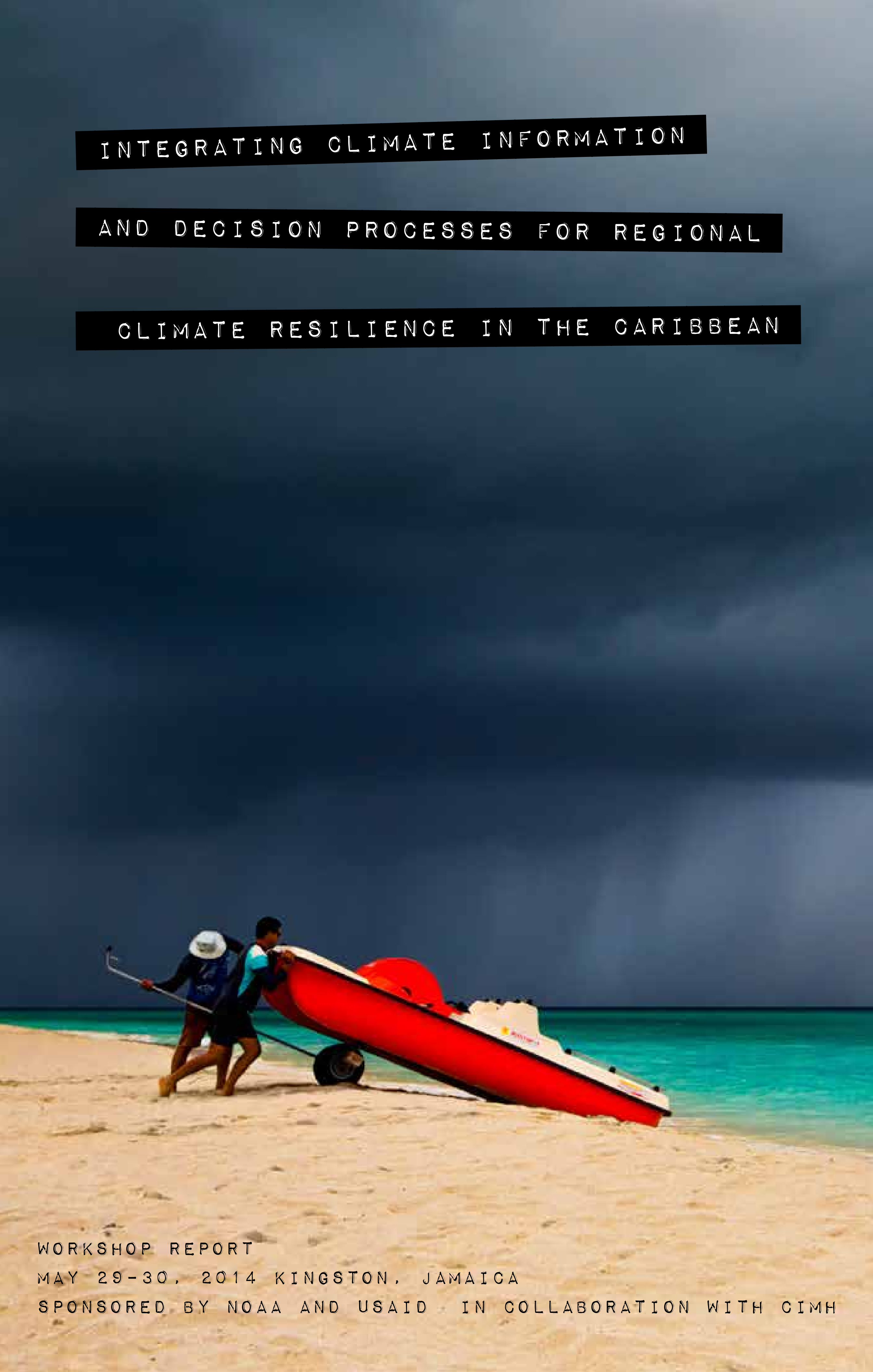
INTEGRATING CLIMATE INFORMATION AND DECISION PROCESSES FOR REGIONAL CLIMATE RESILIENCE IN THE CARIBBEAN



WORKSHOP REPORT

MAY 29-30, 2014 KINGSTON, JAMAICA

SPONSORED BY NOAA AND USAID IN COLLABORATION WITH CIMH

Preface: IRAP Project

The International Research and Applications Project (IRAP), Integrating Climate Information and Decision Processes for Regional Climate Resilience, advances research on adaptation and resilience to climate variability and change while also advancing the application of climate services. The project supports risk management through research-based improvements in design, development, and provision of climate information, particularly as they contribute to national and regional development goals.

While climate information is often one of many components of risk management, limited access, misunderstandings, and the inadequacy of existing information often cause the information to be underused. IRAP seeks to identify opportunities, in collaboration with local partners, to address these barriers in an iterative, end-to-end approach that is problem and solution driven.

IRAP's approach begins with assessments of vulnerability and networks, and the capacity of climate information to inform decisions. Part of this process is to foster local partners that play integral roles throughout the project. Assessment knowledge then leads to the development of new or the modification of existing information or products that are tailored to fit user needs. After these decision support tools are put into action, IRAP evaluates their use, further refining the product, enhancing use, and developing best practices.

In this end-to-end approach, IRAP brings social and physical climate science expertise to bear on the research and service, focusing on three integrated themes: climate vulnerabilities, decision support systems, and evaluation. Identifying climate impacts at the sub-seasonal, seasonal, and longer timescales and determining how they are either amplified or dampened by the social conditions in which they unfold merges physical and social sciences.

IRAP is a joint effort led by researchers at the University of Arizona (UA) and Columbia University's International Research Institute for Climate and Society (IRI). It is funded by the National Oceanic and Atmospheric Administration (NOAA) and U.S. Agency for International Development (USAID) under the NOAA International Research and Applications Program. IRAP has a five-year funding cycle beginning in September 2013. IRAP has focused on the Caribbean region in 2013–2014 and will expand to South and Southeast Asia in 2014 and West Africa in 2015.

Suggested Citation:

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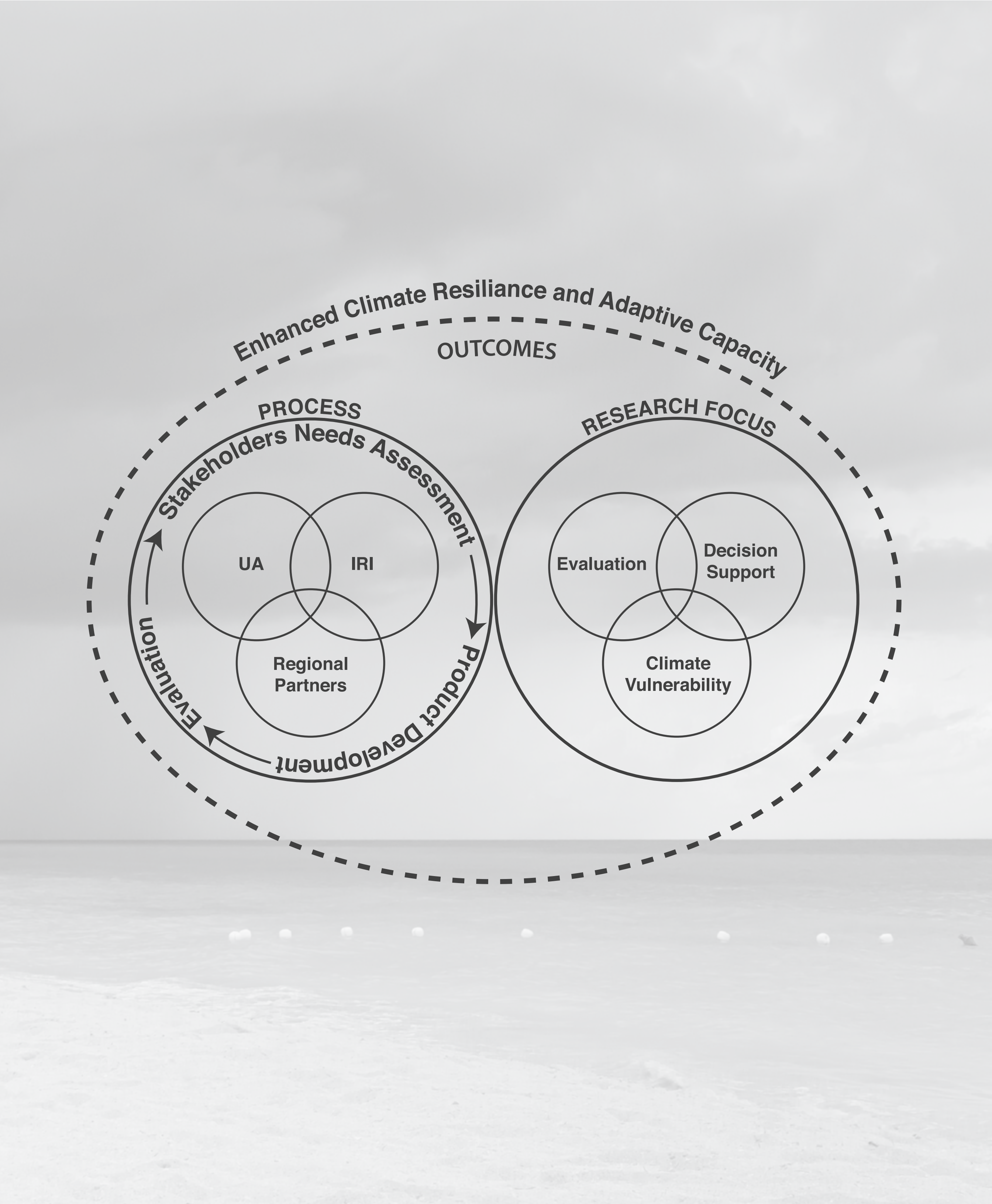

Cover: Varadero, Cuba. People secure a paddle boat on the Varadero Peninsula in Cuba before a tropical storm hits the island in early October. © iStock Photo/Vasko

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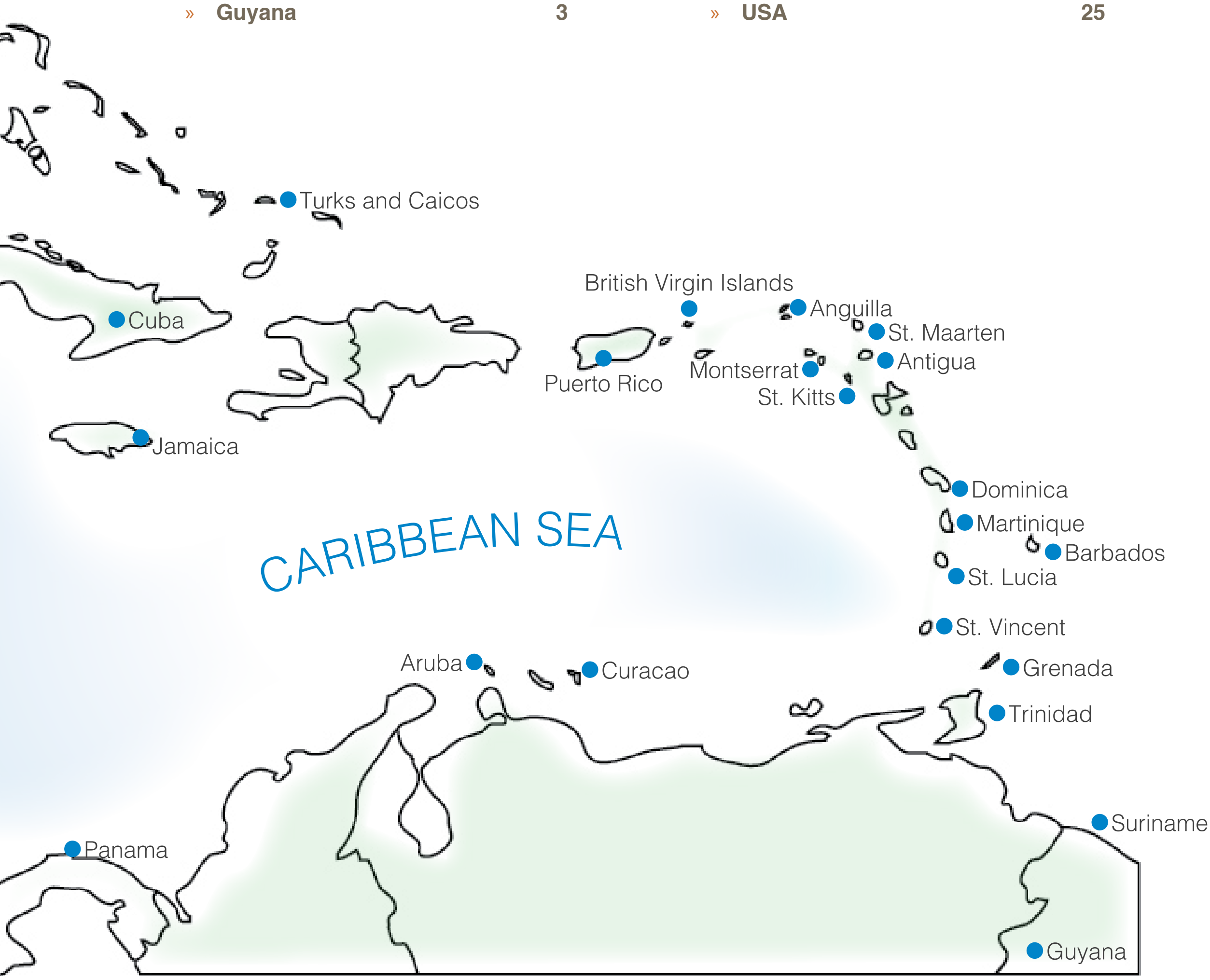
Mafoota Village, Jamaica. Farmers of this town are organized into a cooperative and supply the hotel sector in the St. James area. Photo credit: Francesco Fiondella (IRI).

Sector-based break-out session.

Workshop Participating Countries

» **Anguilla**	**1**	» **Jamaica**	**14**
» **Antigua**	**1**	» **Martinique**	**1**
» **Aruba**	**1**	» **Montserrat**	**1**
» **Barbados**	**10**	» **Panama**	**1**
» **Belize**	**2**	» **Puerto Rico**	**1**
» **British Virgin Islands**	**1**	» **St. Kitts**	**1**
» **Cayman**	**1**	» **St. Lucia**	**3**
» **Costa Rica**	**2**	» **St. Maarten**	**1**
» **Cuba**	**1**	» **St. Vincent**	**2**
» **Curacao**	**1**	» **Suriname**	**1**
» **Dominica**	**2**	» **Tonga**	**1**
» **Fiji**	**1**	» **Trinidad**	**4**
» **Grenada**	**2**	» **Turks and Caicos**	**1**
» **Guyana**	**3**	» **USA**	**25**



Seasonal Climate Risk Management in the Caribbean

Hurricanes and drought are a few climate-related events that routinely cause extensive damage in the Caribbean. In 2010, for example, the most severe drought in 50 years reduced crop production, increased brush fires, and led to widespread water shortages across many islands[1]. That event also revitalized interest in showcasing seasonal climate information to help decision makers better understand the relative chances that extreme climate events would occur in upcoming months.

Would the presentation and discussion of probabilistic drought outlooks and other contextual information have reduced damages caused by the 2010 drought? Could climate information help Caribbean farmers, disaster managers, health workers, and others be more prepared for future events?

The answers to these questions have shades of grey. In some cases, decision makers need more definitive information than what can be produced, while the existing information would be sufficient during other times if it were slightly modified. The nuances reinforce the need for dialog between producers and consumers of climate information and have become driving forces to restart the Caribbean Climate Outlook Forum (CariCOF).

The CariCOF has been held each year since 2012, resuming after a hiatus dating to the late 1990s. The forum brings together national and regional meteorological (met) service professionals and decision makers to produce and discuss seasonal climate forecasts issued for June–August and September–November. It also has become a test bed for innovative climate decision-support tools as well as an opportunity to assess stakeholder needs and strengthen met service and stakeholder networks.

Reflections on the Caribbean Climate Outlook Forum
www.vimeo.com/album/2929233/video/102635036

2014 Climate Outlook Forum

On May 28, 86 participants from 27 countries convened in Kingston, Jamaica, for the 2014 CariCOF (Appendix 1-3), which was the largest CariCOF to date. For the first time, experimental outlooks for temperature and drought were presented along with the traditional seasonal precipitation forecast. The drought forecasts utilized the Climate Predictability Tool (CPT) developed by the International Research Institute for Climate and Society (IRI) and generated at a met service workshop during the two days prior to CariCOF. Participants also discussed the benefits and application of sub-seasonal forecasts.

Lower-than-average temperatures in parts of the Atlantic Ocean and the expectation that El Niño would strengthen influenced the consensus precipitation forecast. The forecast called for general higher probabilities of below-average rainfall and above-average temperature for the June–August (Figure 1) and September–November seasons. On the surface, forecasts for below-average rainfall boded well for reduced climate risks like floods, but a lack of rain is also a major concern for water supply and tourism, and it also only takes one hurricane to cause widespread and severe damage. With climate risk in the region ever present, resiliency to climate—the ability to minimize damage and bounce back from it—requires combining knowledge of the social influences that amplify or dampen the climate event with forecasts and other decision-support tools.

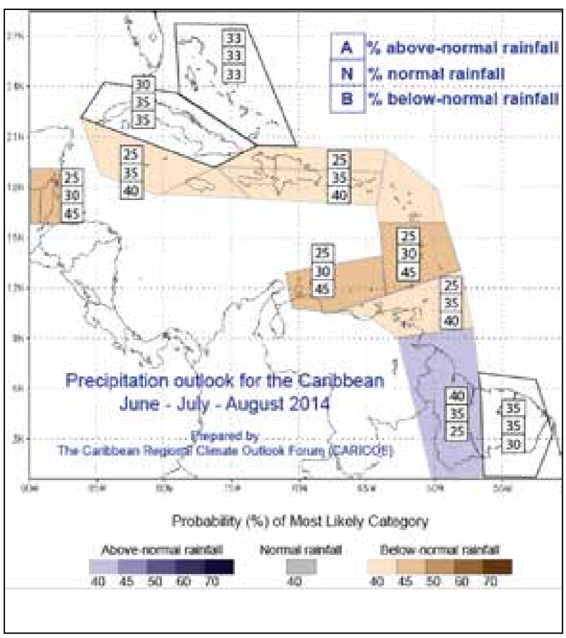


Figure 1. Precipitation outlook for the June–August period prepared for the CariCOF. Recent seasonal climate forecast for the Caribbean can be accessed from the Caribbean Institute for Meteorology and Hydrology (CIMH). **http://www.cimh.edu.bb/?p=precipoutlook**

Goals and Activities of the IRAP Workshop
www.vimeo.com/album/2929233/video/99169676

IRAP Workshop

Following the CariCOF, the IRAP project team facilitated a two-day workshop to explore links between the social and physical aspects of climate risk, building upon the forecast and its related discussions from the CariCOF. The workshop included presentations, discussions, and participatory exercises focused on the themes of climate vulnerability, social networks, regional disasters, and the evaluation of climate information. The workshop launched the IRAP project's engagement in the region and had the following objectives:

1. Advance the understanding of how climate information can inform regional risk management
2. Inform the development of new climate-related decision-support tools, analyses, and future pilot research projects
3. Form new partnerships

In the following report, we summarize the activities from the workshop. We draw principally upon information collected at the event. This includes 11 interviews with CariCOF and IRAP workshop participants; a "World Café" group discussion related to climate vulnerability; a participatory social network mapping exercise; discussions on past Caribbean disasters; a focus group and subsequent plenary discussion on evaluating the provision and use of climate information; and a post-event workshop survey. In some cases, the IRAP team followed up with participants after the CariCOF. This report also supplements the data collected at the workshop with information in published reports.

The information presented here serves as a foundation for future analysis and engagement from which IRAP and CariCOF initiatives can continue to grow.

Members of the University of Arizona IRAP team.

Executive Summary

The International Research and Application Project (IRAP) hosted a two-day workshop that followed the Caribbean Climate Outlook Forum (CariCOF). The workshop contributed to and advanced discussions about the application and impacts of seasonal climate information. It also focused on developing partnerships for future projects that help develop regional capacity to prepare for and respond to climate risks. Interviews, focus groups, and group discussions during the workshop and preceding CariCOF explored the interrelation between the physical climate and social contexts, producing a wealth of information from which future efforts can draw. Below summarizes some of the key insights highlighted by participants during the activities.

Climate Vulnerability

» **Climate vulnerability, measured by sensitivity and adaptive capacity, varies by country and is related to levels of public support and investment in climate information services and early warning systems. It also varies according to the inherent community capacity to protect itself and build and access social capital.**

» **People rely on social capital to respond and recover from extreme events regardless of wealth and geographic location. The relationship between climate information and collective actions that reduce climate vulnerability is seen as a key research gap.**

» **While extreme climatic events affect the livelihoods of the poor and most vulnerable, they also provide opportunities for transformation. New forms of technology such as water storage devices and information sharing can enhance the ability to cope with future events.**

Seasonal Climate Forecast Communication Networks

» **Many participants provided supplemental information to accompany the seasonal climate forecasts. These knowledge-brokering efforts suggest that future workshops should focus on identifying and bolstering the ability to provide contextual information.**

Disasters

- **While hurricane early warning systems provide information a few days in advance, providing forecasts at longer-lead time scales can help people prepare more than a few days in advance.**
- **Disaster preparedness benefits from timely communication between sectors, but that communication is not always present. Participants commented that they did not issue warnings in some situations because they were waiting for information from the meteorological services or the water sector. Similarly, the water and agricultural sectors commented that they did not take actions because they were waiting on warnings from disaster managers.**

Evaluation

- **Participants identified indicators that could help measure progress in meeting the goals of climate information services. These indicators fell into seven categories, including capacity building; forecast quality; customized products; understanding, communication, and information use; demand for climate information; general reporting metrics; and climate-related policies.**
- **Discussions highlighted that sufficient data collection will require synchronized and consistent monitoring across space and time; participants were concerned about the resources needed to accomplish this.**

Opportunities for Future CariCOFs

- **The traditional tercile forecasts are difficult to interpret and have led to underuse in the past; different forecasts and new ways of communicating existing seasonal outlooks can help improve climate information access and use.**
- **Meetings that bring together meteorological service professions and sectoral stakeholders provide important knowledge transfer that can help meteorological services better provide relevant information.**
- **Continued emphasis on training at the CariCOF will help build technical and institutional capacities in the meteorological services to provide climate and weather information.**
- **Convening national CariCOFs that train and develop decision support systems for specific sectors can help enhance the use of climate information in decision making at the national and local levels.**

Select Research Gaps

- **Case studies that evaluate the outcomes of an end-to-end climate service approach, where assessments lead to iterative information development followed by evaluation are necessary to inform climate risk management research and practice.**
- **The most effective combination of public policy (such as climate services and post-hurricane rebuilding efforts) and community responses that build resilience appears not to have been systematically studied.**
- **There is limited understanding of the role of information brokers within the seasonal climate communication network and how their activities influence climate information use.**
- **Developing an understanding of how drought forecasts and sub-seasonal forecasts (forecasts within a 10-day to several months window) can improve decision making.**

Learning to Apply Climate Information in Agriculture. Elizabeth Johnson, Inter-American Institute for Cooperation on Agriculture (IICA).

www.vimeo.com/album/2929233/video/101654958

Caribbean Climate

The Caribbean climate exhibits a pronounced seasonal cycle in precipitation. The wet season occurs between about May and December, and the climate is relatively dry between December and May. The exception is in the Guianas—Guyana, Suriname and French Guiana—which has two rainy seasons: one in May—July and another in November—January. The hurricane season also coincides with the wet season.

Temperatures are relatively constant throughout the year. The temperatures vary within less than 2°C range about the annual mean in southern Caribbean regions to within 5°C range at high elevations in northern regions.

The physical drivers of the seasonality of rainfall in the Caribbean relate to the movement of the Hadley Cell and the Inter-Tropical Convergence Zone (ITCZ). The ITCZ moves from between 2 and 5°N latitude in March to between 12 and 15°N latitude in September. When the ITCZ moves over a region, rain is more frequent. In the Guianas, the two peaks in the rainfall mentioned above occur with the passage of the ITCZ. The hurricane season peaks in September and October, when the sea surface temperatures (SSTs) are warmest and the ITCZ is at its most northerly position.

Slower evolving SSTs patterns in the tropical Pacific Oceans and the Atlantic Ocean also influence seasonal rainfall and hurricanes. However, year-to-year variability contributes more to the total explained variance of extreme rainfall (as measured by the 95th percentile) than longer-scale variability. For example, 50 and 80 percent of the total variance of extreme precipitation observed in the historical record is explained by year-to-year variability, which includes variability caused by the El Nino Southern Oscillation (ENSO), while decadal changes explain most of the remaining variance (Figure 2). Trends in extreme precipitation, on the other hand, account for a relatively small portion of the total extreme precipitation variability. In other precipitation variables, small positive trends have been found in annual total precipitation, daily intensity, maximum number of consecutive dry days, and heavy rainfall events; increasing temperature trends have been more consistent and observed in extreme high temperatures and while fewer cool days, among other temperature indices[2].

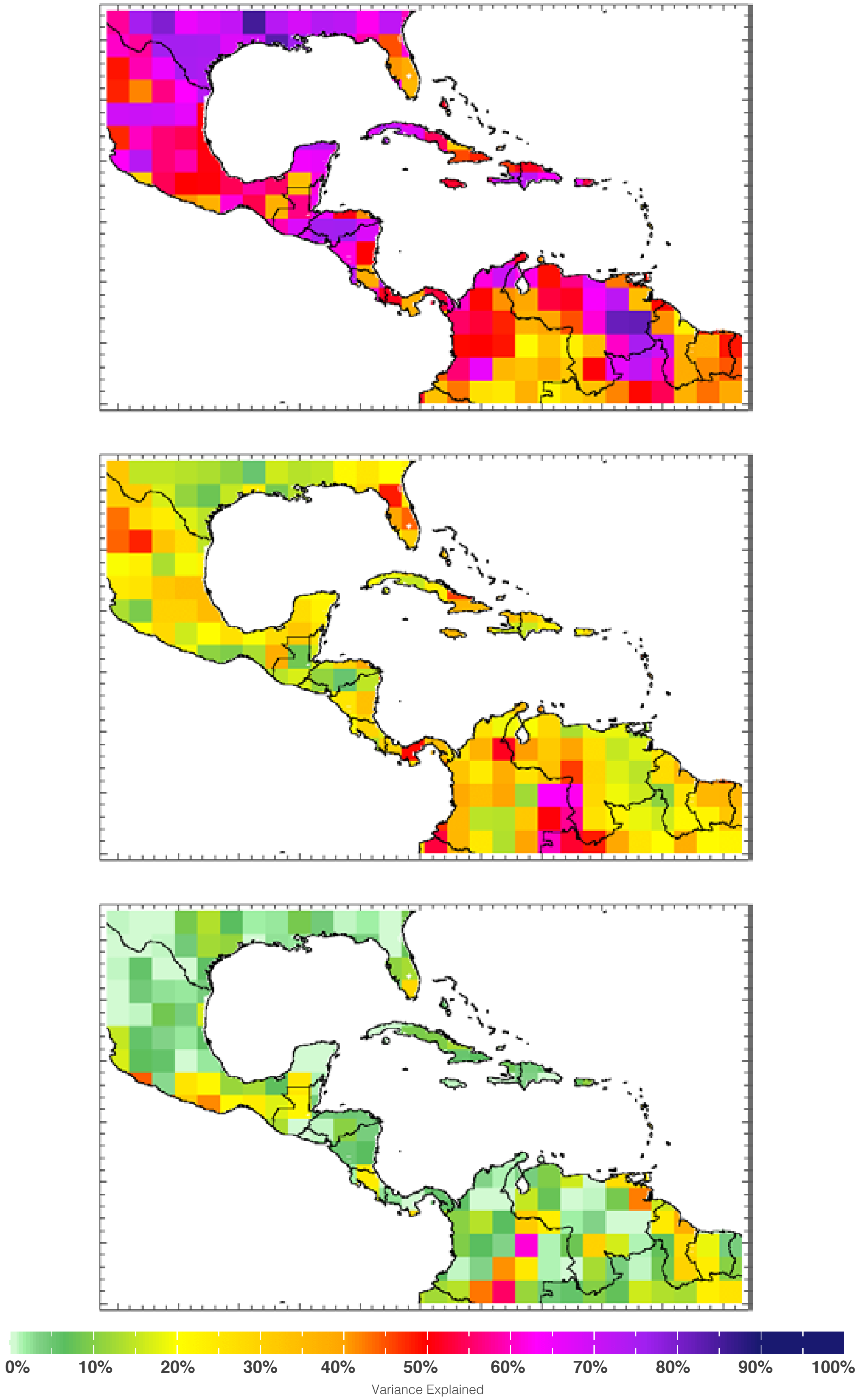


Figure 2. The total variability in extreme precipitation is largely explained by year-to-year precipitation changes (top figure) and changes over decadal periods middle figure). Trends explain a small portion of the total variance (bottom figure). Figure created by Angel Muñoz, IRI.

A History of the CariCOF in 90 Seconds. Cedric Van Meerbeeck, Caribbean Institute for Meteorology and Hydrology (CIMH).

www.vimeo.com/album/2929233/video/101654958

A Brief History of the Caribbean Climate Outlook Forum

The research team interviewed 11 CariCOF participants, recording their perceptions and recollections of past CariCOFs and COFs from other regions. Interviewees ranged from veteran to first-time CariCOF participants and represented a variety of institutions, including the IRI, CIMH, national met services, and regional agricultural organizations. The following is a concise history of the CariCOF, drawing largely from the interviews but also from reports and scholarly journals.

In 1982–83, the strongest El Niño event to date caused widespread loss of life and property around the globe. The extensive damages helped fuel efforts to better understand the physical mechanisms of the ENSO phenomena. Increased research, using a newly installed near real-time ENSO observing system, ultimately led to the development of predictive models that boosted the accuracy of seasonal climate forecasts. With better forecasts and increased awareness of ENSO impacts, demand for seasonal climate information increased[3].

By the mid-1990s, seasonal climate forecasts were in experimental phases in many regions. In Africa, it was common to have several organizations forecasting the climate, and they often produced dissimilar outlooks as a consequence of different models and interpretations of the climate. The discrepancies in the forecasts, in turn, led to confusion in the media and other consumers and ultimately engendered a process for reconciling the forecasts.

In 1996 at a meeting in Victoria Falls in Zimbabwe, participants discussed a process to develop a consensus forecast, laying the foundation for the Climate Outlook Forums (COFS) that have become a main mechanism for creating, discussing, and disseminating seasonal climate information in Africa and abroad. The COF objectives extended beyond creating a regional consensus and included building regional capacity and advancing the science of forecasting. Because the COFs were regional, involving representatives from numerous countries, consensus was reached through negotiation that was sensitive to cultural differences and institutional relationships.

Preparations for the COFs accelerated in early 1997 as an El Niño event materialized, one that became stronger than the 1982–83 event and remains the strongest and most destructive on record. At the end of 1997, the first COFs occurred in southern Africa (Zimbabwe and Namibia), Southeast Asia (Thailand), and South America (Peru and Montevideo). Each COF was unique, generally consisting of three components: the production of the seasonal climate forecast, a workshop with social scientists, and a formal conference in which the forecast was presented to regional decision makers. As the El Niño unfolded, demand for trustworthy information on

current and projected impacts as well as best estimates for El Niño's evolution increased across the globe. Using the COFs in late 1997 as a template, several other regions, including in the Caribbean, convened forums in 1998 during the waning stages of the El Niño. These COFs were focused less on creating a consensus forecast and more on helping meteorological services and decision makers better understand and prepare for climate risks.

It became evident early on that seasonal climate forecast communication and use were nuanced. In many cases, potential decision makers were unable to use the forecasts for numerous reasons, including mismatches in the spatial scale of the information presented and difficulty reconciling forecasts probabilities with decisions. In a few cases, capacity existed to use the information but other challenges arose. One of the more noteworthy lessons from the early COFs occurred in Peru in 1997. Participants there revealed that an El Niño forecast would enable large-scale producers in the fishing industry to respond in ways that hurt small-scale artisanal fishing. Concern that the forecast would have greater consequences than the climate impact itself highlighted the need for awareness of competing interests, unequal capacity to respond, equitable access, and other conditions that shaped forecast use[4]. Despite these challenges, COFs have helped decision makers in the water, disaster management, health, and agriculture sectors better understand climate risk[5].

The COFs have expanded since 1997 and now are routinely organized in 15 regions, including the Caribbean. However, the have each evolved differently.

In the Caribbean, the first COF (CariCOF) was held in March 1998, but demand for the information and stakeholder engagement were minimal. In addition, capacity within countries to inform the production of the regional forecasts was insufficient. These constraints prevented ongoing support for the forums, and the CariCOF halted after only a few forums.

THE CARIBBEAN REGIONAL CLIMATE OUTLOOK FORUM (CARICOF)

WEDNESDAY, MAY 28, 2014

9:00-10:50	2013 AND 2014 WET SEASON CLIMATE OUTLOOKS OF RAINFALL, TEMPERATURE, AND HURRICANES: PRESENTATIONSAND DISCUSSIONS
11:10-12:30	CARIBBEAN CLIMATE IMPACTS DATABASE: PRESENTATION AND DISCUSSION
12:30-1:30	LUNCH
1:30- 1:45	USER FEEDBACK ON THE CARICOF CLIMATE OUTLOOKS
1:45-3:20	STANDARDIZED PRECIPITATION INDEX (SPI) FORECASTING TO SUPPORT DROUGHT EARLY WARNING:PRESENTATION AND DISCUSSION
3:20-3:40	BREAK
3:40-4:30	CLIMATE INFORMATION AT THE SUB-SEASONAL SCALE:PRESENTATION AND DISCUSSION
4:30-5:00	FUTURE CariCOFS

Mafoota Village, Jamaica.

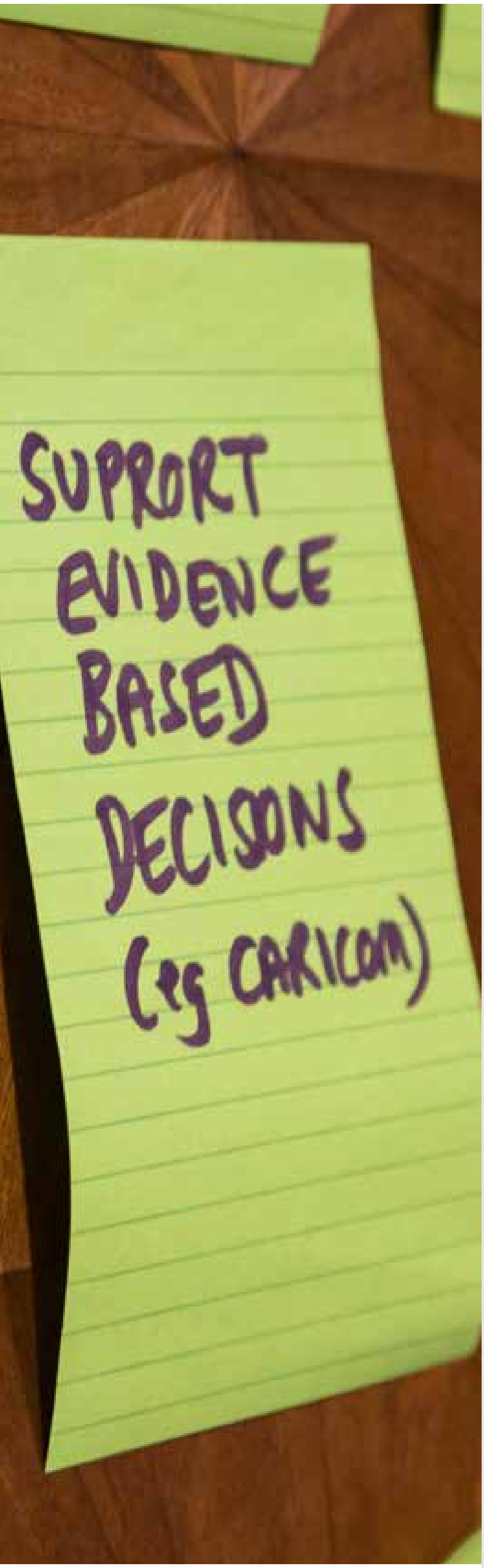
Interest in a CariCOF resurfaced in 2010, partly in response to the worst drought in 50 years, which affected many islands, particularly in the eastern Caribbean. The drought catalyzed regional interest in seasonal climate information at a time when the World Meteorological Organization (WMO) was eager to increase access to climate information and support COFs, which the WMO perceived as being successful at integrating climate information into risk management. A meeting that year in Barbados involving the Caribbean Institute for Meteorology and Hydrology (CIMH), Caribbean Community Climate Change Center (CCCCC), the National Oceanic and Atmospheric Administration (NOAA), IRI, the WMO and other regional stakeholder set in motion plans to reinitiate the CariCOF. In 2012, the first CariCOF in more than a decade was convened in March prior to the wet season, and one has occurred in each subsequent year. The CariCOF rotates the location of the forums to engage more people, particularly decision makers at more local levels that do not have opportunities to attend forums abroad. The event can also strengthen institutional relationships between host country meteorological services and other local organizations.

Despite being funding by external donors, the CariCOF is a regionally directed process. The CIMH acts as lead coordinator, with participation from many of the Caribbean's meteorological services. This leadership has helped the forecast process utilize regional data and expertise; regional insight can make important contributions when climate conditions make seasonal forcasting more challenging.

The CariCOF also prioritizes stakeholder input to inform the development of new decision-support tools. This is facilitated in part through forums that bring together meteorological service professionals and other decision makers. Stakeholder engagement helps expose the meteorological services to climate impacts and information needs from a diversity of communities.

Like the original COFs in the late 1990s, the emphasis of the recent CariCOFs remains on seasonal climate forecasting and capacity building. However, interest is increasing in building awareness and understanding of social vulnerability and in assessing how these conditions can either amplify or dampen seasonal climate risk. Integrating the social and physical aspects of climate risk will become a component of future CariCOFs.

Participants suggested ways to measure the impacts of climate services, pasting their thoughts on “stickies” during day two’s activities. Photo credit: Elisabeth Gawthrop (IRI).



IRAP WORKSHOP

DAY 1

THURSDAY, MAY 29, 2014

- 8:30-9:00 RECEPTION
- 9:00-9:30 OPENING REMARKS
- 9:30-10:00 INTRODUCTION OF IRAP PROJECT AND GOALS OF WORKSHOP
- 10:00-10:15 BREAK
- 10:15-11:45 VULNERABILITY TO CLIMATE VARIABILITY AND CHANGE PRESENTATIONS
- 11:45-12:15 DISCUSSION
- 12:15-1:15 LUNCH
- 1:15-2:45 CLIMATE VULNERABILITY: WORLD CAFE EXERCISE
- 2:45-3:00 BREAK
- 3:00-5:00 DISASTERS PREPAREDNESS IN THE CARIBBEAN EXERCISE

Elisabeth Gawthrop, IRI

Vulnerability to Climate Variability and Change Presentations

Presentation List

Session	Title	Presenter	URL
Vulnerability to Climate Variability and Change	Summary of Seasonal Climate Impacts Discussed in Recent COFs	Adrian Trotman, Caribbean Institute of Meteorology and Hydrology, Barbados	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/AdrianTrotman_IRAP-Workshop_29May14.pdf
	Impacts of Longer-term Climate Changes in the Caribbean Region	Lisa Goddard, International Research Institute for Climate and Society, USA	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/LisaGoddard_IRAP-Workshop_29May14.pdf
	Climate Vulnerability Assessment: What Is It and How Do We Use It	Jim Buizer, University of Arizona, USA	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/JimBuizer_IRAP-Workshop_30May14.pdf
	Geographies of Vulnerability to Climate Variability and Change: Case Studies of Selected Farming Communities in Jamaica	Kevon Rhiney, University of West Indies, Jamaica	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/KevonRhiney_IRAP-Workshop_29May14.pdf
	Social/Economic Drivers Of Vulnerability In The Caribbean	Paulette Bynoe, University of Guyana, Guyana	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/PauletteBynoe_IRAP-Workshop_29May14.pdf
Local Caribbean Projects	IWCAM Demonstration Projects Watershed-based Approaches for Improved Environmental Health and Agricultural Land Planning	Christopher Cox, Caribbean Public Health Agency, Trinidad and Tobago	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/ChristopherCox_IRAP-Workshop_30May14.pdf
	Climate Change Adaptation Activity in Jeffrey Town Jamaica, with particular emphasis on Agriculture	Ivy Gordon, Jeffrey Town Farmers Association, Jamaica	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/IvyGordon_IRAP-Workshop_30May14.pdf
	Climate Sensitive-related Community Projects	Ottis Joslyn, Caribbean Community Climate Change Center, Belize	http://irap.iri.columbia.edu/wp-content/uploads/2014/06/OttisJoslyn_IRAP-Workshop_30May14.pdf

Vulnerability in the Context of Climate

Many social systems in the Caribbean such as households, communities, sectors, or countries experience the impact of climate variability and change. Some groups, however, experience more than others as a result of three interacting factors: the severity of the climate event, including its duration, timing, and geographic location; the preparedness of the social system to absorb or minimize the impacts; and the capacity of the social system to recover to a pre-event stage. These factors are referred to as exposure, sensitivity, and adaptive capacity and together define a system's vulnerability[6]. Higher levels of exposure and sensitivity increase vulnerability, while greater adaptive capacity lowers it. The sum of these factors leads to differences in vulnerability across geographic regions.

Assessing vulnerability helps integrate the physical and social components of climate risk and can provide insights about who is at risk, where the risk is greatest, and what risks are most harmful. Understanding vulnerability also helps highlight strategies to better prepare for and respond to the risks.

To better understand vulnerability in the Caribbean, the IRAP project conducted a background literature review prior to the workshop and a participatory "World Café" discussion session during the workshop. The literature review helped identify areas where understanding of vulnerability is robust or lacking, the World Café discussion session examined in more detail the perceptions of vulnerability of those living in the region. The discussion session also enhanced the participants' understanding of Caribbean vulnerability, provided an initial assessment of regional vulnerability to help inform an IRAP research agenda; and enabled participants to engage, reflect, and tell stories from their experiences.

Literature Review of Caribbean Vulnerability

The literature review focused on the state of knowledge of vulnerability in three Caribbean countries: Jamaica, Barbados, and Trinidad and Tobago. We selected these countries as a starting point because many documents on vulnerability in these countries exist and these nations reflected the demographic, climatic, and economic diversity across the Caribbean. The reviewed documents primarily consisted of reports generated by governmental, non-governmental, and other organizations in the region (see Appendix 4). Academic publications and other relevant documents would contribute to a more complete review.

The reports focused predominantly on the physical and economic impacts of climate variability and change. They highlighted the anticipated impacts to agriculture and coastal regions using crop models and sea level rise projections. The economic impacts to the key sectors of tourism, agriculture, and national infrastructure also were well represented in the reports. Most of the research was conducted sectorally at the country scale and was often driven by available data from other reports; the collection of new, primary data was less frequent than the use of existing information.

We also identified some knowledge gaps, including a lack of research characterizing vulnerability at the scale of individuals and households. Research addressing the interrelationship between sectors also was largely absent. Within agriculture, for example, climate forecasting and crop modeling have provided insights into impacts on the banana crop but not on the banana farmer to any large extent. Similarly, the reports reviewed did not address the different impacts experienced by the farm owner compared to the seasonal farm worker. Finally, the outcomes to an individual or household hinge in part on local factors such as politics, entitlements, resource access, age, gender, and culture. The literature reviewed lacked an integrated view of these factors and also lacked integration with physical climate risks. Moreover, the most effective combination of public policy, such as climate services and post-hurricane rebuilding efforts, and community responses that build resilience does not appears to have been systematically studied.


Elisabeth Gawthrop, IRI

Lisa Goddard, Director of the IRI and co-principal investigator of IRAP, and Walter Baethgen of the IRI..

World Café: Participant Discussions During the Workshop

The diversity of participants at the workshop enabled a discussion of vulnerability from multiple perspectives. To facilitate group dialogs, we utilized the World Café method to address four progressive questions (Table 1). The World Café method has been used in diverse settings to build knowledge and networks by fostering conversations that explores challenging questions. The small groups provide a comfortable setting to share information, and participants are encouraged to cross-pollinate ideas and experiences by periodically moving between groups. A more thorough description of the method is found in Alexander et al. (2004)[7].

Table 1

World Café Discussion Questions	
1.	Considering the seasonal forecasts presented at the COF, what physical impacts do you anticipate? What will you do differently in your job and why?
2.	Thinking of a family with limited resources, how does that family experience a severe climate event (drought, hurricane, etc.) and what do they do to overcome the event?
3.	Thinking of a well-off family, how does that family experience a severe climate event (drought, hurricane, etc.) and what do they do to overcome the event?
4.	Think about sources of support before, during, and after a severe climate event (hurricane, drought, etc.). How is that "support" provided by different organizations?

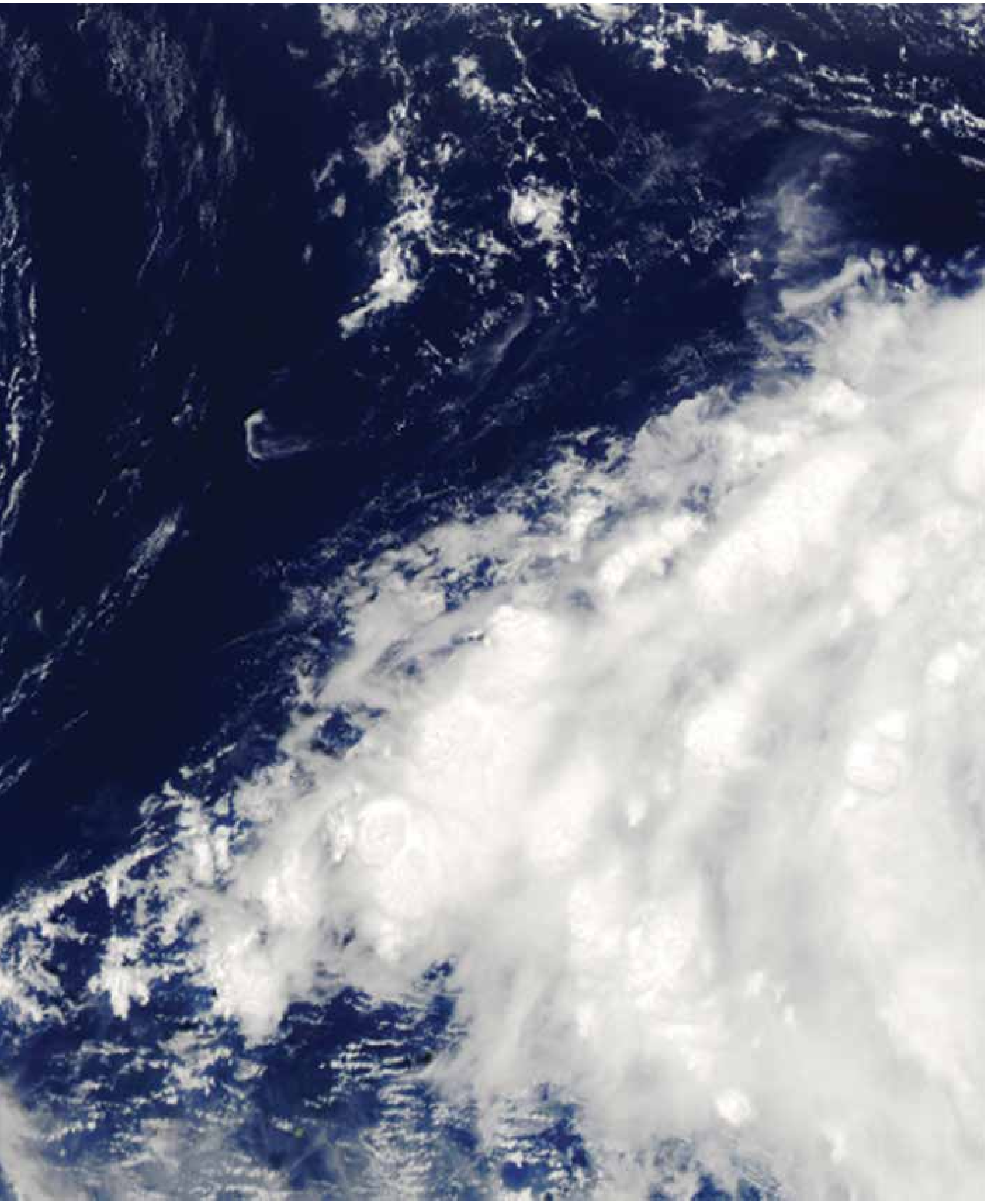
About six to eight participants sat at each table and discussed a question for 15 minutes. At the end of the each discussion, participants switched tables to address the next question. Each table had a facilitator/scribe who helped guide the conversation. They also recorded salient aspects of the discussion, attributing responses to geographic locations.

World Café Discussion Themes

We synthesized the notes from the discussion session into the following conclusions:

- **Physical vulnerability is geographically diverse as a consequence of the hazard frequency and physiographic character of the country (i.e., topography); hurricanes, floods, and droughts were the most frequently cited physical climate risk.**
- **Preparation for an extreme event often occurs only within a few days of the event.**
- **Drought impacts relate to agriculture productivity, health effects, and water security.**
- **Extreme events, even if localized to a few countries, affect regional food prices by disrupting traded food supplies within the Caribbean region.**
- **The level of vulnerability as measured by sensitivity and adaptive capacity varies by country according to levels of public support and investment, including climate information services and early warning systems. It also varies according to the inherent community capacity to protect itself and build and access social capital.**
- **Different national and local capacities to prepare for and respond to extreme events relate to differential access to information, insurance, remittances, and social capital; household assets such as water tanks and generators; and the ability to move or leave an island. National and international resources such as road maintenance, public safety, and external aid also can help improve responses and reduce vulnerability.**
- **People rely on social capital to respond and recover from extreme events regardless of wealth and geographic location; there is some belief that poorer communities rely more heavily on social capital, and as a result of "banding together," these communities may have more functional social networks and community resources.**
- **While extreme climatic events affect the livelihoods of the poor and most vulnerable, they also provide opportunities for transformation. New forms of technology such as water storage devices and of social interaction that includes information sharing can enhance the ability to cope with future events.**
- **Key national-level vulnerability indicators relate to the capacity to prepare for and respond to an extreme event by, for example, pre-positioning resources and quickly reestablishing transportation and information connectivity. Key household-level vulnerability indicators relate to access to water storage tanks and electricity generators.**

Sofia Martinez, IRI



IRAP WORKSHOP

DAY 2

FRIDAY, MAY 30, 2014

- 8:30-9:00 RECEPTION
- 9:00-10:45 SEASONAL FORECAST SOCIAL NETWORK MAPPING EXERCISE
- 10:45-11:00 BREAK
- 11:00-12:30 EVALUATION METRICS DISCUSSION
- 12:30-1:30 LUNCH
- 1:30-3:00 PRESENTATIONS ON CARIBBEAN PROJECTS RELATED TO CLIMATE RISKS
- 3:00-3:15 BREAK
- 3:15-5:00 NEXT STEPS

Disasters in the Caribbean

The societal impacts of climate changes are felt largely through extreme events that escalate into disasters. Hurricanes, floods, and drought routinely strike Caribbean islands, and the frequency and/or intensity of these events is expected to increase in the future[18]. While climate information has the potential to help improve disaster management[19], the extent to which it helps minimize damage requires understanding the types of climate events that cause harm and the nuances of preparedness actions, including their constraints, timing, and scale. This information, in turn, can inform the development of new climate products and the modification of existing ones.

Discussion Topics

The IRAP project facilitated three small-group discussions in which participants discussed their past experiences with disasters. About 29 people participated, representing most Caribbean countries and predominantly the health, water, agriculture, meteorological service, and disaster management sectors. The discussions were guided by a series of questions that helped reveal how disaster managers use climate information, the risk reduction actions often taken, and the opportunities and constraints of those actions (Table 2).

Table 2

Questions	Disc. Groups Divided By
» **What were the worst years in the past several decades?** » **Why were these years the worst?** » **What impacts were felt?**	Geographic region*
» **Do some disasters affect your sector more than other kinds of disasters?** » **What preparedness actions did you take in the three worst disasters?** » **What preparedness actions would you have liked to have taken?** » **Were the worst years bad because you weren't prepared for the climate disaster or because of the intensity of the climatic event?** » **How would these preparedness mentions have improved the ability to respond and recover from the actual disaster?**	Sector
» **When did you find out about the worst disaster?** » **What forecasts would be useful for you to prepare for events in the future?**	Sector

*__Central:__ Barbados, Dominica, St. Lucia, and Saint Vincent and the Grenadines; **Eastern:** Anguilla, Virgin Islands, St. Kitts-Nevis, Montserrat, Antigua, and Barbuda; **North Western:** The Bahamas, Belize, Haiti, Turks and Caicos, and Jamaica; Southern: Grenada, Guyana, Suriname, and Trinidad and Tobago.

In the first discussion, participants identified, according to their own perception, the three worst disasters they experienced in the past several decades. They then discussed those disasters as a group, commenting on the type of information that was issued before and during the event, preparedness actions that were taken, and the events' impacts.

In the second discussion, participants noted the three main preparedness actions taken during these events as well as actions they would liked to have implemented. This discussion was framed by asking the participants to consider how advanced warnings, information about the intensity of the event, and access to other climate information altered their actions.

Finally, for the worst disaster identified, participants discussed when they realized the disaster was happening and the climate information they would have liked to have had for this event. They also discussed the ramifications of receiving a climate forecast that did not turn out as expected.

Common Preparedness Actions and Barriers

Participants most often reported hurricanes as the worst disaster, followed by floods and droughts (Figure 4a). The groups commonly stated that during many of these disasters, warnings were not received or were not received in time to prepare adequately. Participants noted that legal and policy frameworks seem to impede immediate release of watches and warnings through the media. Delayed warnings from the meteorological services or the water sector prevented other organizations from issuing warnings in some instances. Similarly, the water and agricultural sectors commented that they did not take actions because they were waiting on a warning from the disaster management sector. This suggests that improving forecasting dissemination, access, and lead time may help people better prepare for disasters. Participants also listed other barriers, including the lack of mandatory evacuations for residents in at-risk areas and lack of water rationing at early stages of drought.

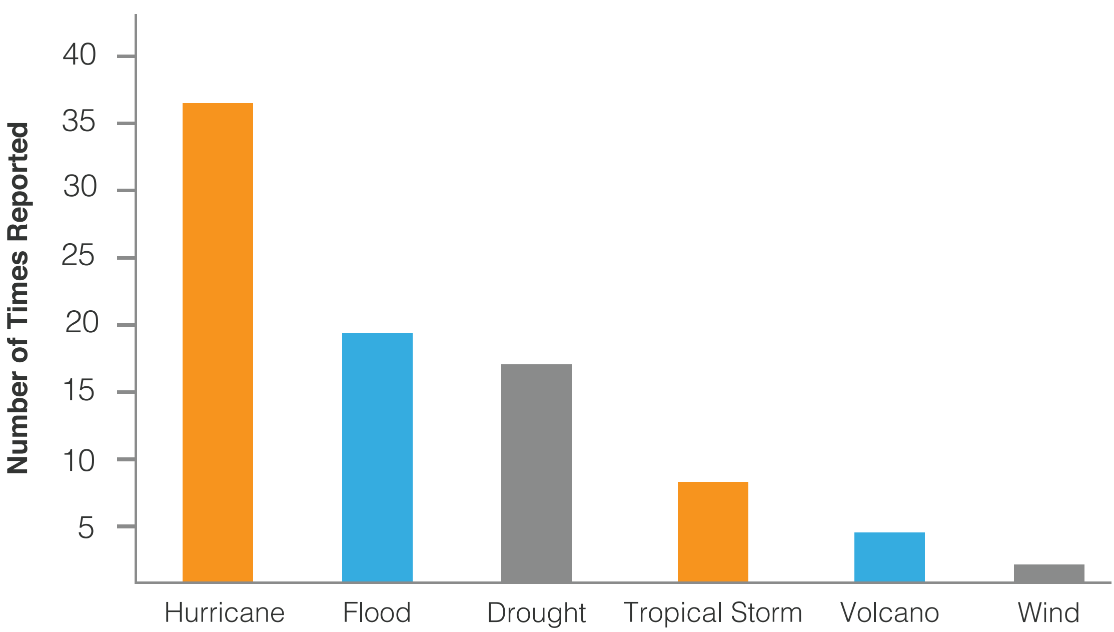


Figure 4a. The number of times participants identified a given disaster as the worst disaster

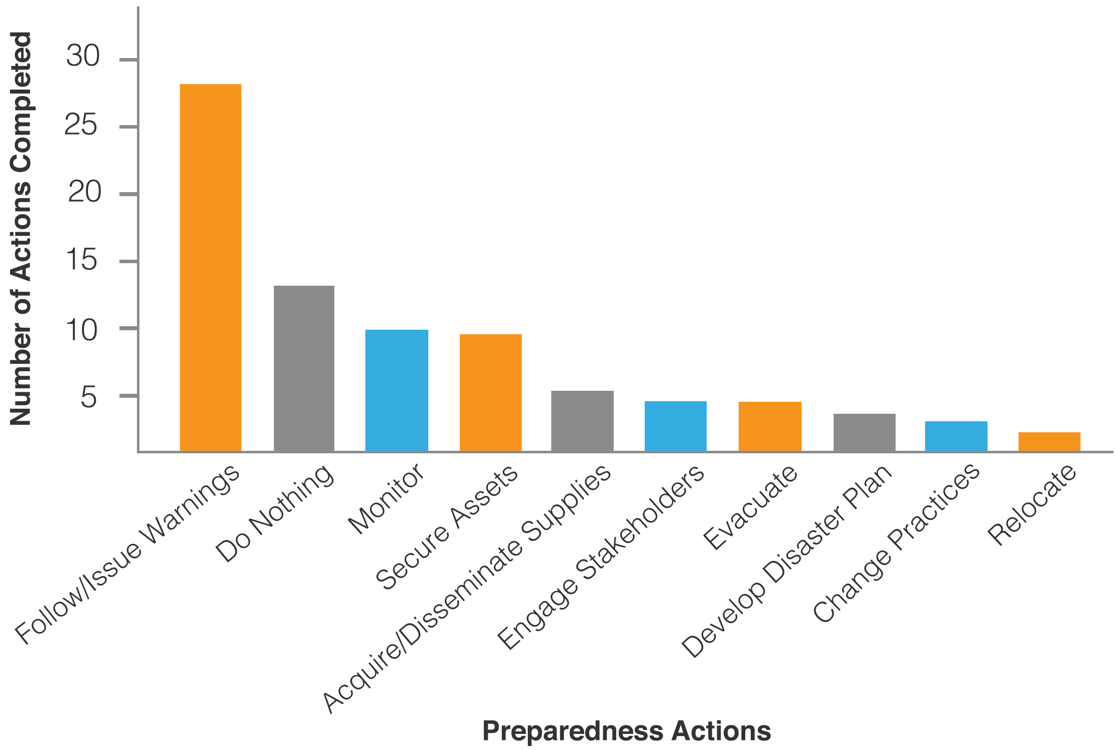


Figure 4b. The number of times participants reported completing a preparedness action during a disaster.

Participants noted that the most common preparedness action was to follow or issue warnings about a disaster (Figure 4b). On the surface, this appears to conflict with statements related to not receiving adequate warnings. However, the second most common response for participants was to do nothing, which could have been related to not receiving the forecast. It could also have been related to the nature of the disaster. For example, the onset of a flood can be sudden, while drought often emerges slowly and is less perceptible. Other preparedness actions reported by participants were monitoring, securing assets, and acquiring and disseminating supplies.

Climate Information Needs

Participants suggested that improvements to existing forecasts and development of new forecasts would help disaster management. While early warning systems exist for hurricanes, forecasts provided with longer lead times can help set preparations in motion more than one to two days in advance. Participants also mentioned the need for daily flood forecasts, with some requesting forecasts that include an analog format, which would compare current events to past conditions. Analogs can help people understand magnitude, location, and impacts of similar past events as well as preparedness actions that worked or failed in the past. Finally, participants suggested that integrating vulnerability into disaster risk reduction can help identify at-risk communities.

Applications of the 2014 CariCOF in the agricultural sector. Elizabeth Johnson, Inter-American Institute for Cooperation on Agriculture (IICA).
www.vimeo.com/album/2929233/video/101654956

Seasonal Climate Forecast Network: An Emerging View

Social capital is often defined as features of social life such as networks, norms, and trust that enable participants to act together more effectively in their pursuit of shared objectives. Because one objective of the CariCOF is to inform climate risk management (see Evaluation Metrics for Caribbean Climate Services, pg. 29), the character of the network in which this information travels and transforms influences the success of this goal. In other words, people who do not receive the information cannot use it. And, even for those who do receive the information, it may only be usable with modification.

We facilitated a social network mapping exercise at the workshop to highlight the connections of the CariCOF and the ways the participants supplemented the forecasts when they shared them with others. We focused on characterizing the networks at the organizational level. This information helps clarify whom in the Caribbean the seasonal climate forecasts reach and what roles stakeholders and meteorological service professionals play in communicating the information. Since the CariCOF venue has changed for each forum since it re-initiated in 2012 in order to involve new people (see Brief History of the CariCOF, pg. 10), the network characterized here does not capture the entire network. Future research will increase the representation of the network.

Social Network Analysis

Social networks are comprised of people linked to one another through relationships[10], and social network analysis (SNA) explains the achievements of individuals or groups by looking at the linkages. SNA has been used in many disciplines, including public health to analyze the spread of infectious diseases[11], agriculture to characterize climate adaptation[12], and wildland fire management to assess the influence of key information disseminators[13].

At the workshop, we adapted the participatory social network method described by Schiffer and Hauck (2010)[14]. Forty attendees of the CariCOF, representing 21 countries, participated in the two-hour mapping exercise. This subset included 24 meteorological (met) services professionals and 16 who we classified as non-meteorologists (non-met). Participants organized themselves into groups of between four and eight. Facilitators stationed at each table guided the participants through three progressive sections. In part one, participants individually answered questions related to how and with whom they will share the seasonal climate information. In part two, these

connections were mapped on a poster board placed in the center of the table; each participant drew on the same poster board. Finally, using the map as a guide, each group discussed four questions designed to elicit the nuances of how and why people communicate the seasonal climate forecasts (Table 3).

Table 3

Seasonal Climate Information Network Discussion Questions
1. Does the group of people with whom you intend to communicate this year's forecast differ from the group of people with whom you communicated in the past, and if so, why?
2. How does the network change if the forecast is above vs. below (more drought or more rain)? Does the number of people with whom you communicate change based on the forecast?
3. Who is missing from the map and why? (Are there people/countries/sectors missing?)
4. What are obstacles you face in growing and enhancing your communication network around seasonal climate information?

Preliminary Social Network Analysis Results

We combined all responses to produce a single season climate forecast network map; in some situations, we follow up with participants after the meeting to clarify their responses. For simplicity, Figures 5a and 5b show the networks of met service professionals and non-met service professionals. The seasonal climate information network identified by the workshop participants has the following key features:

» **The network is centralized.**

» **The network has relatively low number of connections (i.e., low density).**

» **People and organizations tend to receive the seasonal climate forecasts from only one or a few sources.**

» **Met and non-met service professionals mostly communicate within their country; they also tend to communicate across many sectors within their respective country.**

Characteristics of Centrality and Density in Climate Resilience Studies

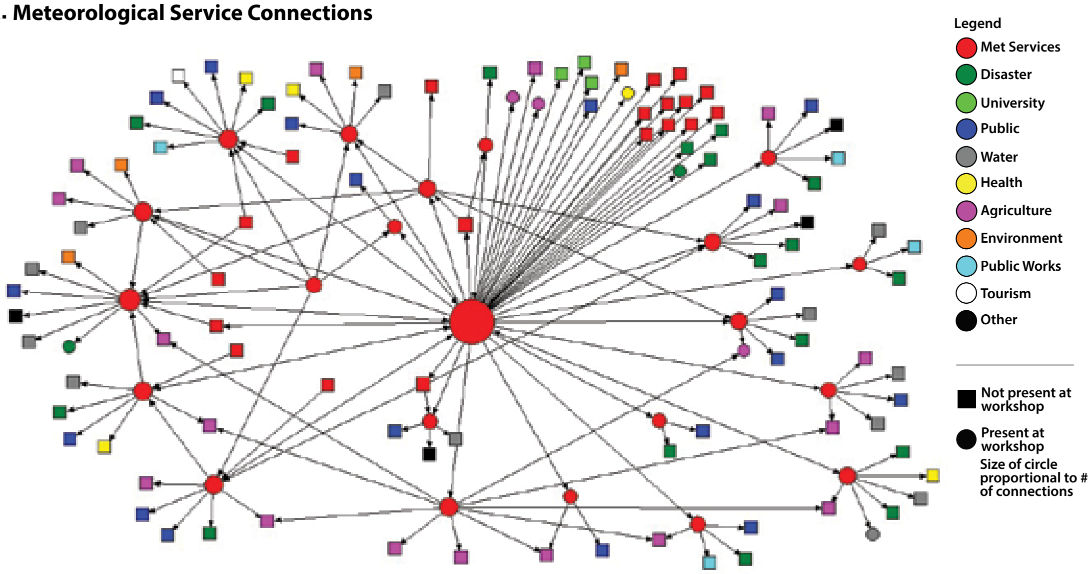
A centralized network is characterized when one or a few organizations possess a large number of ties[15]. CIMH fills this role as being the primary disseminators of the seasonal climate forecast across a wide range of organizations and sectors. The advantages of a centralized network are that it enables the relatively quick and efficient spread of information[16] and it is effective in forming groups and building support for action through the central actors' abilities to prioritize and coordinate activities. Some disadvantages of centralized networks relate to the central actors' difficulty in maintaining close contact with the many actors. Also, in highly centralized networks, influence can be unequal. Consequently, concerns related to legitimacy and the proper inclusion of other actors needs to be carefully stewarded[17].

Network density is defined as the number of connections per network actor. Similar to centrality, it can have opposing effects depending on the context. For example, a high density may contribute to the strengthening of trust between individuals and groups and may increase accessibility to information[18]. On the other hand, a high density can cause individuals to adopt similar perceptions, which can impede the incorporation of new information.

Information Brokers

Both met and non-met service professional communicate with diverse audiences. Met service professionals, on average, share the seasonal climate information with about 6.2 organizations (4.6 excluding CIMH), while non-met service professionals share the forecasts with 3.8 organizations. However, even the most valuable information may not be utilized if it is difficult to understand, regardless of how many people it reaches. This applies to the seasonal climate forecast, which has a history of underuse or neglect for numerous reasons, including difficulty in interpreting the forecast and being bereft of local meaning[19]. The discussion session, however, revealed that adding supplemental information to the forecasts addresses these challenges. These knowledge-brokering efforts are summarized in Table 4 and suggest that future efforts to enhance the use of seasonal forecasts should also bolster the ability to provide contextual information.

5a. Meteorological Service Connections



5b. Non-meteorological Service Connections

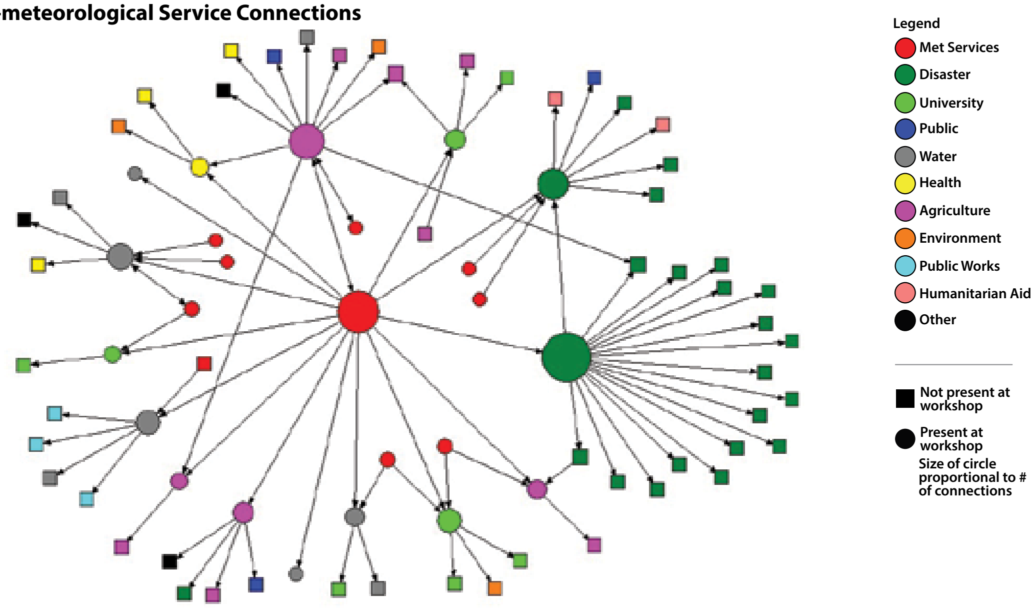


Figure 5. (a) Seasonal climate forecast communication connections for meteorological service professionals. (b) Seasonal climate forecast communication connections for non-meteorological service professionals. Node colors correspond to different sectors. Arrows denote the direction of the communication.

Table 4

Group: Non Meteorological Service Professionals

Brokering Activities	Number Responses	Select Responses
Forecast clarification	6	» **Explain legend (i.e., the meaning of above normal)** » **Write out abbreviations** » **Use examples or explain terminology** » **Include a simplified interpretation of what the forecast means** » **Provide information on uncertainty**
Supplemental data that puts forecast in the context of weather and climate variability	3	» **Add data specific to country and locale (i.e., rainfall, temperature)** » **Add rainfall information**
Explanation of potential local impacts	9	» **Use examples of what the forecast would mean to farming** » **Provide impacts on crops** » **Include information on potential impacts for sectors and counties** » **State implications for mosquito breeding potential** » **Report impacts on environmental quality in general**
Recommendation on preparations	8	» **Provide recommendations on actions to be taken** » **Provide responses of use of forecast information for planning** » **Add information on proposed collaborative actions to be taken between the two isles for preparedness and mitigation planning** » **Provide recommendations on required action per sector and collectively for preparedness and mitigation planning** » **Provide recommendations on prepositioning of resources** » **Advise on expected impacts and actions to take**
Summary of current conditions	1	» **Report local field conditions**
Additional data or information	2	» **Provide information to be used in planning and engineering** » **Include previous forecast and outcomes to compare likely impacts**

Group: Meteorological Service Professionals

Brokering Activities	Number Responses	Select Responses
Forecast clarification	5	» **Provide information on how to interpret the information** » **Include information on how to interpret and respond** » **Explain acronyms**
Supplemental data that puts forecast in the context of weather and climate variability	12	» **Provide expected upper and lower amounts and expected amounts during normal, above- and below-normal seasons** » **Provide monthly summaries, forecast background, and discussion** » **Provide information about the last season's conditions, including maximum and minimum temperatures and rainfall** » **Possibly adjust and add information to suit our country's topography and livelihoods** » **Review of the past three months' rainfall**
Explanation of potential local impacts	4	» **Note how the islands would be affected** » **Suggest implications of the current outlook** » **Talk about likely impacts based on sectors**
Recommendation on preparations	2	» **Provide advice to farming community** » **Provide information on how to interpret and respond**
Summary of current conditions	2	» **Include information about accessing the data online** » **Provide SMS format and feedback**
Additional data or information	2	» **Include short summary of the outlook to newspapers** » **Provide adequate headlines and take away messages**

Information brokering activities commonly identified by participants during the seasonal climate forecast network activity.

Steps Toward Identifying Evaluation Metrics for Caribbean Climate Services

Climate services include the development, provision, and contextualization of climate-related information to support decision making at all levels of society[20]. While there are examples in which these services have enhanced economic and social well-being, there are also cases in which they have been neglected or underused, in part because information was developed without detailed knowledge of its use. Evaluating how climate services are applied and their outcomes can be an instructive component of providing services that meet the needs of decision makers.

Evaluation has gained importance in climate services in recent years as burgeoning demand for climate information has increased the importance of customizing products and effectively allocating limited resources. Evaluation can reveal whether the outcomes of an activity satisfy that activity's goals. This requires not only stating the goals, but also detailing how performance will be measured. Because the CariCOF is the main mechanism for capacity building and for the production and disseminating of seasonal climate information, an assessment of the use and impact of the CariCOF and its products can help inform the creation of new information and ensure that ongoing activities do not become outdated.

The IRAP project began developing an evaluation of the CariCOF by convening a small focus group consisting of 15 participants and then facilitating a plenary discussion with all of the workshop participants. In both cases, the following questions were addressed:

1. What are the goals of the CariCOF and of similar climate services in this region?
2. What indicators can be used practically to measure whether these goals are being met?

Possible Goals of the CariCOF and Other Climate Services

The focus group and plenary discussion identified several potential goals of the CariCOF and other climate services in the region (Table 5).

Table 5

Possible Goals of the CariCOF and Other Similar Climate Services
1. Develop useful outputs and products
2. Improve communication of climate information
3. Build capacity, community, and networks
4. Support evidence-based decision making
5. Improve quality and relevance of climate information used in decision making
6. Promote and inform better policies
7. Clarify when climate information should not be used in decisions
8. Reduce vulnerability and build resilience
9. Enhance livelihoods and incomes

Possible Indicators for Evaluating Climate Services

There also was general agreement among the participants about the benefit of collecting information to evaluate the provision of climate information in meeting the aforementioned goals. Participants described several themes and their related indicators that could be used to measure progress (Table 6). While data for some of these indicators are currently being collected, others would require new monitoring efforts. However, the discussions also highlighted that sufficient

data collection will require synchronized and consistent monitoring across space and time, and participants were concerned about the time and resources needed to collect the information.

Table 6. Participants described themes and their related indicators that could be used to measure progress toward meeting the goals listed in table 5.

Themes	Indicators	Goals Addressed
Capacity Building	» Who attends the COFs (numbers, sectors, countries, agencies, returnees, etc.) » Who is trained in creating, communicating, and using outlooks	1, 2, 3, 7
Forecast Quality	» Comparisons of previous outlooks to observations (skill, reliability) » Confidence in forecasts by COF participants	1, 3, 7
Customized Products	» Number of secondary products developed that are tailored to specific uses/sectors	1, 2, 3, 4, 5, 8, 9
Understanding, Communication, and Use	» Follow-up surveys of COF participants and broader user community (did they understand products, how did they use them, with whom did they communicate) » Number and type of COF products presented on web, newsletters, and media » General public awareness of climate (analysis of media, public opinion) » Jobs that include climate responsibilities » Farmers and households receiving and using climate information	1, 2, 7, 4, 8,
Demand	» Web hits, downloads, calls to CIMH, CCCCC, etc. » Requests to brief or consult government agencies	1, 2, 3, 4, 5, 6
General Reporting Metrics	Data used for other evaluation or reporting purposes that is relevant to understand climate-related outcomes, including: » Disaster/disease incidence, impacts, responses » Agricultural production, food prices » Poverty measures » Data collection by international agencies (e.g., World Bank)	1, 4, 5
Climate-informed Policies	» Reports and policies that mention climate information or risks » Use of climate risk management tools	1, 4, 6, 8, 9

Improving the CariCOF and Next Steps.
www.vimeo.com/album/2929233/video/101557388

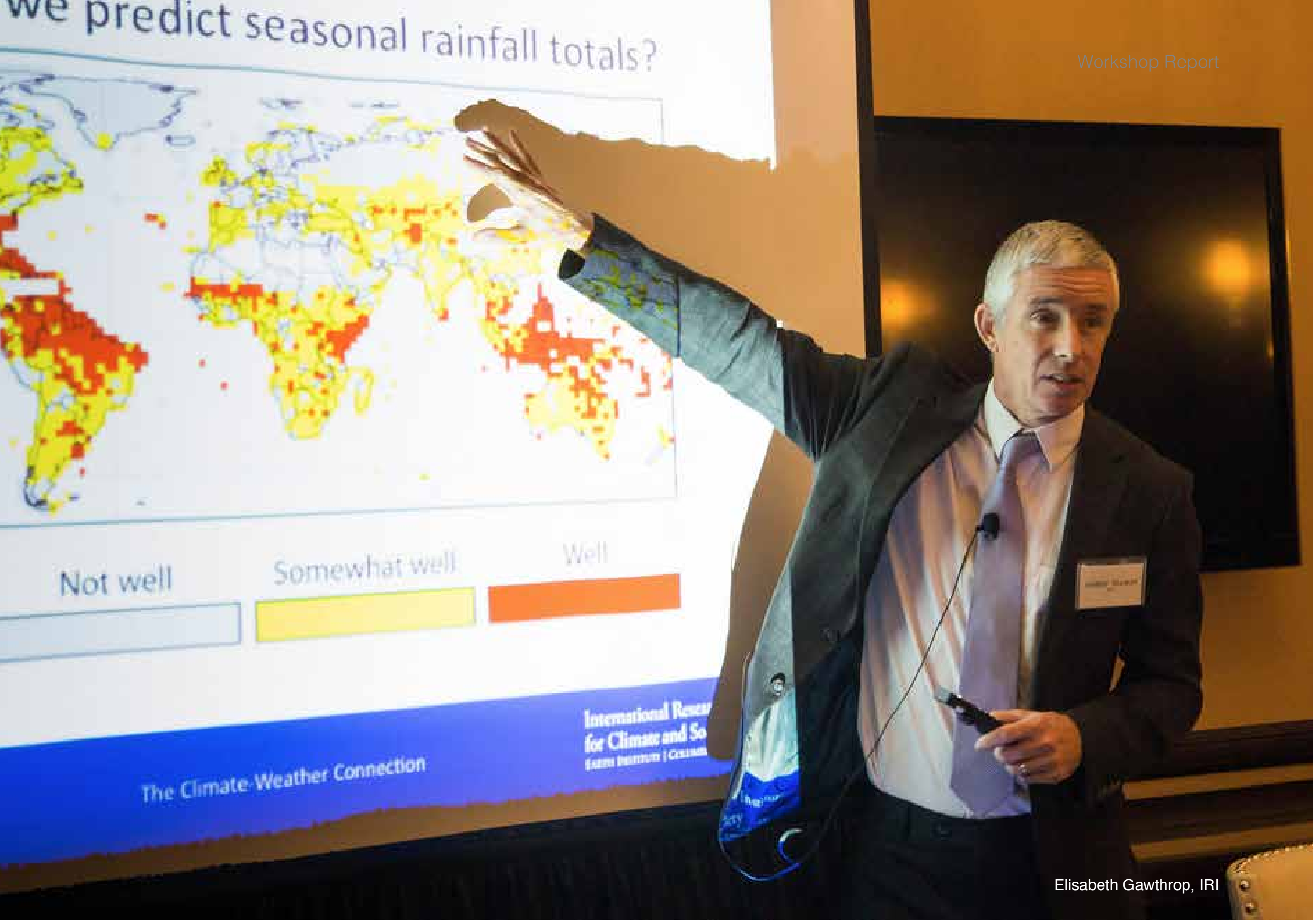
Seasonal Climate Information: Barriers and Opportunities for future CariCOFs

During several exercises and in the 11 interviews held, participants discussed their barriers to using seasonal climate information. Their responses are summarized in Table 7 and are similar to those noted elsewhere[21]. Some barriers are difficult to overcome, such as "other job responsibilities" or "communicating the forecast is not part of [their] job," which might require hiring new personnel. Many barriers can be addressed, and those provide some guidance for points of emphasis for future CariCOFs. For example, the comment, "both forecast communicators and recipients may not understand how reliable the forecast is," suggests that information on past accuracy could help improve trust. Also, the comment that it is "difficult to answer what the forecast means for different people" can be addressed with campaigns to document the relevance of climate forecasts. While these activities are currently part of the CariCOF process, they may require more focused treatment and widespread communication, especially since the CariCOFs are convened in different locations each year and therefore do not necessarily engage the same people.

It is worth highlighting some of the comments in more detail. They generally fell into three categories: Capacity, Communication, and Relevance.

Capacity

Interviewees stated that the CariCOF has helped create a strong community for regional meteorological services and has provided valuable training, especially for early career staff. For example, it was agreed at the CariCOF to include training on sub-seasonal information next year, with the goal of providing information on the types of weather-related outcomes that might be expected given a probabilistic seasonal forecast. CariCOF's continued emphasis on training will help build technical and institutional capacities in the meteorological services. An element of these trainings could address weather and climate monitoring limitations because, as one respondent stated, "many countries do not have real time data, [which] is a major weakness affecting the accuracy of the models; a lot of the countries don't have funding allocated for weather stations, rain gauges, etc." Respondents also noted the challenges of limited staffing. One respondent stated the "meteorological services in many countries can barely keep up with the weather, and there is great difficulty in adding seasonal forecasting to their duties." This suggests that addressing staffing issues should accompany efforts to incorporate climate forecasting into



Elisabeth Gawthrop, IRI

meteorological service portfolios. Also, the purview of some meteorological services is more focused than others. One comment stated that in "countries where the met service is a separate entity, I think these fulfill a more broad-based function than where [met services] are set up in the airport structure and its focus is on providing aviation services."

Clarity and Communication

Interviewees expressed confusion and frustration with the tercile forecast system. One comment stated: "I know for sure that certain people that we have worked with, at certain levels, particularly if you are talking to a minister, look at the forecast and shut off. It is not obvious what to do with a tercile forecast, especially when there isn't a strong signal." However, even when forecasts favor wet or dry conditions, the format is not user friendly. One respondent pointed out "the fact that we had the big drought in 2010 and it was clear that the product had been out there but it didn't grab attention and it should have; people look at it and can't really understand it." Because tercile forecasts are difficult to interpret and communicate, one respondent stated: "we have to have a communications specialist in this forum so that they can bring to us best practices in terms of how this information can be communicated. Because what we might want to say to the people in health you may not use the same language for the people in water, and we need that kind of communication, risk communication, component to the forecast." Media would also benefit from attending the forums so that they help convey risk and clarify meaning. Enhancing understanding of the forecast can also be aided by providing supplemental information that helps contextualize it and "translate [it] into responses."

Relevance

Interviewees generally recognized that the CariCOF is producing and distributing useful climate information. However, convening national COFs that train and develop decision support tools for specific sectors can help enhance the use of climate information in decision making at the national and local levels. Several informants noted that the regional COF is not where the strongest dialogues between meteorological office and decision makers take place, in part because only a few people from each sector are able to attend, and those who do attend might not have the capacity to make decisions. "National COFs… draw more people into the discussion because

[they are] at the national/local levels where the action is, where decisions are made." National COFs also help address limited travel funding. Moreover, a more local discussion fuels developing new climate information services. One respondent stated: "The only way to start to tailor [information] is to sit down with separate users [and see] what they are getting from an outlook; how can this be extrapolated to have specific applications within agriculture, for example, and even within agriculture towards pest management or towards irrigation."

Table 7

Barrier	Common Responses
Capacity (job/organization limitations)	» **Communicating the forecast is "not part of the job"** » **Other job responsibilities, time is limited** » **Lack of mechanisms within organizations to distribute and communicate the forecast** » **Lack of a communications specialist within organizations** » **Limited technological capacity (e.g. website infrastructure; data collection)**
Understanding	» **The public does not understand the impacts and therefore would not act on the forecast** » **Limited understanding of seasonal forecast, which limits public and organizational buy-in**
Communication	» **Communicators have to be able to explain it; difficulty communicating uncertainty and probability associated with forecast** » **The tercile format is difficult to understand; media does not understand the forecast and do not communicate them effectively to the public**
Relevance	» **Difficult to make the information appropriate for recipients** » **Need more information specific to each sectors so they can communicate the impacts** » **Difficult to answer what the forecast means for different people**
Trust	» **The sender needs to trust the information because they are putting their name on the line** » **Both forecast communicators and recipients may not understand how reliable the forecast is**

A dairy farmer heads home after participating in an interactive exercise in December 2013 to determine worst drought years with IRI and other project partners. Photo credit: Sofia Martinez (IRI).

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Appendices

Appendix 1: Workshop Attendees Table

Name	Country	Organization	Sector
Adrian Shaw	Jamaica	Jamaica Meteorological Service	Meteorology and/or climate services
Adrian Trotman	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Andrea Applewhaite	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Andrea Gerlak	USA	The University of Arizona	Academic
Andrew Robertson	USA	Columbia University	Academic
Ángel Muñoz	USA	Columbia University	Academic
Avalon Porter	Cayman	Meteorological Office	Meteorology and/or climate services
Berny Fallas	Costa Rica	Instituto Costarricense de Electricidad (ICE)	Urban Planning
Candice Ramkissoon	Trinidad	Caribbean Disaster Emergengy Management Agency (CDEMA)	Disaster management
Catherine Cumberbatch	Belize	Meteorological Office	Meteorology and/or climate services
Catherine Vaughan	USA	Columbia University	Academic
Cavell Francis-Rhiney	Jamaica	Rural Agricultural Development Authority (RADA)	Agriculture
Cedric Van Meerbeeck	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Christina Green	USA	The University of Arizona	Academic
Christopher Cox	St. Lucia	Caribbean Public Health Agency (CARPHA)	Health
Daniel Osgood	USA	Columbia University	Academic
David Farrell	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Denniston Fraser	British Virgin Islands	Meteorological Office	Meteorology and/or climate services
Desiree Neverson	St. Vincent	Meteorological Office	Meteorology and/or climate services
Diana Liverman	USA	The University of Arizona	Academic
Dianne Dormer	Jamaica	Caribbean Meteorological Organization (CMO)	Meteorology and/or climate services
Donna Canterbury	Guyana	Guyana Water Inc.	Water
Doodnauth Ramlakhan	Guyana	Meteorological Office	Meteorology and/or climate services
Elisabeth Gawthrop	USA	Columbia University	Academic
Elizabeth Johnson	Jamaica	Inter-American Institute for Cooperation on Agriculture (IICA)	Agriculture
Fimber Frank	Grenada	Meteorological Office	Meteorology and/or climate services
Francine Webb	Jamaica	Rural Agricultural Development Authority (RADA)	Agriculture
Gayle Drakes	Barbados	Caribbean Disaster Emergency Management Agency (CDEMA)	Disaster management

Name	Country	Organization	Sector
Geoffrey Marshall	Jamaica	Jamaican Water Resource Authority	Water
Glendell DeSouza	Trinidad	Caribbean Meteorological Organization (CMO)	Meteorology and/or climate services
Glenroy Brown	Jamaica	Jamaica Meteorological Service	Meteorology and/or climate services
Hastin Barnes	Antigua	Antigua Public Utilities Authority (APUA)	Urban Planning
Ivy Gordon	Jamaica	Jeffrey Town Farmers	Agriculture
Jacqueline Spence	Jamaica	Jamaica Meteorological Service	Meteorology and/or climate services
Jean-Louis Maridet	Martinique	Meteorological Office	Meteorology and/or climate services
Jeffrey Jennings	Anguilla	Meteorological Office	Meteorology and/or climate services
Jeremy Collymore	Barbados		Other
Jim Buizer	USA	The University of Arizona	Academic
Joffrey Boekhoudt	Curacao	Meteorological Office	Meteorology and/or climate services
John Furlow	USA	USAID	International Development
Joseph Irish	Montserrat	Meteorological Office	Meteorology and/or climate services
Junior Mathurin	St. Lucia	Water Risk Management Association	Water
Kelli Armstrong	USA	Columbia University	Academic
Kendre Wilson	Turks and Caicos	Meteorological Office	Meteorology and/or climate services
Kenneth Kerr	Trinidad	Meteorological Office	Meteorology and/or climate services
Kevon Rhiney	Jamaica	UWI Geography and Geology Department	Academic
Leslie Simpson	Jamaica	Caribbean Agricultural Research and Development Institute (CARDI)	Agriculture
Lisa Goddard	USA	Columbia University	Academic
Lisa Kirton-Reed	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Lisa Vaughan	USA	National Oceanic and Atmospheric Administration (NOAA)	Meteorology and/or climate services
Marck Oduber	Aruba	Meteorological Office	Meteorology and/or climate services
Marieta Hernandez-Sosa	Cuba	Instituto de Meteorología (INSMET)	Meteorology and/or climate services
Mea Halperin	USA	Columbia University	Academic
Meredith Muth	USA	National Oceanic and Atmospheric Administration (NOAA)	Meteorology and/or climate services
Michael Taylor	Jamaica	Department of Physics, UWI	Academic
Norville Abraham	St. Vincent	Caribbean Farmers' Network (CaFAN)	Agriculture
Odalys Martinez	Puerto Rico	Meteorological Office	Meteorology and/or climate services

Name	Country	Organization	Sector
Ottis Joslyn	Belize	Caribbean Community Climate Change Center (CCCCC)	Meteorology and/or climate services
Patricia Ramirez	Costa Rica	Comité Regional de Recursos Hidráulicos Sistema de la Integración Centroamericana (CRRH-SICA)	Water
Paulette Bynoe	Guyana	University of Guyana	Academic
Pilar Lopez	Panama		Other
Richard Johnson	USA	The University of Arizona	Academic
Rosalind Blenman	Barbados	Meteorological Office	Meteorology and/or climate services
Samantha Garvin	USA	Columbia University	Academic
Seluvaia Finaulahi	Tonga		Other
Sharon Hutchinson	Trinidad	University of West Indies	Academic
Shawn Greenaway	St. Kitts	St. Kitts Water	Water
Shelly-Ann Cox	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Sheryl Etienne-LeBlanc	St. Maarten	Meteorological Office	Meteorology and/or climate services
Shontelle Stoute	Barbados	Caribbean Institute for Meteorology and Hydrology	Meteorology and/or climate services
Simon Mason	USA	Columbia University	Academic
Sowdamini Saraswati	USA	Columbia University	Academic
Sukarni Mitro	Suriname	Meteorological Office	Meteorology and/or climate services
Swastika Devi	Fiji		Other
Sylvester St. Ville	Dominica	Ministry of Health	Health
Tanya O'Garra	USA	Columbia University	Academic
Tracy-Ann Hyman	Jamaica	University of West Indies	Academic
Trevor Thompson	Grenada	National Oceanic and Atmospheric Administration (NOAA)	Meteorology and/or climate services
Vadlamani Kumar	USA	National Oceanic and Atmospheric Administration (NOAA)	Meteorology and/or climate services
Valerie Roundtree	USA	The University of Arizona	Academic
Venantius Descartes	St. Lucia	Meteorological Office	Meteorology and/or climate services
Vernie Marcellin-Honore	Dominica	Meteorological Office	Meteorology and/or climate services
Walter Baethgen	USA	Columbia University	Academic
Wasilla Thiaw	USA	National Oceanic and Atmospheric Administration (NOAA)	Meteorology and/or climate services
Wordsworth Gordon	Jamaica	Jeffrey Town Farmers	Agriculture
Zack Guido	USA	The University of Arizona	Academic

Appendix 2: Sectoral Attendance

Sector Categoires	Number
a. Health	2
b. Water	5
c. Tourism	0
d. Fisheries	0
e. Disaster management	2
f. Agriculture	7
g. International Development	1
h. Urban planning	2
i. Meteorology and/or climate services	38
j. Academic	25
k. Other (please specify):	4

Appendix 3: Country Attendance

Countries	Number
Anguilla	1
Antigua	1
Aruba	1
Barbados	10
Belize	2
British Virgin Islands	1
Cayman	1
Costa Rica	2
Cuba	1
Curacao	1
Dominica	2
Fiji	1
Grenada	2
Guyana	3
Jamaica	14
Martinique	1
Montserrat	1
Panama	1
Puerto Rico	1
St. Kitts	1
St. Lucia	3
St. Maarten	1
St. Vincent	2
Suriname	1
Tonga	1
Trinidad	4
Turks and Caicos	1
USA	25

Appendix 4: World Café Literature Review References

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