caribbean), and particularly so in the Southeastern Caribbean. This may lead to drought concerns towards the next dry season.
- Areas with existing water shortages may not see full recovery by the end of the wet season, in particular Barbados, Belize, central Hispaniola, Eastern Jamaica, the Leeward Islands, Trinidad and Tobago, US Caribbean Territories and the Windward Islands.