The Caribbean Regional Climate Outlook Forum (CariCOF)

Wet/Hurricane Season

Castries, St. Lucia

June 1st – 2nd 2015

Report

Prepared by CIMH and CariCOF

The gathering of meteorologists, trainers and representatives from climate sensitive sectors from across the region was the third of its kind for the Wet/Hurricane Season Caribbean Climate Outlook Forum (CariCOF). This forum followed on the heels of three and a half days of training for meteorologists by personnel from the Caribbean Institute of Meteorology and Hydrology (CIMH), the International Research Institute (IRI) and the National Oceanic and Atmospheric Administration (NOAA). During this training the possibility of incorporating coral reef monitoring for the Caribbean was explored.

Similar to other forums, representatives from the CIMH and the meteorological services presented the outlooks and engaged in discussion with the various stakeholders in an effort to improve products as well as their delivery in keeping with effective early warning.

This forum was held over two days at the Bay Garden Hotel, St. Lucia commencing on June 1st 2015- the beginning of the Atlantic hurricane season. See ***Appendix I*** for a list of participants.

1.0 Opening Ceremony

The 2015 Wet/Hurricane Season CariCOF officially got on the way with an opening ceremony where the Deputy Permanent Secretary of the Ministry of Infrastructure, Port Services and Transport in Saint Lucia; Director of Saint Lucia Meteorological Services; Chief of Applied Meteorology and Climatology of the CIMH; and the Director of the IRI gave opening remarks.

1.1 Adrian Trotman, Chief of Applied Meteorology and Climatology, Agrometeorologist, CIMH

Mr Trotman welcomed all participants to the meeting and thanked the many project partners for their support for this CariCOF. The projects include The Building Capacity to Manage Water Resources and Climate Risk in the Caribbean[1]; The Centre for Resource Management and Environmental Studies (CERMES), University of the West Indies (UWI); The CIMH; The Building Regional Climate Capacity in the Caribbean (BRCCC)[2]; The Program for Implementing the Global Framework for Climate Services (GFCS) at the regional and international scales; and the Voluntary Cooperation Program (VCP)[3], and the Program for Implementing the Global Framework for Climate Services (GFCS) at Regional and National Scales[4].

Mr Trotman brought greetings from the Principal of CIMH, Dr David Farrell, and apologized for his absence, as well as the Director of the Caribbean Meteorological Organization (CMO), Mr Tyrone Sutherland, both of whom were attending Congress of the World Meteorological Organization.

The wealth of support from the IRI with respect to training, to CIMH and the wider region has been very valuable and will continue to be valuable as developing regions often look forward for technical support from Global cutting-edge institutions, since technical capacity is lacking. He lauded the IRI for providing their support readily upon request. Mr Trotman thanked the meteorologists who put great effort into the previously held training, supported by climatologists from the IRI and highlighted that with the new products (Caribbean Coral Reef Watch, Extreme Rainfall Outlook) being introduced to the stakeholders will play an integral role in helping the CariCOF team in delivering such.

Mr Trotman noted that the wet and dry seasons present their own concerns, especially with respect to water availability, thus giving birth to the first ever Dry Season CariCOF in November/December 2014 in Antigua and Barbuda. This will continue in 2015 in another Caribbean drought prone country - St. Kitts and Nevis.

1.2 Vernantius Descartes, Director of Saint Lucia Meteorological Services

Mr Descartes welcomed participants on behalf of Saint Lucia's Meteorological Services and expressed his hope in having healthy discussions among stakeholders. Saint Lucia has been involved

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[1] Partnership made possible with the generous support of the American People through funds from the United States Agency for International Development (USAID) as managed by Higher Education for Development (HED). The implementation partners of this project are the International Research Institute for Climate and Society (IRI) of the Columbia University of New York., CIMH and the Centre for Resources Management and Environmental Studies (CERMES) of the University of the West Indies (UWI).

[2] Partnership between CIMH, USAID and The World Meteorological Organization (WMO)

[3] Partnership between the National Oceanic and Atmospheric Administration (NOAA), WMO and CIMH.

[4] Partnership between Environment Canada, WMO and CIMH.

with the CariCOF for a long time and hopes that everyone involved works together to meet the objectives of this CariCOF.

1.3 Dr Lisa Goddard, Director of the International Research Institute (IRI)

Dr Goddard mentioned that the Climate Outlook Forum (COF) process is a very important one as those within the region have also acknowledged this fact and have invested their energy in such. She lauded the CariCOF team as trail blazers, leading the way for COFs around the world. This Regional Climate Outlook Forum (RCOF) has developed products that other RCOFs around the world have not as yet. The development of the Drought Outlook and Drought Monitoring is now sparking the interest in other parts of the world.

The COF process is important not only for the information being provided, but also for capacity building among stakeholders within the region. The seasonal climate outlooks are critical to decision makers in planning. We will experience climate change one year at a time and thus the region will need to adapt one year at a time. She alluded to the fact that having good climate information that people can use across all timescales is important for climate change adaptation and resilience. The sustainability of this process lies in the fact that CariCOF is thinking about how to be relevant in the society that we live in along with having a strong and talented team working together.

1.4 Ivor Daniel, Deputy Permanent Secretary of the Ministry of Infrastructure, Port Services and Transport, Saint Lucia

In his speech, Mr Daniel welcomed all participants to Saint Lucia, the Helen of the West, and to the 2015 Wet/Hurricane season CariCOF. He was hopeful that those who engaged in the training workshop had a productive session. The effects of climate variability and change cause serious global issues and challenges and no island or nation can effectively tackle it on its own. Small Island Developing States (SIDS) like those in the Caribbean continue to suffer yearly from the devastating effects of hydro-meteorological hazards and severely hampering the process of development. Saint Lucia is very familiar with having to divert limited resources to rebuilding infrastructure after being impacted by hazards. Thus this nation understands the benefits and seriousness of the CariCOF and noted that partnerships need to be established and maintained for collective efforts at tackling climate variability and change through disaster risk reduction and other initiatives. Climate outlook forums are critical to the development and delivery of early warning systems and CariCOF provides training and builds capacity within the region. In Saint Lucia the products produced by CariCOF have been used in decision making in their flood and drought and early warning system. Mr Daniel expresses his contentment with the efforts of CIMH and their partners in having such a forum and he expects two days of healthy discussion among users and providers of climate information. He mentioned that he was looking forward to the unveiling of additional products.

2.0 Presentations

2.1 Wet/Hurricane Season Climatology of the Caribbean; the 2014 Wet/Hurricane Season in the Caribbean: a retrospective by Wazita Scott (CIMH)

The wet season across the Caribbean spans from May/June to November and essentially coincides with the Atlantic hurricane season. These two seasons have similar drivers, namely i) northward

motion of the Inter-Tropical Convergent Zone (ITCZ), ii) the strong northward motion of the sub-tropical high, iii) high Sea Surface Temperatures SSTs, as well as iv) tropical waves that migrate westward from off the West African Coast). Rainfall totals usually peak around September/October occurring when the SSTs are high and the ITCZ is at its northern most position. The retraction of the ITCZ and the decrease in high SSTs marks the end of the wet season and the beginning of the dry season.

Ms Scott presented a map of the climatology of rainfall totals (***Appendix II***) during June, July and August with the southernmost portion of the Caribbean (The Guianas) being the wettest and the ABC Islands and the area encompassing eastern Cuba, north-western Haïti and the Turks and Caicos Islands being the driest. However, during September, October and November rainfall totals increase northwards from the south of the region with The Guianas becoming drier. These months were presented as they coincide with the forecast period for this CariCOF.

With respect to temperatures, they generally rise with the progression of the wet/hurricane season.

In retrospect of the 2014 wet/hurricane season, SPI[5] maps for June to November showed that the majority of the Caribbean region was drier than normal. Despite this there were several impacts noted among some countries causing damage to infrastructure, loss in revenue, and even loss of lives: Turks and Caicos (Tropical Storm Cristobal); St. Vincent and the Grenadines (Tropical Wave); Antigua and Barbuda (Tropical Storm Gonzalo); Haiti, Dominican Republic and Puerto Rico (Flooding); and Jamaica, Belize, Guyana, Antigua and Barbuda (drought).

2.2 Wet/Hurricane Season Climate Outlook by Andre Joyeux, Saint Lucia Meteorological Services

Mr Joyeux presented the climate outlook for the region for rainfall, temperature, drought (***Appendix III***) and hurricanes. The precipitation, temperature and drought outlooks were produced using the CPT[6] v 14.7.6 tool in conjunction with global model predictions.

The precipitation outlook suggests that rainfall amounts for June to August are likely to be normal to below normal for most of the region except for The Bahamas. The longer lead outlook, September through November, also suggests similar for the region.

Normal to below-normal temperatures is most likely across Aruba, Trinidad and Tobago during June to August whereas all other areas are expected to be normal to above normal. The longer lead outlook for September through November suggests normal to above-normal temperatures for the entire region with the greatest certainty for anomalous warming expected over Cayman Islands and Jamaica and to a lesser extent in the vicinity of Trinidad and Tobago.

A drought watch is recommended for some of the territories of the Greater Antilles (a change from the previous outlook of no concern), the Leeward Islands and Northern Guyana. All other areas are considered no concern. The hydrological year (ending the end of November – also marking the end of the Hurricane Season) shows a marked improvement in water status across most of the region,

[5] Standardized Precipitation Index. An index which uses rainfall as its input and shows the degree of wetness or drying of an area.
[6] Climate Predictability Tool; developed and maintained by Dr Simon Mason (IRI)

but still suggesting some concerns over the Leeward and northern Windward Islands, with a possibility of warning status for St. Lucia. This must be closely monitored.

The predictions of the June to November Atlantic Hurricane Season by Dr Klotzbach and Prof Gray suggests a quieter season due to the development of the El Nino with seven named storms and three hurricanes, with one major (at least category 3) hurricane. Mr Joyeux cautioned participants that despite the prediction for a below normal hurricane season, some of the most destructive systems occurred during these "quiet" times – as it only takes one system to be destructive.

2.2.1 Discussion: Expected Climate Impacts from the Outlook (Facilitated by Adrian Trotman, CIMH)

Participants were invited to discuss the forecasts presented for the 2015 Wet/Hurricane season and the implications such a forecast would have.

Glenroy Brown (Jamaica Meteorological Services) stated that there is some concern regarding the prediction of a below normal rainfall season for their area. This could give rise to some water issues for 2016 if it continues as the country would be going into a dry season with lower than normal water reserves. The Meteorological Service will continue to monitor the outlooks and convene a meeting, if necessary, with the Ministers of Government to put measures in place.

> Mr Trotman alluded to the fact that this is similar to what transpired in the drought of 2009/2010 where the 2009 wet season was below normal, thus entering into the 2009/2010 dry season with below normal water reserves for the region. Concern did not surface until the wet season drew close to an end and the usual water amounts were not realised.

John Mwansa (General Manager Ag.) of the Barbados Water Authority (BWA) asked whether the outlooks would be able to say how much above or below normal a season is likely to be.

> Dr Cedric Van Meerbeeck (Climatologist, CIMH) in his response stated that using, for example, the precipitation outlook alone, the darker the red/brown on the legend, the more confident we are that the area will be below-normal and the degree of drying compared to average will be greater also.

Lisa Goddard (IRI) asked about the connection between the current drought monitoring and the drought outlooks. In the current drought outlook some of the areas which were previously tagged as drought watch are now displaying no concern even though the precipitation outlook is depicting below normal conditions for the same area(s).

> Dr Van Meerbeeck mentioned that the thresholds applied for the dry season would be different to that for the wet season. You need a smaller deficit of rainfall in the dry season to have a higher alert level. Even though we are in the wet season and the prediction shows a large shift to below normal, there will still be sufficient amount of water to support our activities.
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> Mr Trotman also reiterated that a moderate drought during the dry season will impact more than a moderate drought during the wet season due to the relative degree of drying. The greatest concern is the potential for impacts, rather than just the deficit in rainfall.

John Mwansa (BWA): if your wet season was wet and your dry season is dry, does that constitute a drought?

> Mr Trotman stated that the drought outlook utilizes information on the rainfall of the previous two months (already measured rainfall) and a four-month forecast. So there is a combination of what we know and what is forecasted for rainfall to make the drought outlook. Thus the outlook will look different to the current one (where the wet season is expected to be below normal) if the wet season was normal to above normal.

Anthony Herman (Belle Vue Farmer's Cooperative) was interested in the feasibility of obtaining information at least two years in advance to facilitate planning.

> Dr Van Meerbeeck in his response stated that drought is a seasonal problem in the Caribbean and is not easy to predict beyond one season.

Kenton Chance (Caribbean Media Corporation, CMC) requested the precipitation outlook for the region to be communicated to the media audience in layman's terms and state the impacts such an outlook would have on the productive sectors in the region. Mr Chance also queried whether what we are seeing now is as a result of climate change, or some other phenomena.

> Dr Van Meerbeeck responded with an explanation of the outlooks. He stated that we can expect that the temperatures will be higher throughout the entire region and in this case may not feel as hot because of the drier air being present. Owing to the presence of drier air there will possibly be fewer wet spells and showers, and thus less accumulation of rainfall throughout much of the region, except for The Bahamas. The cause of such activity is shouldered by the development of the El Nino, which suppresses rainfall activity in the Caribbean. However The Bahamas, during an El Nino event, tend to have the opposite outcome. With respect to impacts, a drier than normal wet season will raise concern for the upcoming dry season. During the dry season there is a great demand for water from tourism and agriculture and also for extinguishing fires. The advantage of having this information allows for early preparation for what could possibly take place later.

Howie Prince, Director of National Emergency Management Organisation (NEMO) raised a concern of the disclaimer which CIMH placed on its outlooks that the institute is not an official forecasting agency. As disaster managers are responsible for disseminating information to save lives as it pertains to early warning, they need to be able to quote the source of the information they are providing.

> Mr Trotman stated that CIMH is not an official forecasting entity. However, as a regional agency CIMH has a mandate to support National Meteorological and Hydrological Services (NMHSs) with climate information, including climate early warning. With respect to weather forecasting each country has its own NMHS and in the case of St. Vincent and the Grenadines, they are supported officially by the Barbados Meteorological Service. These national services have the responsibility, which can include taking information from CIMH, for advising or alerting their public.

2.3 NOAA Coral Reef Watch (CRW) Coral Bleaching Alerts by Mark Eakin, PhD. (NOAA)

Dr Eakin's presentation began with discussion of the importance and decline of coral reefs. Coral reefs have economic value in food security, tourism and shoreline protection from strong waves. Land based pollution from run-off, fishing and climate change are factors impacting coral reefs. In his presentation, Dr Eakin's focus was particularly with respect to coral bleaching.

When corals are stressed by factors such as high temperature, corals eject algae from their cells, which give them their colour and provide them with nutrients. As a result, the coral looks white or bleached. If the stress continues the corals will eventually die. The corals are however able to rehabilitate if the stress is removed. To this end Coral Reef Watch (CRW) has developed products, with a resolution of 5 kilometres, to assist in monitoring reefs for bleaching incidences due to high temperatures, using geostationary satellites.

A series of products are developed using satellite information that includes Sea Surface Temperatures (SST) and anomalies, Hotspot, Degree Heating Weeks. From these, bleaching alerts can be issued suggesting imminent bleaching. There is also an outlook provided up to 16 weeks in advance. A number of bleaching events were identified over the past years, including in the Caribbean, and particularly coinciding with El Nino events. Frequent thermal stress events mean that corals would have little time to recover between events. Some of the bleaching events identified occurred in 1990, 1995 (more serious event), 1998 (associated with El Niño), 2005 (biggest coral stress in the Caribbean when USVI[7] experienced 90% bleaching) and 2010 (Southern Caribbean impacted).

With the emergence of El Niño in March 2015, major bleaching is possible in the Caribbean. This may not be the biggest of events but some impacts are likely and this is cause for concern. Generally, bleaching impacts are observed in the Lesser Antilles late in the calendar year (from September to October). The outlook suggests significant enough warming in the vicinity of The Bahamas in about 12 weeks (i.e. around August). The NOAA CRW can provide relevant products for monitoring and forecasting bleaching events. The current 5km products can zoom in to a fine scale to provide relevant products for a given island.

Staff of the NOAA CRW is willing to support CariCOF and Caribbean countries in generating an outlook newsletter similar to that produced for the Pacific COF with monthly updates starting from May/June in each year and ending in December.

2.3.1 Questions/Comments:

Below are questions/comments from the stakeholders to the presenter.

Ivan Rodrigues, of the Antigua Public Utilities Association (APUA): queried the expected temperature increase. Whether 1-2 °C or 10-15 °C.

> Dr Eakin: It takes just a 1°C rise above the normal warmest month of the year for bleaching to occur. Ocean temperature anomalies, for the most part, range from 1-2°C.

Dr John Mwansa of the BWA: What is the connection between coral bleaching and fisheries?

[7] United States Virgin Islands

Dr Eakin: Impacts are not immediate after an event (1-2 years after). There can be reductions in fish food on reefs resulting in shifts in variety of species in subsequent years.

Jeffrey Jennings, Anguilla: What can scientists do to make coral adaptable to heat change?

Dr Eakin: There is not much that can be done other than managing other stressors thereby reducing the impact due to thermal stress. However, there is some on-going research looking into reducing the effects.

Lester Arnold of the OECS[8] Commission: What is the correlation between bleaching of coral and ocean acidification?

Dr Eakin: There is a big interaction. Both warming and ocean acidification have the same root cause and carbon dioxide and ocean acidification makes it harder for coral to grow. Ocean acidification breaks down coral reef making it more susceptible to bleaching. Continuous monitoring of oceanic conditions and the effects of ocean acidification and carbon dioxide levels is ongoing.

Walter Baethgen, IRI: What response plans are there for short term?

Dr Eakin: Local based mitigation actions to ensure reefs resilience to effects such as shading and cooling of reefs. Early warning information is provided to aid in mitigation. Continued monitoring of reefs will locate resilient areas and aid in the protection for next event.

Anthony Herman, Belle Vue Farmers Corporation: Do you have a scale from 1 to 10 with impacts farmers cause on Coral Bleaching?

Dr Eakin: Negative impact. Poor land use often results in sedimentation.

Through understanding the linkage between food production and tourism, Mr Herman mentioned a ridge to ridge project which uses fertilizers more efficiently, reducing impacts by ensuring cleaner rivers.

Shelly-Ann Cox, CIMH: What would participants like to see added in a draft newsletter?

Some participants wished for the presented outlook to be comprehensive. Other participants would like to see finer detail with respect to scale. Areas that are likely to experience high bleaching would be necessary and also give idea of areas to visit for restoration and threats of local sources of runoff.

Kareem Sabir, Barbados Coastal Zone management Unit. Is a 5 km resolution suitable for Barbados?

Dr Eakin: 5km resolution is the best available now. Although a 1 km would help even further, satellite timing and overpass currently does not allow for it.

Roché Mahon, PhD, CIMH: Are there any examples of products tailored for stakeholders who are not technology savvy, e.g. for tailoring for the tourist industry?

[8] Organisation of Eastern Caribbean States

Dr Eakin: Currently there are no products. However, divers understand the present products. They assist with volunteered surveys and the dive operators communicate the information to tourists and other divers.

2.4 Sub-seasonal Forecast Product (extreme rainfall) by Dr Cedric Van Meerbeeck, CIMH

Dr Van Meerbeeck proposed two new products[9] of the CariCOF, which focus on contextualizing precipitation outlooks. He first began by highlighting the impact of extreme rainfall during the wet/hurricane season and the benefit of such forecasts.

During the wet/hurricane season there is concern of flooding and damage to infrastructure. This damage does not occur with the accumulation of rainfall over three months but it usually occurs from wet spells over a few days. To obtain more pertinent information on what rainfall will do there is need to go beyond just looking at an overview of the total rainfall totals in the next three months. There will be different sectoral impacts for different durations and amount of rainfall.

Given the previously presented three month precipitation outlook for June to August, the region is likely to receive less than normal rainfall amounts. However, there is other information that can be provided to assist with decision making. The language however, must be understandable and salient, meaning the information provided should be pertinent to the stakeholder. Essentially, in contextualising the outlook, forecasts can be improved to best inform Climate Early Warning through scientific research by looking at the risk the climate poses; rainfall occurrences and intensity; and wetness/flood potential alert.

One of the new products presented was an outlook for frequency of wet days. This is essentially a forecast of how many wet days[10] are likely within a season. The frequency of wet days within a season can tell you whether there will be a good spread of rainfall throughout or a concentration of wet days with a series of dry spells in between. Rainfall in a wet season would be deemed to be well spread if the frequency is high or it is concentrated if the frequency if low. Scant rainfall in a dry season is deemed to be spread if the frequency is low or it is concentrated if the frequency is very low.

Another new product introduced was the 7-day wet and very spells outlooks. This is a seven day period with precipitation within the top twenty per cent, resp. top ten per cent of the historical record. This outlook also suggested a below normal number of such extreme rainfall events across the region. The forecast can also be tailored for precipitation within the top ten per cent however; the certainty of such a forecast would be reduced and probabilities would be lower.

Combining the precipitation outlook, the wet day outlook and the 7-day wet spell outlook for June through August one could conclude that rainfall for the region is expected to be below to normal with fewer wet days and wet spells than usual. The implication of such a forecast would be a reduced potential for floods for the region, with the exception of The Bahamas.

Dr Van Meerbeeck reiterated the need for stakeholder feedback in identifying thresholds, what kind of wet spells are most impactful, and timescales.

[9] Proposed outlooks can be viewed here

[10] A wet day was defined as a day with at least 1 millimetre of rainfall

2.4.1 Questions/Comments:

John Mwansa (BWA): Expressed his gratitude in a product that finally points in the direction of the water managers. With such a product the water managers would be able to determine, with the number of wet days predicted, whether water requirements would be met for the season.

Anthony Herman (Bell Vue Farms, Saint Lucia): How do you simplify this information for farmers?

> Mr Trotman (CIMH): The communication of such information is something we want to look at in greater detail in the future, but with the assistance of a communications specialist. What we are seeking to do now is to develop early warning specific to certain sectors. That is, identifying thresholds.

Sherod James (Antigua and Barbuda Disaster Preparedness Agency): Would like to see a suite of products at the disaster level, such as drought extent and intensity leading up to the hurricane season, level of damage during storms etc.

Shawn Boyce (Chief Hydrologist, CIMH): Urged caution on looking at wet spells and flooding as there are many other characteristics to be considered. Interest should be on doing a retrospect forecast across the region of flood events and see how they compare to the wet spells.

> Adrian Trotman (CIMH): In agreeing with Mr Boyce, and because other characteristics such as land use are not taken into account, we then use the term flood potential rather than flood risk.

Leslie Simpson, CARDI: Interested in the product since it directly relates to agricultural drought, since the sector looks at replenishing rooting zone rather than aquifer. He queries whether the product can be done on a monthly basis as oppose to three months. There needs to be an understanding of frequency of rainfall on a monthly basis so that the farmer can relate it to soil type and crop.

> Simon Mason, PhD. (IRI): More research would be necessary as to what timescale the quality of the forecast deteriorates; as it becomes too dependent on random differences (i.e. the forecast becomes noisy).

Stakeholder from the Global Water Partnership, GWP: raised the possibility of the model being more interactive.

> Dr Van Meerbeeck: To provide customizable products, there must be a sectoral approach. Automation, online products/systems need to ask more specific questions. There needs to be a clarification of what is needed via automation.

2.5 CariCOF Theatre

CariCOF Theatre, the third of its kind featured participants from the CariCOF member states in drama and dance. The drama was entitled “The Great Castries Flood of 2015” and demonstrated how effective an early warning system could be in the event of a climate related hazard.

2.6 The Development of Sector Specific Early Warning Information Systems Across Climate Timescales (EWISACTs) by Roché Mahon, PhD. (CIMH) and Dale Rankine, PhD. (CIMH)

Dr Rankine opened the presentation by mentioning that Caribbean EWISACTs should have the right temporal and spatial scales with tailored products that are delivered in a timely manner. This work is being done under the Programme for Building Regional Climate Capacity in the Caribbean (BRCCC Programme). The sectors of focus go beyond the four Global Framework for Climate Services (GFCS) priority areas – agriculture and food security, water, health and disaster risk reduction – to include tourism and energy given their importance to the Caribbean.

The concept of the EWISACTS was explored:

- It integrates information that will help early warning and decision making.
- Products presently used and the sectors they have been tailored for.
- Some progress has been made, but still a lot of work has to be done.

The SPI monitoring and outlook products can be related to agriculture and water management as the durations of the SPIs impacts thee two sectors differently. However, in respect to the other climate products, they can be packaged in such a way than can be more beneficial to the sectors. There is still much work to do in tailoring all products and services for the sectors.

An Early Warning System (EWS) consists of the set of capacities to generate and disseminate timely and meaningful warning information to enable individuals, communities, and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. This is the aim of the sectoral EWISACTs.

Dr Mahon began her portion of the presentation by highlighting that the five-pillar approach of the Global Framework for Climate Services (GFCS) is the framework in which climate services are delivered (***Appendix IV***). These five functional components or pillars of the GFCS address the entire chain for the production, management, delivery and application of climate information and services. It is therefore the Caribbean's starting point for organizing our thinking around what could be the structure of sectoral EWISACTs since sectoral EWISACTs will contribute to the implementation of the GFCS.

Dr Mahon continued by saying that we need to recognise that similar parallel structures and systems also exist in each climate sensitive sector. For example, in the tourism industry, one would find the sectoral equivalent of the CSIS encompassed in the tourism sector's Management Information System for Tourism (MIST). For health, CARPHA coordinates a Regional Public Health Information System with data on variables that are important to the sector coming from the national surveillance network and feeding into a centralized information repository known as the Caribbean Surveillance System (CARISURV). So there is a need going forward to map each of what would now be 10 pillars – 5 that are provider driven and 5 that are user driven. Doing this allows for the identification of the best entry points for the climate service pillars to connect and integrate with what is already going on

in each climate sensitive sector. Eventually, this generalised 'dual structure' is expected to be integrated and tailored into one cohesive sectoral EWISACTs design.

Caribbean sectoral EWISACTs are built around three core principles that inform a six-step methodological approach (***Appendix V***). Each step of the methodological approach has been carefully chosen to address the gaps that have been previously identified. One significant part of the first step of establishing ownership mechanisms was the establishment of the Consortium of Regional Sectoral EWISACTs Coordination Partners comprising of regional level sectoral partners (CARDI, CWWA, CDEMA, CARPHA, CARILEC and CTO/CHTA) that represent each of the six climate sensitive sectors along with the CIMH. This Consortium had its first meeting May 6-7, 2015 where discussions were had concerning the draft Conceptual Framework and Methodology, as well as, draft Terms of Reference for the Consortium and for sector specific responsibilities. The Consortium also discussed a draft Work and Implementation Plan (WIP) for the next eighteen months (ending January 2017). There is the hope that by January 2017 progress would be made in four Outcome Areas; (i) establishment of relationships between meteorologists/climatologists, scientists from other sectors and policy makers from across sectors, (ii) development, deployment and platform integration of sector-specific forecasting/planning models in the form of early warning systems, (iii) enhanced institutional capacity and (iv) enhanced adaptive capacity.

Dr Mahon emphasised that the sectoral EWISACTs agenda which seeks to deliver climate services to six climate sensitive sectors in the Caribbean could possibly lead to the development of a Caribbean Framework for Climate Services (CFCS). The CFCS would:

1. Provide a strategic long-term (10-15 year) approach to regional and national level implementation of the GFCS in the Caribbean;
2. Connect existing international frameworks and bring them in line/integrate with regional priorities;
3. Provide a mechanism for creating an agenda/vision that is of direct relevance to Caribbean territories;
4. Respond to the need for sustainability of initiatives; and
5. Promote regional ownership of the climate service agenda.

Such a framework will be developed through consultation and collaboration with sectoral, national, regional, donor and other relevant representatives. In going forward, the CFCS would have to be complemented by a Monitoring, Evaluation and Reporting (MER) framework. A MER is necessary for measuring impacts, thus providing the evidence base for the usefulness of climate service interventions.

Participants were then asked to participate in the Caribbean Climate Services Baseline Survey which was launched to seek to baseline users and their needs.

2.6.1 Questions/Comments:

Justin Sealy, Saint Lucia Water and Sewerage Co. Inc.: Have you considered tailoring information for civil engineers?

Dr Mahon: In designing sectoral EWISACTs we do recognize that within each sector there are smaller disaggregated groups. It is very complex but we are thinking about it going forward. There is no concrete plan of action as yet, but we are looking to get there.

2.7 Break-Out Groups (Facilitated by Adrian Trotman, CIMH)

Stakeholders were grouped by sector and asked to discuss the implications of the forecast and outlooks. These questions asked fuelled the discussion:

1. What are the implications of the 2015 outlook for your sector?
2. How will the new products benefit?
3. What other information would you like to see and on what timescale?

See ***Appendix VI*** for the responses.

In summary of the session Mr Trotman urged stakeholders to always relate the outlook to the season they are in, as impacts depend on the time of the year. Droughts in the Caribbean, for example, are seasonal and largely associated with extended and/or intense dry seasons. The rains for 2015 will begin at some point during the wet season, but there is the concern of less rain during, and/or an early end to, the wet season.

DAY 2

2.8 Climate Impacts Database (CID) Validation Workshop

Day two of the CariCOF assembly mainly focused on the Climate Impacts Database (CID) validation where participants were given an overview of the development process of the database, and invited stakeholders to work hands-on with the tool. The successful launch of the CID (version 2) took place later that evening at the Bay Garden's Inn with the Deputy Permanent Secretary of the Ministry of Infrastructure, Port Services and Transport of Saint Lucia, CariCOF participants, and media personnel in attendance.

2.9 From Roots to Results: The Caribbean Climate Impacts Database (CID) by Shelly-Ann Cox, CIMH

The CID is an open-source geospatial, online inventory of historical impacts (meteorological, hydrological, hydro-meteorological). The repository contains impact data for 17 Caribbean countries with some records dating as far back as 1780. The CID also has a sectoral focus and archives impacts affecting five climate sensitive sectors – agriculture and food security, water, disaster risk management, health, energy and tourism. It addresses the disconnect between climate and disaster impacts and the response to impacts at the national and sectoral levels by the inclusion of available response mechanisms and standard operating procedures.

Its functionalities lend to the ability to perform queries on such impacts per country, region/district as well as access responses to the impacts and basic analysis. The data repository for 17 countries was populated via data from CDEMA, DesInventar[11], national databases, as well as data mining on various websites and documents.

[11] UNISDR Disaster Information Management System

Ms Cox used the analogy of a tree and bearing fruit to describe the development process of the CID. She began the presentation focusing on the roots and the steps taken to anchor the development process and facilitate the production of valuable outputs. First detailing the steps in the CID development concept, then outlining how stakeholders were engaged to seek their input into the development process. Data collection methods were highlighted and main sources of data were presented.

The watering aspect of the analogy focused on the technological developments. A brief overview was given of the Information and Communication Technology (ICT) development process. This process included choosing a robust database management system that can be sustained and facilitate the development of a web based user interface.

The presentation concluded with an outline of the outputs or fruits that were produced. These three fruits were the development of a decision support system for climate sensitive sectors, a regional network of impact reporters and increase capacity.

2.10 CID Standard Operating Procedures by Shelly-Ann Cox, CIMH

The rationale for developing the Standard Operating Procedures (SOPs) for the CID was (i) to provide guidance on the correct procedures of reporting impacts; (ii) inform users of the strategy for development and plans for the future; (iii) standardize actions to ensure quality of data; (iv) be a reputable platform to be used by the research community and; (v) maintain the integrity of the CID and its sustainability.

These procedures were developed under five main headings- data submission, reporting mechanism, user access, monitoring and evaluation and sustainability.

Data submitted to the database is validated before being published to the CID. This ensures that all data is standardized. With respect to the reporting mechanism of the CID, it can occur at three levels - regional, national and community. User access is also on three levels where one can act as a viewer, reporter or researcher. Under the monitoring and evaluation heading, both quantitative and qualitative methods were highlighted. The presentation concluded with the overview of the sustainability concept of the CID which features an iterative process of research, data ingestion, product delivery and integration into EWISACTs.

2.11 CID Tutorial Exercise (Facilitated by Daison Lowe, CIMH)

Before facilitating the tutorial exercise Daison Lowe, IT specialist at CIMH, gave an overview of the technical aspects of the CID. He outlined the technical details such as the programming languages and open sourced software used to develop the application. He also presented a schematic of how the CID works when a query is made and when an impact is reported by a user. The process of designing and ensuring the functionality of the user interface was also presented.

Participants were given a step-by-step outline of the features of the CID web-based interface, via a tutorial session. They were invited to register by means of email before exploring the CID's functionalities. Some challenges were experienced by the participants during the tutorial were difficulties entering dates, the overload to the CIMH server and slow Internet speed due to the number of participants using the application. Although these challenges were experienced, participants were still able to complete the tutorial session and the quiz.

2.11 Operational Use of the CID (Facilitated by Shelly-Ann Cox, CIMH)

After the lunch break, participants were invited to divide into six groups to take part in an interactive exercise. Each group was given a scenario of fictitious climate related event. They were encouraged to discuss what actions they would take to prepare for the event, how they would respond when the even took place and how they would report the impacts that occurred. This exercise helped participants to understand the importance of the CID and how it can be used to support their operational duties.

2.12 International Research and Applications Program: Integrating Climate Information and Decision Processes for Regional Climate Resilience, by Dr Lisa Goddard, IRI

Since May 2014, the IRAP project has been supporting the activities of CariCOF. IRAP is a research and applications project in year two of its five years, being implemented in the Caribbean, West Africa and the Indo-Gangetic Plain. Apart from supporting CariCOF, IRAP, along with the Inter-American Institute for Cooperation in Agriculture (IICA), The Coffee Board of Jamaica and CIMH, pilots a Coffee Leaf Rust (CLR) project in Jamaica. This pilot project is meant to demonstrate the support of climate services in managing climate-sensitive problems – in this case the disease coffee leaf rust. It is hopeful that through this same approach could be scaled down to other parts of the Caribbean as CLR affects plants not only in Jamaica but around the world. It is further hoped that the entire approach can be used to serve other problems in other climate-sensitive sectors.

Listed below is the five pillar approach of IRAP, and the outcomes of the CLR Project as an example:

1. Identify Vulnerabilities and Opportunities in Climate variability and change in collaboration with “Stakeholders”;
    - Harvesting, fertilizer and pesticide applications all occur at differing times differ between low and high elevation farmers. This shows vulnerabilities between the two different communities.
2. Understand/quantify/reduce uncertainties;
    - Climate monitoring and prediction done via Jamaica Meteorological Service. This can be fed into CLR management and prediction.
    - Temperature affects germination on plants, how readily CLR attacks the plant, and is also a factor on the effectiveness on fertilizer and fungicides. Temperatures greater than 22 degrees Celsius has been determined as a threshold for CLR.
    - Fungicides can kill CLR is applied in time. However, money is wasted if it rains after application.
    - Plants are more resistant if well nourished. However, fertilizer is more effective with good rains.
3. Identify interventions (technologies that reduce vulnerability);
4. Identify policies and institutional arrangements that reduce vulnerability and/or transfer risks and;
    - Ministers in Jamaica on the Climate working group were already on board with the project on the outset. They created a partnership between the Ministry of Agriculture and the Meteorological Service.
5. Design evaluation at outset of targeted interventions and engagement.

2.13 The role of the CID in the DRM Early Warning Information System across Climate Time Scales (EWISACTS) by Roché Mahon PhD., CIMH.

In her presentation, Dr Mahon looked at the sustainability of the CID. She gave an overview of how it has, through its development in Phase I, provided key solutions with regard to reporting impacts of climate variability and change, and proposed how to build on these solutions going forward in Phase II.

In Phase I of the CID development, it has filled several gaps that haven been identified:

i. Lack of systemic, centralized inventory of climate impacts
   - CID provides the concept, methodology and software that underpins a system of collection, query, retrieval, and (basic) analysis of information about climate impacts based on pre-existing official data in 17 Caribbean countries

ii. Missing sectoral focus of climate impacts data
   - Impacts data available on 5 climate sensitive sectors

iii. Under-representation of heat wave impacts
   - Inclusion of heat wave as a climate impact category

iv. Disconnect between impacts and response to impacts
   - CID links impacts with response mechanisms (e.g., national operational practice; CDEMA Standard Operating Procedures)

v. Lack of geo-referenced climate impacts
   - Impacts are linked to high resolution spatial context

Following the launch of the CID, gaps in Phase II of CID development that will now be tackled include:

i. Augmenting the historical archive with data presently “trapped” in paper and web-based sources
   - CID will pursue a data harvesting methodology that will retrieve and integrate data from paper and web-based sources

ii. Under-representation of positive climate impacts
   - CID will include both positive and negative climate impacts

iii. Lack of seamless integration of impacts reporting in response and recovery phases
   - Integration of inventory of impacts reported in the Caribbean Dewetra platform (an overarching disaster management platform) with the CID

iv. Weak linkages between climate information, impacts and concrete action
   - Underpinned by the necessary research, a new interface tool linked to the CID interface will be developed and will enable sector users to link current forecasts to appropriate mitigation and response strategies

v. Generic issues re: data integrity and data standardization
   - Re-examining and strengthening CID protocols around meta-data and the standardization of spatial datasets

There is a need to promote a better understanding of the utility of the CID amongst potential users (what it can offer, how to use). Another mode of outreach would be working with the disaster risk management community to integrate the CID into response and recovery mechanisms.

In closing, Dr Mahon emphasised that the CID is a solution that is 'born and bred' in the Caribbean. Both CIMH, as well as, sectoral and other users have a vested interest in iteratively making the database better. CIMH is committed to the CID's improvement and the process will continue in partnership with users.

3.0 Closing Remarks/ The Way Forward (Adrian Trotman, CIMH)

In his closing remarks, Mr Trotman noted that the CID, when conceptualized, was just a data impact archive. It was subsequently merged with another activity related to drought and extreme rainfall. Thus later in the day would be something larger than was envisaged two years ago. The success of this database is greatly attributed to Ms Shelly-Ann Cox of the CIMH who engaged with stakeholders to make the database what it is today.

Mr Trotman also thanked stakeholders in their engagement over the past two days and there is now much to work on in providing climate products. CIMH and the Meteorological Services of the region will continue to work with its international partners, particularly the IRI to continue to develop and tailor new products. He also noted that CIMH is virtually guaranteed CariCOF funding until the end of 2016 – implying that there should be at least three more CariCOF sessions. He also anticipates that the CariCOF of May 2016 will have a health focus. He wished all safe journeys back to their homelands.

4.0 CID Launch Reception

Eighteen months of development culminated with the launch of the Caribbean CID at the Bay Garden Inn, St. Lucia. The new application that provides an evidence-based information archive that supports the forecasting and modelling of climate risks was official launched on the evening of the 2nd June. Mr Ivor Daniel, the Deputy Permanent Secretary of the Ministry of Infrastructure, Port Services and Transport in Saint Lucia endorsed the CID and expressed his hope that this new tool would support regional growth resilient to climate risks. In his remarks, Dr Walter E. Baethgen, Project Director, and Head of the Regional and Sectorial Research Program for Latin America and the Caribbean at the IRI commented that the impacts database represents a significant step forward to address the lack of data in the region.

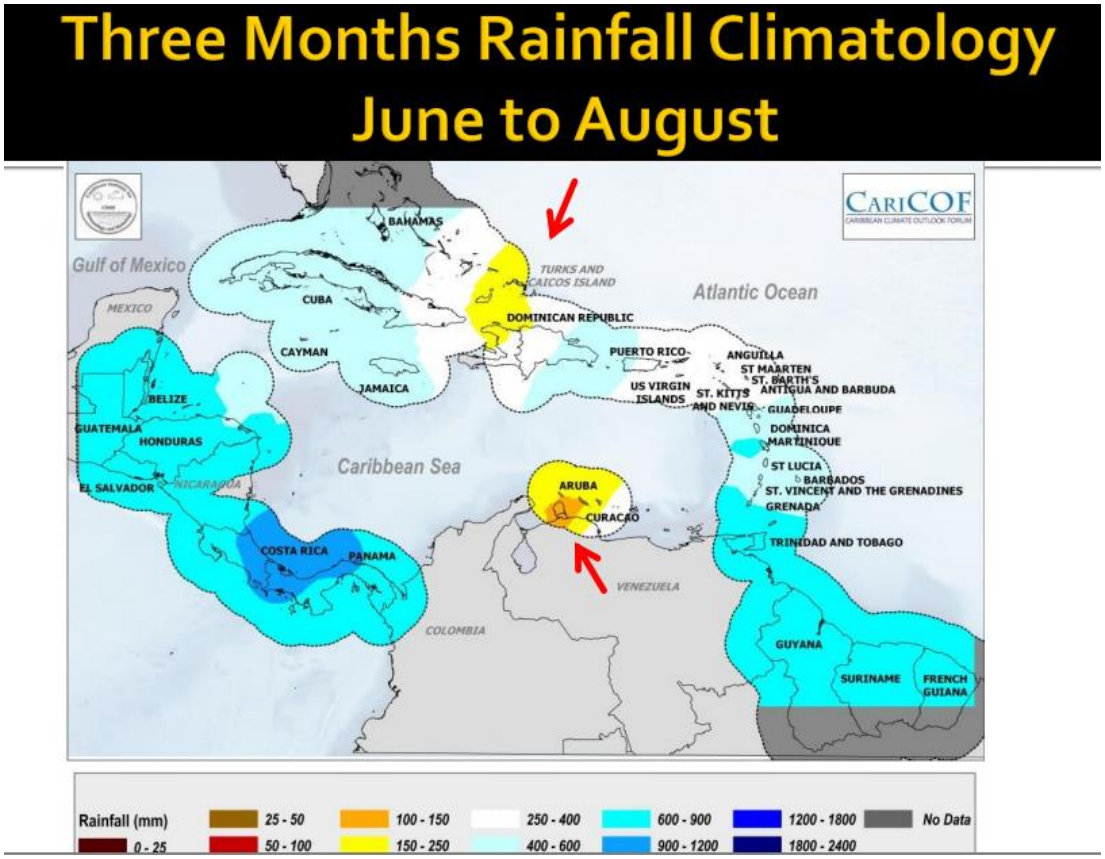
After the formal launch, persons attending the launch were treated to climate impact themed cocktails and cupcakes which were good conversation starters for networking.

Appendix I: CariCOF May/June 2015 Attendee List

	Last Name	First Name	Country
1	Aaron	Arlene	Trinidad & Tobago Meteorological Service
2	Abraham	Norville	CaFAN
3	Adams	Royron	Saint Lucia Insurance council
4	Allen	Ted	IRI
5	Applewhaite	Andrea	CIMH
6	Armstrong	Kelli	IRI
7	Arnold	Lester	OECS
8	Benjamin	Vincere	St. Kitts Meteorological Service
9	Bennett	Gregory	NEPA Jamaica
10	Brown	Glenroy	Jamaica Meteorological Service
11	Burke	Bevon	CZMU Antigua
12	Chance	Kenton	CMC
13	Clauzel	Shermaine	CARPHA
14	Constantin	Thaddeus	Ministry of Agriculture
15	Corriette	Don	Dominica ODM
16	Cox	Shellyanne	CIMH
17	Cumberbatch	Catherine	Belize Meteorological Service
18	Destin	Dale	Antigua Meteorological Service
19	Dickson	Samantha	NADMA Grenada
20	Eakin	Mark	USA
21	Emmanuel	Shanna	Saint Lucia Fisheries Dept
22	Etienne-LeBlanc	Sheryl	St. Maarten Meteorological Service
23	Gajadhar	Webster	St. Lucia Meteorological Service
24	Geiger	Erick	USA
25	Gibier	Florian	Martinique Meteorological Service
26	Goddard	Lisa	IRI
27	Guido	zack	
28	Hamer	Seon	UOG
29	Herman	Anthony	Belle Vue Farms
30	Hernandez	Marieta	Cuba Meteorological Service
31	Hyacinth	Nicholai	Water and Sewerage Co. Inc.
32	Irausquin	Lothar	Aruba Meteorological Service
33	James	Sherrod	DEM Antigua
34	Jennings	Jeffrey	Anguilla
35	Jones	Albert	CCCCC
36	Jones	Jhordanne	CSGM UWI Jamaica
37	Joseph	Ivaline	NEMO
38	Joyeux	Andre	Saint Lucia
39	King	Arnold	Bahamas Meteorological Service
40	Kirton-Reed	Lisa	CIMH
41	Layne	Davina	CTO
42	Lewis	Lennox	CDB
43	Lowe	Daison	CIMH
44	Mahon	Roché	CIMH
45	Marcellin-Honore	Vernie	Dominica Meteorological Service
46	Martinez	Odalys	Puerto Rico Meteorological Service
47	Mason	Simon	USA
48	McPherson	Eron	Guyana Meteorological/Hydrological Service
49	Meade	Daren	Montserrat

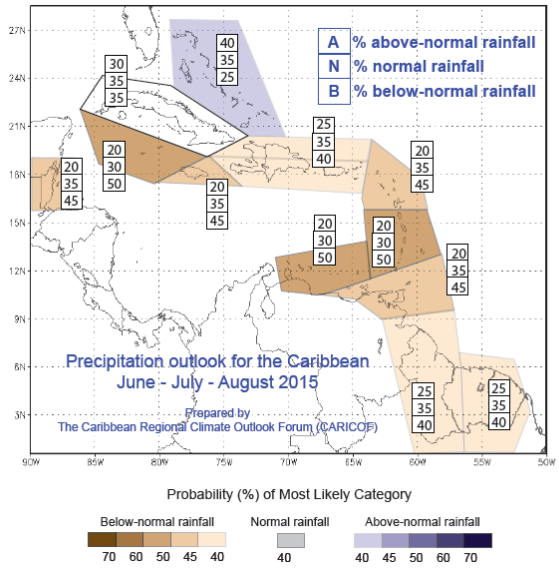
50	Menzies	Steve	WMO
51	Mitro	Sukarni	Suriname Meteorological Service
52	Mohammed	Elizabeth	CRFM BZE STV
53	Munoz	Angel	IRI
54	Murray	Brian	Barbados Meteorological Service
55	Nelson	Thomas	Saint Lucia Fisheries Dept
56	Neverson-Jack	Desiree	St. Vincent Meteorological Service
57	Pierre	Donna	CDEMA
58	Porter	Avalon	Cayman Islands Meteorological Service
59	Prince	Howie	NEMO St. Vincent
60	Rankine	Dale	CIMH
61	Rodrigues	Ivan	APUA
62	Sabir	Kareem	CZMU Barbados
63	Scott	Wazita	CIMH
64	Sealy	Justin	Saint Lucia Water and Sewerage Co. Inc.
65	Simpson	Leslie	CARDI
66	Smith	Jacinda	ODPM Trinidad & Tobago
67	St. Louis	Joralia	Saint Lucia Insurance Council
68	Stephenson	Kervin	IICA Saint Lucia
69	Stoute	Shontelle	CIMH
70	Tamar	Gerard	Grenada Meteorological Service
71	Trotman	Adrian	CIMH
72	van Meerbeeck	Cedric	CIMH
73	Viloria	Cecilia	Dominican Republic
74	Wells	Elena	Saint Lucia Physical Development
75	Willie	Shem	Saint Lucia Meteorological Service
76	Wilson	Henry	DEMA Turks & Caicos Islands

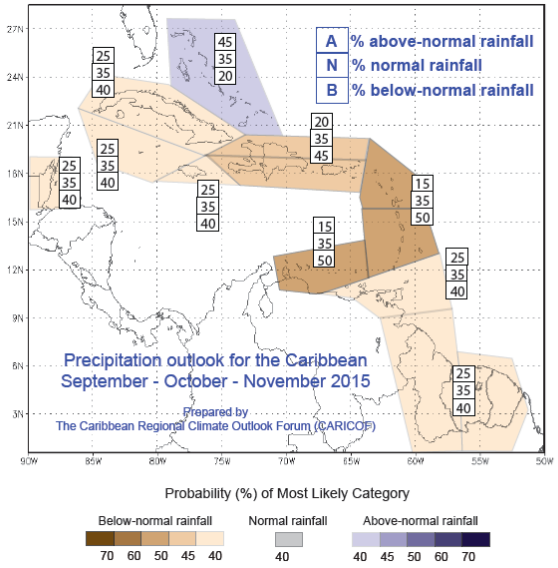
Appendix II: Climatology of the Caribbean



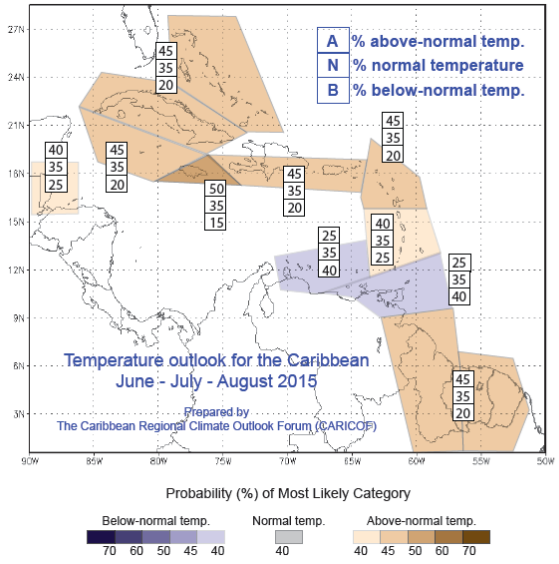
Appendix III: Climate Outlooks

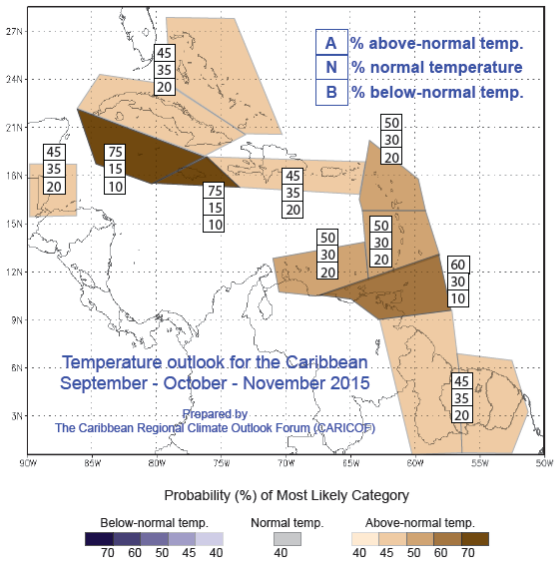
Precipitation Outlooks





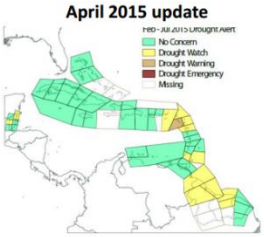
Temperature Outlooks



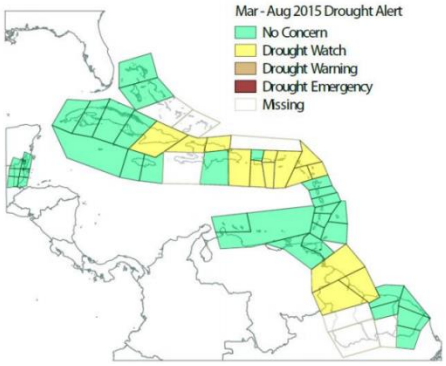


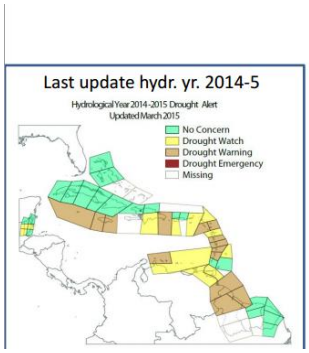
Drought Outlooks

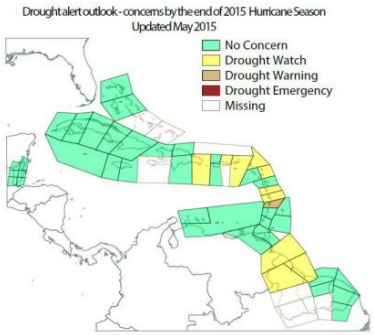
April 2015 update



May 2015's update:
Some drought concern is noted in eastern Cuba, Guyana, Leeward Islands, Puerto Rico and parts of Hispaniola.

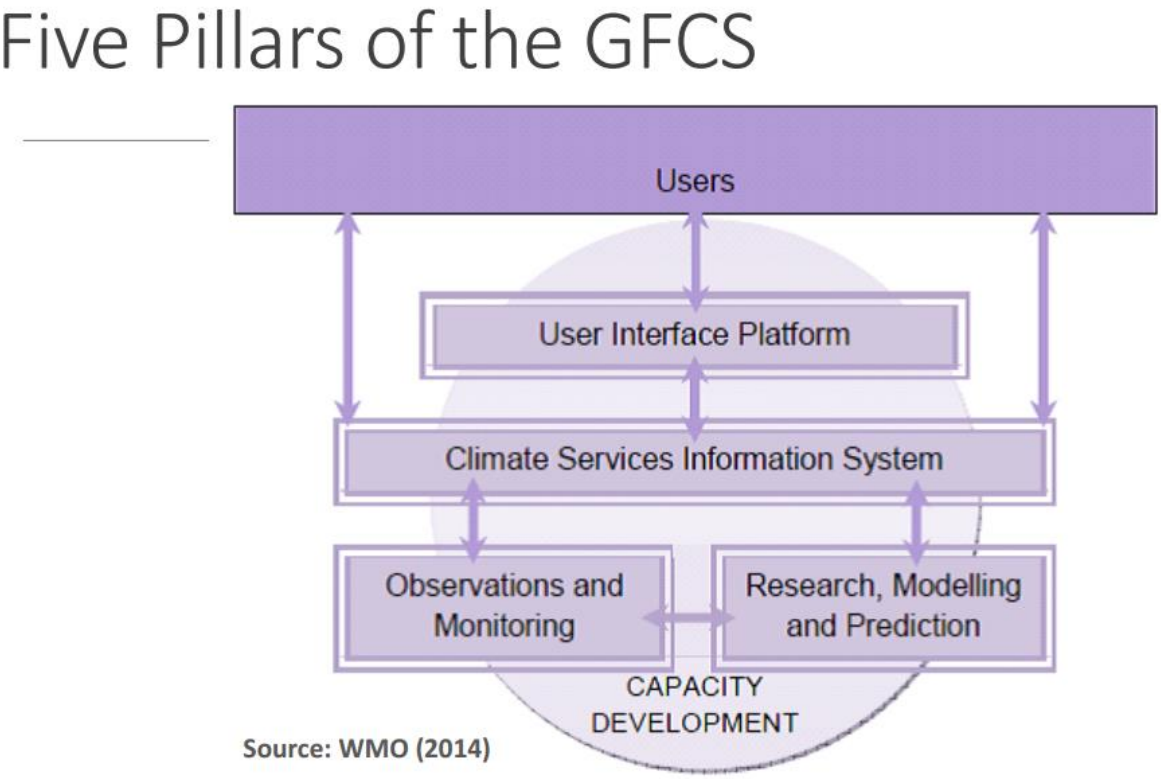




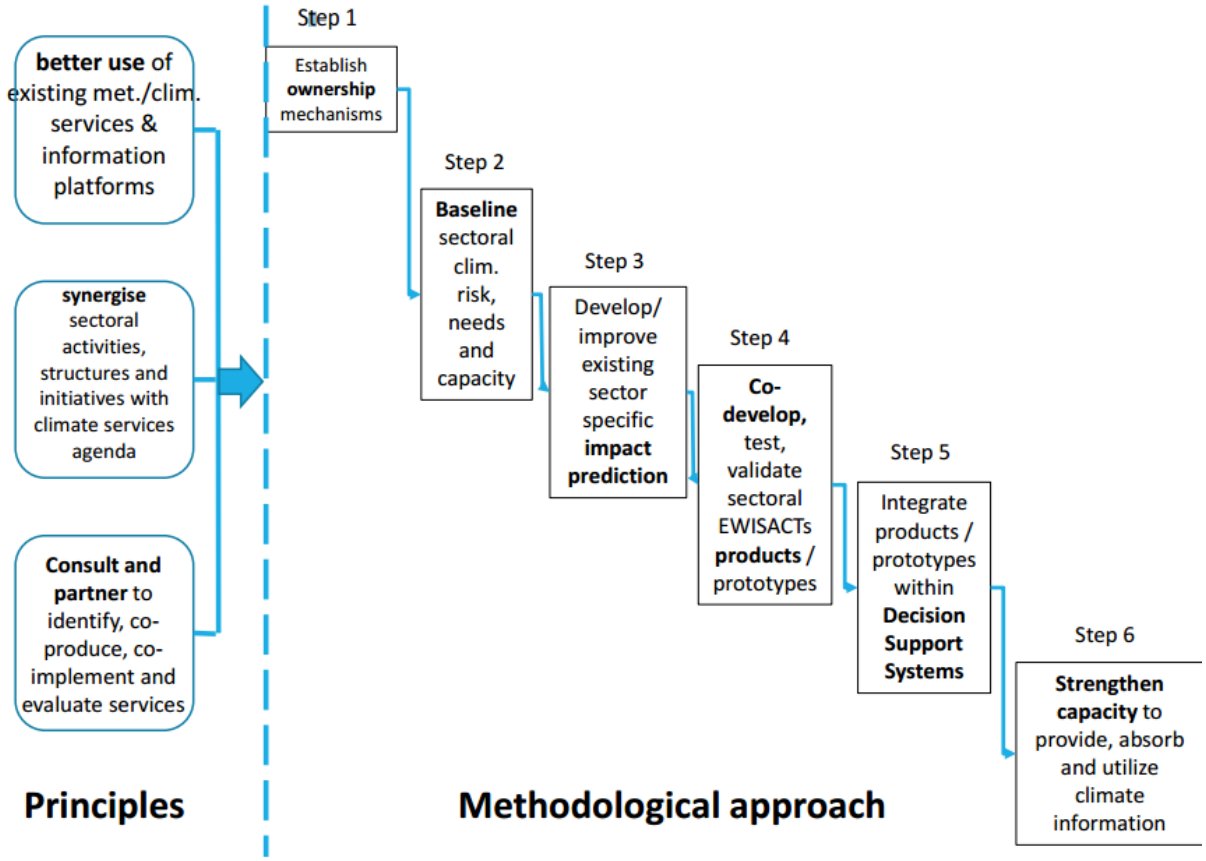


Follow this link for the full publication of the outlook.

Appendix IV: GFCS Five-Pillar Approach



Appendix V: EWISACTs Design



Appendix VI: Sectoral Responses

What are the Implications of the 2015 Outlook for Your Sector?

Agriculture, Forestry, Fisheries and Environment

- Ground water reserves are low
- High evapo-transpiration
- High chance of drought
- Increases in bush fire possibility
- Crop failures/ low productivity and quality
- High probability of soil erosion
- Increased chances of livestock mortality due to increases in diseases
- Increases in pests and diseases (both livestock and plants)
- Increase dependence on desalinated water
- Salt water intrusion
- Changes in fauna movement/migration
- Increased sedimentation in the marine environment
- Increase in number of fishing days
- Decrease in the use of fertilizer
- Decrease in the likelihood of floods
- Less likelihood for damage to infrastructure/assets from storm events

Water

- Less surface water for production
- Less ground water recharge
- Better raw water quality due to lower siltation
- Increased water restrictions
- Increase in irrigation demand
- Increased demand on limited water supplies due to reduced supplies from alternative sources (e.g. rainwater and harvesting)
- Increased energy consumption due to increased pumping
- Salt water intrusion due to over abstraction
- Increased treatment costs
- Reduced revenues

Disaster Risk Managers

- Below normal precipitation gives rise to:
- Above normal temperatures
- Drought warning for Saint Lucia
- Drought watch for the north eastern Caribbean
- Implications:
    - Sanitation
    - Impacts on the economy/ commerce (Tourism)
    - Landslides (soil creep) / rockfalls
    - Vegetative loss
    - Flash flooding

- Bush fires
- Siltation of water ways
- Increased asthma / other respiratory (air quality) health issues and heat stress
- Water security threatened further
- Food security threatened further

- Worst case scenario:
  - Loss of business
  - Importation of water
  - Closing of production plants
  - Vector borne diseases increased
  - Crime
  - Uncontrollable fires
  - Closing of educational institutions
  - Increased coral bleaching (long term impacts on tourism)
  - Overall increased vulnerability and poverty

How will the new products benefit?

Agriculture, Forestry, Fisheries and Environment

- Allows for better planning (crop production)
  - Management of water/soil
  - Crop planning and production
  - Pest and disease mitigation
- CRW provides a plan for increase monitoring of reefs and the creation of action plans (mitigation)
- The Extreme Rainfall outlook would help in preparing for the event by:
  - Clearing bloackages
  - Public awareness drives
  - Enacting disaster management plans

Water

- 3-month CRW (for countries with desalination plants)
  - The concern however, is the impacts of brine discharge on corals
- Extreme rainfall updates
  - Monthly updates
  - Coverage should be increased
- Rainfall amounts and not just probability

Disaster Risk Managers

- For coastal managers and tourism
- Monitoring marine water quality
- Useful for flash flooding ad landslide incidence, as well as storm surge impacts
- Useful for sustainable development of rural livelihoods, especially on the coast
- Drainage management, natural and industrial
- Extreme rainfall:
  - Useful for coastal management

- Complimentary for disaster management
- Coral reef watch:
  - Useful but more long term potential

What other information would you like to see and on what timescale?

Agriculture, Forestry, Fisheries and Environment

- Oceanic currents (monthly)
- Wind patterns (monthly)
- Refined scale for Sea Surface Temperatures (SST) consideration for spatial
- Flood outlook

Water

- More specific quantitative measures of climate change impacts (e.g. sea level rise)
  - Hot spells
  - Oceanic currents
  - Other drought indices (other than SPI)
    - Incorporate evepo-transpiration
  - Drought restriction triggers

Disaster Risk Managers

- Monthly and seasonal wave forecasts (useful for fishermen to help protect assets)
- Sargassum sea weed forecasts and monitoring