"This report was funded by a grant from the NOAA Adaptation Sciences program (Grant # NA23OAR4310114), with funding from the United States Department of State. The opinions, findings and conclusions stated herein are those of the author[s] and do not necessarily reflect those of the United States Department of State."

Enhancing Climate Resilience in the Caribbean Through the Improvement of Caribbean Climate Outlook Forums (CariCOF) Project

Prepared for the Caribbean Institute for Meteorology and Hydrology

Submitted October 31, 2024
Revised December 12, 2024

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LIST OF ACRONYMS

AACARI	Agricultural Alliance of the Caribbean
CariCOF	Caribbean Climate Outlook Forum
CARDI	Caribbean Agricultural Research & Development Institute
CARICOM	Caribbean Community
CAROGEN	CariCOF Outlook Generator
CARPHA	Caribbean Public Health Agency
CCID	Caribbean Climate Impacts Database
CDEMA	Caribbean Disaster Emergency Management Agency
CHTA	Caribbean Hotel and Tourism Association
CIMH	Caribbean Institute for Meteorology and Hydrology
CPT	Climate Predictability Tool
CTO	Caribbean Tourism Organization
DRM	Disaster Risk Management
EWISACTs	Sectoral Early Warning Information Systems Across Climate Timescales
GFCS	Global Framework for Climate Services
GWP-C	Global Water Partnership - Caribbean
IRL	International Resilience Lab
M&E	Monitoring and Evaluation
n	Number
NCOFs	National Climate Outlook Forums
NMHS	National Meteorological and Hydrological Services
PAHO	Pan American Health Organization
RCF	Regional Climate Forum
RPA	Regional Roadmap and Plan of Action
OECS	Organization of Eastern Caribbean States
SPI	Standardized Precipitation Index
TOR	Terms of Reference
W&C	Weather and Climate
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Summary

The Caribbean Climate Outlook Forum (CariCOF) consists of four interrelated and temporally distinct activities, each of which have their own objectives. A monthly virtual discussion convenes forecasters to refine seasonal climate outlooks both at the national and regional scales. This is followed by the dissemination of the products to the public each month. A multi-day and in-person training for forecasters occurs twice each year prior to the onset of the wet and dry seasons and helps forecasters hone forecasting techniques. Finally, a multi-day event, the "Forum," follows the forecaster training and creates a space for forecasters and sectoral stakeholders to interact around seasonal risk management twice a year.

The numerous and distinct activities make the CariCOF a knowledge network. The network is centered around seasonal risk information with the Caribbean Institute for Meteorology and Hydrology (CIMH) as its primary steward. The network has subnetworks whereby information and knowledge penetrate to the national levels through forecaster and sectoral stakeholder relationships.

In the broadest sense, the CariCOF has an overarching goal of advancing regional climate resilience in the Caribbean. Across the four activities, it pursues this goal by creating regional climate information products, developing professional networks, increasing climate risk awareness, strengthening stakeholder and forecaster capacities, and elevating the importance of enhancing seasonal climate risk management.

The goal of the CariCOF is pursued against a backdrop of numerous barriers perceived by the CariCOF participants to impede the use of seasonal climate information. Some barriers have been long-standing, like limitations in the technical capacity of the smaller-island states and difficulties associated with interpreting the meaning of the technical information. Other barriers are localized or newer, like integrating CariCOF information into national plans, and still others have waned in frequency and/or hindrance over time. Many of the barriers in the Caribbean are well evidenced across the world.

While barriers include the technical quality of the information, people we surveyed and interviewed generally perceive the information produced by CariCOF to be credible. Access to information is also not considered a major barrier. In this context, a major achievement of the CariCOF has been the development of new products and services, and the current state of the CariCOF is marked by its contribution to 19 outlooks, bulletins, and other analytical tools. The product development has been a "living laboratory" that has increased choice, ostensibly providing information for a larger number of people. But more information is not a panacea, nor immune to the creation of different challenges. Over the years, the CariCOF has also focused on tailoring their products to societal sectors and providing support for the use of climate information by facilitating collaboration, brokering, and learning.

The in-person Forum has engaged more than 500 people since 2014, about half of whom have attended more than one Forum. The participants that we surveyed (n=123) and interviewed

(n=27) who experienced at least one CariCOF almost uniformly perceive that the CariCOF has played an important role in seasonal climate risk management in the Caribbean. The evidence for this can be seen in the diverse uses of CariCOF information.

Our position on use is broader than the traditional model used in climate services. The traditional model conceptualizes "use" almost exclusively in relation to decision-support that leads to tangible and observable activities. A singular focus on the role of climate information in decision-making is narrow and overlooks the benefits of relationships, learning, and emotional effect. Each of these uses have strong associations with the capacities that generate climate resilience as evidenced across diverse fields including public health, agricultural economics, humanitarian aid, and sustainable development. Moreover, by the admission of the people who participate in the CariCOF, the benefits of the CariCOF are largely about learning and relationships. Characterizing "use" broadly is therefore an apt fit for the CariCOF and aligned to the goals of climate services writ large.

In this context, there are diverse uses of the information supported by the CariCOF. While many of the uses that influence decision-making directly were bereft of details needed to make a strong link between the information and the decision, the people we queried perceive the information to be important. The diversity of uses we chronicle present evidence in support of this perception.

The use of the information in multiple ways leads to a central question about the CariCOF: How does it advance seasonal climate resilience?

Our answer to this question is through several interdependent pathways. The pathways manifest because the CariCOF has had an influence on the use of climate information in decision-making, and on learning, relationships, and emotional effect, which are more difficult-to-measure but are themselves foundations for future decision-making. In fact, CariCOF participants identified six common objectives of the CariCOF that together go beyond decision-support.

The CariCOF's influence on information use is but one pathway it influences regional climate resilience. Our conclusion is that the CariCOF has also had a substantial influence on regional resilience by its influence on spreading an interdisciplinary risk management approach, sparking national-level seasonal risk management, being a platform to train forecasters, increasing awareness of climate impacts and risk management tools, and helping to drive a regional agenda for climate resilience.

Focus of Report

In totality, this report addresses eight topics specified in the Terms of Reference (TOR). Specifically, they relate to the barriers to communication, the CariCOF's network character, the quality and credibility of the information, the brokering activities, the use of the information, and the role of the CariCOF in regional climate resilience. Our inquiry has generated numerous Key Results that we briefly highlight in this Executive Summary and in more detail in the report that follows. And, while the Key Results showcase the wide-ranging impact of the CariCOF and provide explanations for its pathways of change, this research also had a goal to articulate opportunities for evolution. We briefly discuss these frontiers here as well, and we also elaborate on them in more detail in the main report.

The results and conclusion are based on layering complementary insights from five distinct research activities. We conducted an online survey among CariCOF participants in which 123 people responded. We interviewed 27 people who have had extensive experience over the years with the CariCOF. We analyzed all available CariCOF's agendas since 2014. We hosted two participatory workshops sessions at the Guyana CariCOF in May 2024, each 90 minutes and involving a total of 59 people. And we drew on our observations at the 2024 Guyana CariCOF.

Before proceeding, we will define terms and concepts. First, at mentioned above, the CariCOF is more than a "Forum." Our references to the "CariCOF" refer to the entire package, with "Forecaster Discussion," "Forecaster Training," "Forum", and "Monthly Outlook Dissemination," referring the separate components. Second, we consider CariCOF information products to consist of all the climate outlooks produced by CIMH[1] and the sectoral climate bulletins. Third, seasonal outlooks are comprised of a packet of information that presents and contextualizes the anticipated future climate conditions. Fourth, we use "forecasters" and "sectoral stakeholders" to represent the two main participants of the CariCOF. Finally, while we recognize the technical distinction between the words "forecasts" and "outlooks," we use them synonymously, which also reflects how people we interviewed understand the terms.

Key Results

1. CariCOF is more than a Forum.

The four main activities of the CariCOF are the following: 1) forecast discussions among forecasters that is convened each month; 2) an in-person, multi-day technical training for forecasters that is often convened twice a year; 3) an in-person, multi-day Forum attended by forecasters and sectoral stakeholders that is often convened twice a year; and 4) the dissemination of climate information products each month.

2. Participants recognize six main objectives of the CariCOF.

The six main objectives identified by CariCOF participants are the following: 1) to train forecasters to create and communicate seasonal climate outlooks; 2) to develop regional climate information products; 3) to assess the utility of new seasonal climate information products; 4) to increase understanding about the outlooks and climate risks, impacts, and solutions; 5) to create new professional connections and strengthen existing ones; and 6) to elevate the importance of seasonal climate risk management in the region.

3. Communication barriers persist but have reduced over time.

Over time, communicating climate information has become easier for both forecasters and sectoral stakeholders. Nonetheless, persistent challenges remain, including brokering climate information, providing explanations and supplementary details, clarifying the technical nature of the information, and tailoring for specific user groups.

[1] except for the SPI Outlook

4. The CariCOF network has expanded, and participants share the information.
At least 500 people have participated in one or more in-person Forums. Following the Guyana CariCOF in May 2024, the forecasters who participated in the CariCOF shared climate information with organizations in numerous sectors, while sectoral stakeholders who participanted in the CariCOF shared the information mostly within their own organizations.

5. The EWISACTs and CariCOF relationship has been of mutual benefit.
The Sectoral Early Warning Information Systems Across Climate Timescales (EWISACTs) has influenced the CariCOF by 1) encouraging continued participation of sectoral stakeholders in the Forum, 2) injecting sectoral perspectives into the design of climate products, and 3) providing a pathway for disseminating climate information across and within sectoral networks. In turn, CariCOF has helped advance EWISACTs goals and has helped shape the EWISACTs agenda for developing climate early warning information.

6. Contributions to diverse climate products.
There are 19 seasonal climate outlooks, bulletins, and decision-support tools to which the CariCOF has contributed. The high diversity of climate products has advantages and disadvantages. On the one hand, the CariCOF has significantly improved product development and provided information to a larger audience. On the other hand, creating new products is a challenge to the existing human resources, particularly for the smaller nations.

7. The quality and credibility of CariCOF climate products are high.
Forecasters and sectoral stakeholders have a positive perception of the scientific credibility of CariCOF products. The high level of perceived credibility may have been influenced by repeated exposure to the information over time and the perceived relevance of the information.

8. Information brokering activities deemed important are access and comprehension.
Increasing the ability of stakeholders to understand and access CariCOF information were the two most frequently emphasized objectives of information brokering. In general, the CariCOF participants believe that access and understanding of climate information is high in the region. Nonetheless, there is a desire by some participants to increase the CariCOF's emphasis on the education of climate science at the Forum, particularly to benefit the sectoral stakeholders.

9. Activities at the Forum.
Activities at the Forum generally fall into three categories: presentations, organized participatory activities, and discussion sessions. We highlight five results. (1) The time allocated for presentations have been more than participatory activities and discussions. (2) A large fraction of all three activities have been led by climate information producers. (3) Most Forums have introduced new outlooks or decision-support tools, and/or have organized activities to advance existing outlooks or tools. (4) Efforts to understand information uses, gaps, and needs were more prominent prior to 2018. (5) There is no sustained evaluation of CariCOF.

10. The use of CariCOF information goes beyond decision-making.
The CariCOF information is being used for decision-support and to influence relationships, learning, and emotional effect.

11. The CariCOF contributes to regional climate resilience through six pathways.

The six pathways by which the CariCOF influences resilience in the Caribbean are 1) it facilitates the use of climate information; 2) it enhances a holistic and interdisciplinary approach to risk management; 3) it helps spark national-level risk management; 4) it strengthens the capacity of regional forecasters; 5) it raises awareness of climate impacts and risk management tools; and 6) it supports the development of a regional agenda for climate resilience.

Opportunities For Evolution

The CariCOF is a "living lab." The outlooks have evolved, different Caribbean initiatives have interacted with the CariCOF, and the Forum activities have addressed diverse risk management themes. In the spirit of growth, the totality of our results sheds light on opportunities for the CariCOF to evolve. The following 11 opportunities relate to three complimentary themes: strategic planning, monitoring and evaluation, and the form and format of the Forum. The 11 opportunities are meant to spark discussion on innovation and not to be prescriptions.

Strategic Planning

1. Develop a CariCOF roadmap.

The CariCOF is an informal institution that influences regional climate risk management by advancing several objectives. However, among CariCOF participants, the objectives could be clearer and more transparent. Much like the EWISACTs developed a roadmap for early warning in the Caribbean, the CariCOF could engage in a similar planning exercise to publicly articulate the primary objectives and choreograph a sequence of activities to meet them. Clear objectives would manage participants' expectations and, thus, limit misperceptions. The roadmap could help strategically layer activities. It would further allow the CariCOF to develop key performance indicators and identify ways of routine monitoring and evaluation. This could further help CariCOF leadership make an argument for continued funding. The objectives and roadmap do not need to be fixed in time but can be refined with periodic revisioning.

2. Capitalize more on the moment.

The Forum is a significant event, mostly for the host country. How, then, can the CariCOF better capitalize on the Forum to capture the attention of non-host countries? This question takes inspiration from comments highlighting an opportunity for the CariCOF to become savvier with communication technologies, in particular video, and to be strategic about messaging. Because the forecasts are both regional and national, their presentation at the Forum could be offered in a hybrid format and designed to draw broader attention. This format could extend the reach and be cost-effective. Media could be invited from other countries. While internet connectivity and bandwidth may present limitations, there are perhaps new and economical solutions like Star Link. Alternatively, the session could be designed with videos in mind. It could be recorded and uploaded to websites and feature short segments to facilitate post distribution via social media. The session in which forecasts are presented at the Forum could also include stakeholder presentations to complement the forecasts with national-level views and experiences.

3. Reconcile trade-offs in the CariCOF approach.

There have been intentional decisions to expand the CariCOF product line and to be strategic with invitations to attend. These decisions are justifiable, but also create trade-offs. Our analysis

revealed three areas where trade-offs appear most consequential. 1) There is a deliberate strategy to have a mix of experienced CariCOF attendees and first-time attendees. The challenge is to thread the needle, making the information not too technical for the new attendees but not too repetitive and elemental for the seasoned attendees. There is evidence that that new sectoral stakeholders are overwhelmed, while more seasoned attendees what a deeper engagement. 2) There is an emphasis on new products. Product growth appeals to a larger number of users and fits more applications. However, a growing product line strains the limited resources available to tailor products while adding more tasks at national levels. 3) The topics of focus at the Forum are varied but, in the process, the Forum does not reach the depth that some participants desire.

Monitoring and Evaluation

4. Learn about the CariCOF.

While some monitoring and evaluation (M&E) has been conducted, there is room for expansion and to make it more routine. We identified three opportunities to enhance M&E of the CariCOF: 1) utilize anonymous feedback forms, 2) increase the frequency of feedback, and 3) make written feedback an expectation for participation in the Forum.

5. Frequent monitoring of the network.

The CariCOF network is likely large and in constant flux. Continuous monitoring of the network could generate useful insights for programmatic decisions. It could reveal sectoral or institutional gaps to inform invitations. It could generate knowledge about which products are shared, providing rationale on which to prioritize and customize while also prompting deliberations on which to sunset. It could generate examples of how CariCOF affects climate risk management and how it supports regional resilience, which could be used as rational for future funding. The learning produced from frequent network monitoring could be valuable information for funders, regional decision-makers, and Climate Outlook Forums hosted in other regions. The monitoring of the network need not be burdensome. The tool we developed, for example, takes only about ten minutes to complete and it, or a version of it, could be implemented after future CariCOFs.

6. Monitor use.

It was not possible to understand in depth how climate information is used for decision-making, largely because forecasters and sectoral stakeholders were unable to provide concrete and detailed examples. A dedicated process at the CariCOF to collect examples could help monitor and evaluate the existing climate products, customization, the need for new climate products, and/or the retirement of existing ones. This information also would be essential for demonstrating the societal impact of the CariCOF. However, a focus on decision-making could be complimented by cataloging other non-instrumental uses because the CariCOF participants benefit from their participation via learning, relationships, and emotional effect. A broader focus on use could contribute to more complete accounting of the benefits of the CariCOF.

Forum Form and Format

7. Training for sectoral stakeholders.

The CariCOF trains forecasters, but no training exists for sectoral stakeholders. A sectoral stakeholder training could advance the social learning at the CariCOF by placing sectoral

stakeholders in a better position to converse with the forecasters and to interpret and explain the forecasts to people in their networks. Training could occur in a session within the current two-day Forum or be developed separately. A sectoral stakeholder training could focus on interpreting the forecasts, risk communication, demystifying how forecasts are made, or on broader climate topics. While some of these topics have been covered in past Forums, there are new sectoral stakeholder participants at each CariCOF, and repeat attendees have also suggested deeper dives into some topics.

8. Training on communication and information brokering.

Both sectoral stakeholders and forecasters who attend the CariCOF communicate the information within their networks. Consequently, communication is a salient topic among CariCOF participants and ripe for future training sessions. The science of risk communication is evolving as are new tools like AI generated text and video and social media platforms. Training could focus on these topics or delve into topics where in-house expertise resides, such as communicating forecast uncertainty, tailoring messages for different uses, and lessons learned about communication among CariCOF participants. While there has been an emphasis on communication in past Forums, this topic is prime for refreshers and/or an ongoing series. Coupling these sessions with video and hybrid recordings could be an ever-green resource.

9. Create space at the Forum for sectoral stakeholders to share experiences.

Presentations at the Forum are the most common session type. Most of these presentations are delivered by forecasters, CIMH, research organizations, or another climate information producer group. There is an opportunity to expand the voices at the Forum and provide space for sectoral stakeholders to share their national experiences by presenting on lessons learned, challenges, and the relationship between climate information and their work. Such a format could help improve understanding of sectoral information use and gaps. Sectoral stakeholder presentations have occurred in the past and could be made a more prominent or regular occurrence in the future.

10. Increase time for discussions after presentations.

A large fraction of the time allocated on the Forum agendas is for presentations, while far less time is allocated for discussions. Furthermore, presentations often run longer than planned and consequently time is taken from the discussions to keep on schedule. Allocating more time for discussions could offer several benefits for participants, including an exchange of national experiences, clarifications that lead to a deeper understanding of topics, and feedback that can inform future forums.

11. Explore climate risk management activities.

There is an opportunity to develop sessions at the Forum that make climate risk management activities central. Historically, the Forum seeks to increase awareness of and tools for climate risk management. In so doing, the primary question asked at the CariCOF has been: *How can seasonal climate information contribute to climate risk management?* A complementary approach could develop sessions focused on the activities being implemented (or that are needed) to prepare for the dry and wet seasons, heat waves, climate change, among others. Inquiry then can be made about the role of climate information in supporting those activities. In this construction, the primary question asked is: *How can climate risk management be supported by climate information?*

1. INTRODUCTION

The Caribbean region stands out as one of the most climate-sensitive areas globally and is particularly prone to disasters (IPCC, 2014; UNISDR, 2013). The disasters affect all sectors of society, with a disproportionate impact on the most vulnerable communities. One way to support communities is to provide usable weather and climate (W&C) information (Lemos et al., 2012).

While providing W&C information is crucial for the Caribbean region, its use is not guaranteed (Mahon & Trotman, 2018). Mahon and Trotman (2018) assessed the use of climate information in the region and identified three main barriers: 1) end-use climate literacy gaps; 2) the nature and quality of the climate information; and 3) processes of engagement between providers and users of W&C information. These barriers highlight the importance of addressing various factors that go beyond the mere provision of W&C information to ensure effective use.

One mechanism to go beyond the mere provision of W&C information to ensure effective use is through regional forums that convene scientists and decision makers in the production and dissemination of W&C information. The Caribbean Climate Outlook Forum (CariCOF) is an example of a regional forum in the Caribbean. It is organized by the Caribbean Institute for Meteorology and Hydrology (CIMH).

The CariCOF history dates to 1998 but it began to be a routine initiative in 2012. Since 2014, it has been convened regularly. Previous studies investigated the CariCOFs between 2014 and 2016 (Guido et al., 2016; Gerlak et al., 2017; Gerlak et al., 2020). This report marks a reassessment of the CariCOF to account for its changing in form and function and to bring out new insights instructive for designing future CariCOFs. An author on this report was also a co-author on the three studies between 2014 and 2016.

As stated in the Terms of Reference (TOR), the study pursued the following eight objectives.

1. (1a) Re-assess the nature and extent of information brokering and communication activities at the CariCOF; and (1b) how these activities affect planning, decision and policymaking.
2. Assess persistent and/or new barriers to seasonal climate forecast communication (since 2014).
3. Assess the structure, extent, and evolution of knowledge networks at CariCOF that contributes to information generation and dissemination.
4. Assess whether and how the CariCOF is improving the quality and credibility of the climate information it offers.
5. Assess whether and how the CariCOF is diversifying climate products for applications and contexts.
6. Assess if and how CariCOF participation influences use of climate information.
7. Assess the impact of EWISACTs on CariCOF.

For better readability, we grouped these objectives into sections, and we present each section in the report in a logical order. Table 1 corresponds the TOR objectives to the sections in this report. The first two sections and the last were not specified in the TOR. We nonetheless address them because the first two provide important context for those that follow, while the final section

addresses the impact of the CariCOF on regional resilience, which is an underlying interest of this assessment.

Table 1. Cross references between the sections in the results and the eight objectives listed in the TOR. The numbers aside the TOR objectives correspond to their order of presentation in the TOR.

Sections	TOR Objectives
2.1. What is the CariCOF	
2.2. CariCOF Objectives	
2.3. CariCOF Information Barriers	2. Assess persistent and/or new barriers to Seasonal Climate Forecast communication (since 2014).
2.4. CariCOF Network Character and Influence	3. Assess the structure, extent, and evolution of knowledge networks at CariCOF that contributes to information generation and dissemination. 7. Assess the impact of the Early Warning Information Systems Across Climate Timescales (EWISACT)s Consortium on CariCOF.
2.5. Technical Information: Diversity, Quality, and Credibility	5. Assess whether and how the CariCOF is diversifying climate products for applications and contexts. 4. Assess whether and how the CariCOF is improving the quality and credibility of the climate information it offers.
2.6. Information Brokering at the CariCOF: Nature, Extent and Influence on Use	(1a) Re-assess the nature and extent of information brokering and communication activities at the CariCOF (1b) how these activities affect planning, decision and policymaking.
2.7. CariCOF Information Use	6. Assess if and how CariCOF participation influences use of climate information.
2.8. What is the role of the CariCOF in regional seasonal climate resilience?	

The results are based on layering complementary insights from descriptive statistics generated from the online survey, a qualitative analysis of interviews, an analysis of all the available CariCOF's agendas since 2014, two participatory workshops sessions facilitated by the research team at the Guyana CariCOF in May 2024, and the authors' participant observations at the 2024 Guyana CariCOF. Our methods of data collection and analysis are described in the Methodology Section that follows the Opportunities for CariCOF Evolution.

We use quotes from the interviews where appropriate to include the voices and perspectives of the CariCOF participants. Some quotes have been slightly edited for anonymity. We select quotes because they represent ideas that were common in the interviews and because they provide a particularly insightful idea. However, we also include at times idiosyncratic ideas when they present uncommon views that can nevertheless be instructive.

Before proceeding, we need to define several terms and concepts. First, it was difficult to separate the CariCOF as an initiative from the broader activities of the CIMH, particularly with respect to the climate products developed. For purposes of this report, we define the CariCOF products as consisting of the sectoral climate bulletins and all the climate outlooks produced by

CIMH except for the SPI Outlook[2]. We came to this determination in consultation with CIMH and by referring to the Caribbean Regional Climate Center's website, which labels a set of climate outlooks[3] as "CariCOF Climate Outlooks."

Second, our assessment leads us to define the CariCOF as being constituted of four interrelated and temporally distinct activities. The activities are: 1) a monthly forecast discussion convened remotely among forecasters and led by CIMH; 2) a multi-day, invitation-only, and in-person technical training workshop for forecasters that is led by CIMH, has contributions from external trainers, and is convened twice a year; 3) a multi-day, invitation-only and in-person forum to strengthen capacity for forecasts and sectoral stakeholders led by CIMH twice a year; and 4) the dissemination of climate information products on a monthly basis. While this definition is itself a finding, it is equally important to understand from the onset that we are pursuing the research objectives from this comprehensive view of the CariCOF. Throughout this report, we will refer to each component as "Forecaster Discussion," "Forecaster Training," "Forum", and "Monthly Outlook Dissemination," respectively.

Third, we do not consider the seasonal outlooks to be simply a map or data depicting future conditions. Rather, an outlook is a packet of information that presents and contextualizes the anticipated future climate conditions. It can include recent past conditions, current conditions, historical averages for the season of interest, and potential impacts related to the forecasted conditions, including communication of uncertainty with respect to the anticipated conditions and impacts.

Fourth, we used the terms "forecasters" and "sectoral stakeholders" to represent the two main participants of the CariCOF. Forecasters are participants who analyze climate data to produce seasonal climate information and/or who work in organizations that focus on Meteorology and/or Climate, this includes the CariCOF organizers. Sectoral stakeholders are all other participants of the CariCOF.

Finally, we use the words "forecasts" and "outlooks" synonymously. We recognize the technical distinction between the words, but they are commonly used interchangeably by sectoral stakeholders. In this report, both words refer mostly to the sub-seasonal to seasonal timescale, which summarizes climate conditions from a few weeks to up to a year. Often, the seasonal outlooks represent 3-month intervals and are made for different lead-times.

2. RESULTS

The results section addresses the eight research objectives specified in the TOR along with three additional questions: what is the CariCOF, what are the objectives of the CariCOF, and what is its role in advancing regional resilience. These three additional questions are important for the assessment of the influence of CariCOF.

[2] see: https://rcc.cimh.edu.bb/spi-outlook/

[3] see: https://rcc.cimh.edu.bb/climate-outlooks/

This section proceeds first with a discussion on the objectives of the CariCOF as perceived by its participants, and is followed by sections on information barriers, the CariCOF network, the technical information produced at the CariCOF, information use, and the CariCOF's influence on regional resilience.

2.1 What is the CariCOF?

The use of the word "forum" in the CariCOF name is an apt starting place. Forums, according to Merriam Webster, are "mediums of open discussion or expression of ideas." The CariCOF is indeed a medium and not a singular activity. In fact, the CariCOF is constituted of four interrelated and temporally distinct activities, each of which have their own set of objectives. The activities are:

1. A monthly forecast discussion convened remotely among forecasters and led by CIMH.
2. A multi-day, invitation-only, and in-person technical training workshop for forecasters that is led by CIMH, has contributions from external trainers, and is convened, often bi-annually, prior to the onset of the wet and dry seasons in the Caribbean.
3. A multi-day, invitation-only, and in-person forum of forecasters and sectoral stakeholders led by CIMH and hosted, often, twice a year following and in the same location as the forecaster training event.
4. The monthly dissemination of climate information products.

The Forecast Discussion is attended by members of the NMHS and CIMH. It occurs every month except the two months during which the in-person CariCOF meeting and training is convened. The discussions in some way compare national forecasts to the regional forecasts. The discussion can influence the final versions of both the national forecasts and the regional forecasts. After the discussion, the national forecasts are disseminated by the NMHS to their national stakeholders and public and the regional forecasts are shared through regional stakeholders, websites, and listservs. There are a variety of ways in which the information is disseminated and packaged. Often, the forecasts are accompanied by other climate information such as historical averages, climate conditions in preceding months, and information on impacts.

Twice a year, an in-person technical training for forecasters is convened prior to a gathering of invited Caribbean sectoral stakeholders, forecasters, and dignitaries. These live events occur often in May and November before the onset of the wet and dry seasons, respectively, and are hosted in different Caribbean countries. The in-person technical training for forecasters reviews statistical forecasting techniques and data assimilation often using the Climate Predictability Tool (CPT) software; it further explores new forecasting products, like sub-seasonal forecasts or heatwave forecasts.

The Forum is often a 2-day intensive symposium of open discussion and exchanges of ideas. It is interactive and has participation from forecasters, sectoral stakeholders, and invited presenters. The latter includes governmental dignitaries and media. The Forum predominantly involves presentations and activities about seasonal climate outlooks, risk, impacts, and experiences.

The final activity of the CariCOF is the act of sharing the information. The diversity of the ways the information is shared as well as the diversity of the information itself requires this to be considered a unique dimension of the CariCOF.

2.2 CariCOF Objectives

The CariCOF's Forums and Forecaster Trainings have routinely occurred a total of 22 times since 2014. Its persistence and frequency, coupled with high repeat attendance–44% (272) of the 624 people who have attended a CariCOF (including members of CIMH) have attended more than one–helps make the CariCOF a knowledge system. Knowledge systems are conceptualized as consisting of a group of people who hold similar knowledge and who engaged in a process for knowledge generation and exchange (Guido et al., 2022).

The CariCOF has an overarching goal of advancing regional climate resilience, which it pursues in numerous ways. To identify how the CariCOF advances this goal, participants selected from a predefined set of options which they perceived as the CariCOF's main objectives. The results in Figure 1 show that the two most frequently selected options, at 58% and 49%, respectively, were to increase understanding and interpretation of the outlooks and to identify ways to improve both the quality and relevance of the technical information. Most of the objectives were selected by at least 10% of the respondents.

The interviews provided complementary insights to Figure 1 and revealed additional ways the CariCOF advances regional resilience. These include:

Forecaster
> *I think the goal is to bring people together to share knowledge with each other. And the end result is to get the information to the stakeholders so they can make the proper decisions.*

Sectoral Stakeholder
> *The main goals, the first one, is keeping the stakeholders updated with the most recent and reliable information and outlooks. And the second would be, keeping, ensuring that there's capacity development across the met services.*

CariCOF Decision-maker
> *I would say CariCOF is a forum that provides opportunities for capacity development through regular training events and the ability to disseminate that information…. So, training and dissemination would be the main ones; within dissemination, you can get interpretation, access.*

Based on the responses to the survey questions and interviews, we consider the following six objectives to represent the diversity of commonly held views about the objectives of the CariCOF.

1. To train forecasters to create and communicate seasonal climate outlooks.
2. To create monthly, regional climate information products.
3. To assess the utility of new seasonal climate information products.
4. To increase understanding about the outlooks and climate impacts, risks, and solutions, including opportunities for new climate information products.
5. To create new professional connections and strengthen existing ones.
6. To elevate the importance of seasonal climate risk management in the region (and often especially for the host countries).

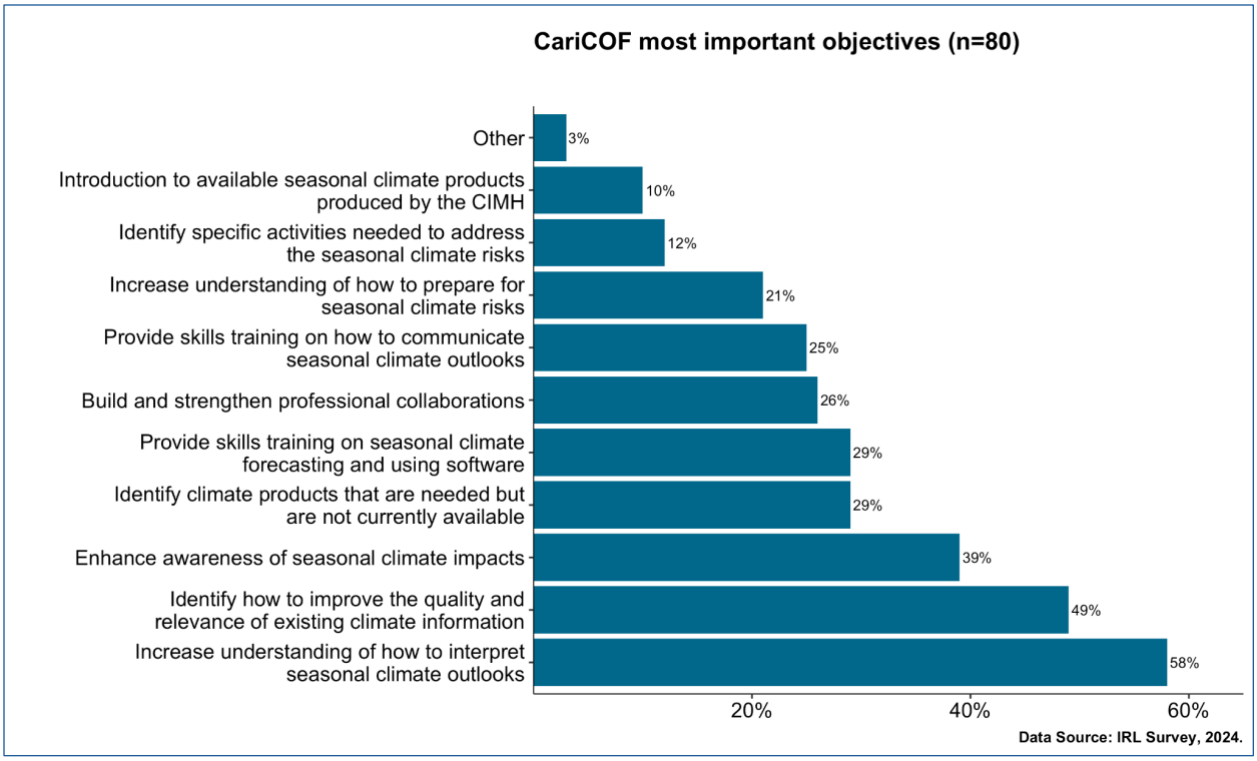

Figure 1. Objectives of the CariCOF. Online survey results to the question: "In your opinion, what are the most important objectives of the CariCOF?" Respondents could select up to three choices from the options listed in the figure. The total number of respondents was 80 (there is no differentiation by self-reported sectional representation).

2.3 CariCOF Communication Barriers

In this section, we address a research objective stated in the TOR as:

1. What are the barriers (new and longstanding) to seasonal climate forecast communication?

A large majority of respondents from the online survey, 78.1% of the 97 respondents, communicate seasonal climate outlooks and/or bulletins among their professional networks. This evidence highlights the need to understand and address the challenges that people experience when communicating the information.

While the challenges are not, on the surface, preventative of sharing information, they likely lower the information's ultimate effect and reach. Scholars and practitioners have for decades made this point, describing the numerous barriers people experience in trying to apply the information and in their communication of it. In 1977, for example, Michael Glantz showed that a hypothetical, 100% accurate seasonal forecast would have had a limited effect in ameliorating the impacts of a severe drought in the West African Sahel. Instead, political, institutional, and economic barriers would have effectively prevented people from acting on the information (Glantz, 1977). Inclusive of a political economic constraint, a large body of evidence compiled over the ensuing decades have identified at least 15 different barriers. They relate to the technical nature of the information, the process of information production, how information is translated

and communicated, and whether the information can be assimilated into decision-making contexts (Appendix 1, Table 1.1). Our assessment of barriers in the online survey drew from this literature base.

Among our sample of online survey respondents, we asked three separate questions about communication barriers. One question focused on the qualities of the information itself, another on the circumstances unique to the person sharing the information, and a third on whether communication has become more, or less, challenging than in the past.

With respect to the nature of the information, the four most frequently selected challenges were the following.

- The information required additional explanations and supplementary information (48% of the respondents selected this option).
- The information is technical (42%).
- The information is not tailored for specific groups (37%).
- The geographic scale of the information is large (36%).

Figure 2 also shows that a large fraction of the respondents, about 19% of the 73 respondants, did not experience any communication challenges.

The interviews elaborated on several of these challenges. The following comment emphasizes a tension between the large spatial scale of the CariCOF information and a more national scale of decision-making. The following quote was edited slightly for anonymity.

> Sectoral Stakeholder: *When we work with countries to develop a national plan, part of that plan would involve looking at the climate outlook and the risks, so that as you plan, you are considering this information. I think we are still at early days of ensuring that we integrate that kind of information from the CariCOF because the scale of the information is regional [and not at a national level].*

The professional circumstances of the person communicating the information also create challenges, circumstances like the availability of time to communicate, knowledge on how to tailor the information, and one's ability to reach a larger audience. In fact, many people stated that their communication activities reached a limited number of people (40%) and that they had limited capacity to tailor the information (29%). These two barriers were also emphasized in the interviews, as illustrated in the following:

> Forecaster: *For so many years now, we've been posting newsletters on our website, and people still aren't aware of it*

> Forecaster: *Individual countries may not have the capacity to do what they have to do, like for example…, right now I am the only one doing this. Compiling data and running the models. I may not have enough time to really reach out to my stakeholders as I should to get their feedback on the products because of staff shortage.*

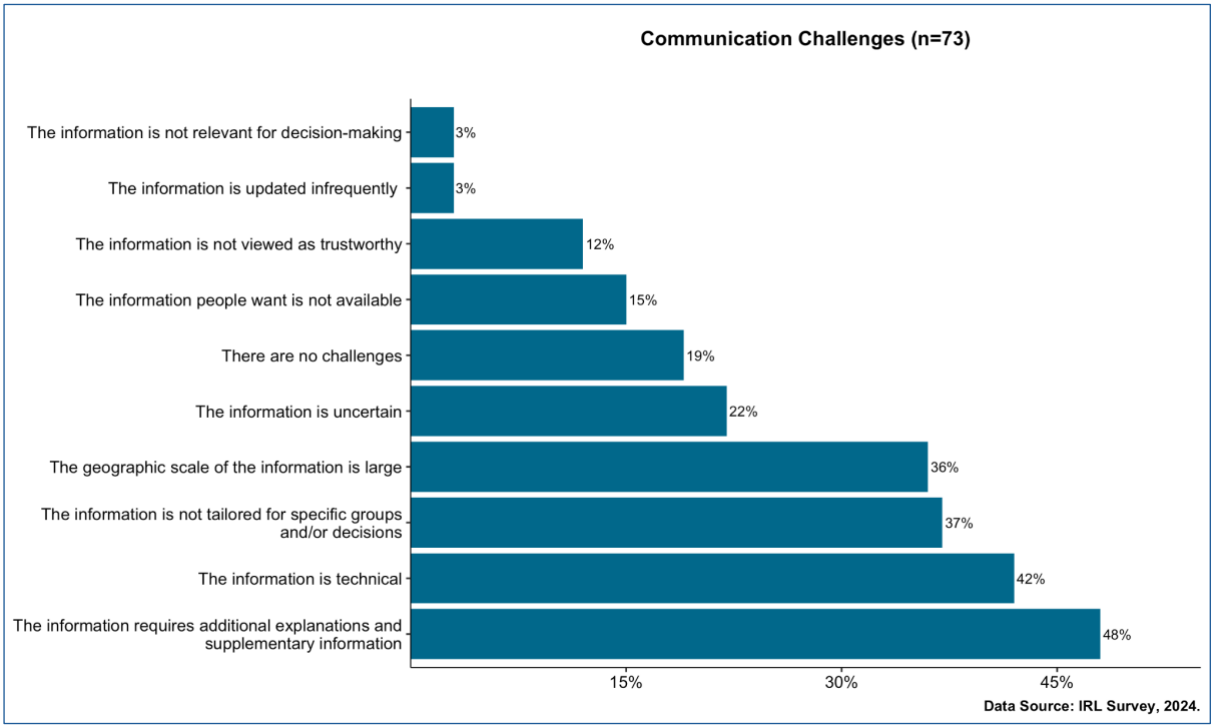

Figure 2. Challenges to communication reported as a percentage of the responses to the question: "Climate information is technical and can present challenges to communication. Based on your experience, which of the following qualities about climate information present challenges to you when you communicate or share the seasonal climate outlooks and/or bulletins for the Caribbean? Select all that apply."

The challenge of tailoring is a function of human resources but is not exclusively related to the availability of human resources. The interviewees and workshop participants also discussed knowledge gaps related to how the seasonal climate information is used, and by whom. Even

when uses were stated, there was a tendency to highlight generalities as opposed to specific use-cases, and it was easier for people to identify how others used the information than themselves. This begs the question of how tailoring is achieved if the use-case is unspecified. Indeed, there were several instances in which people suggested a need for a more explicit understanding of how the information is used to provide better guidance and products for end-users. This was stated in an interview as:

> Sectoral Stakeholder | *We need to aggressively see how information can be used to inform decisions.*

We also note that when asked about their personal circumstances, 25% of the respondents stated they did not experience any communication challenges. Of these 25%, 70% have attended two or more CariCOFs. This is similar in percentage to those who thought the information didn't present communication challenges, as noted above.

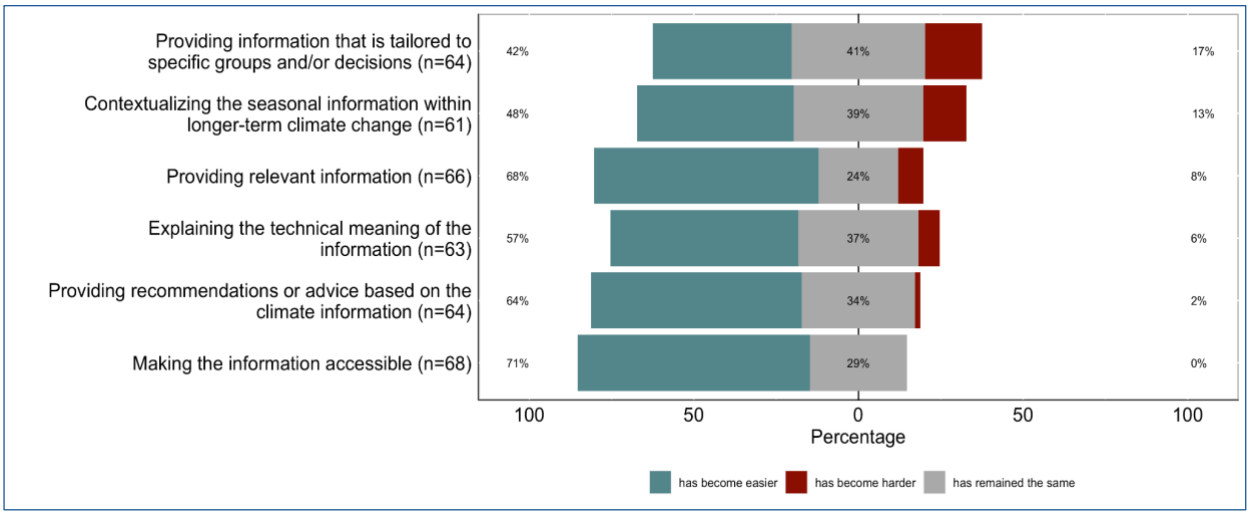

Figure 3. Changes in the difficulty of different communication activities over time. The six activities are stated on the y-axis. The question in the survey was: "Based on your experiences over time with communicating or sharing the seasonal climate outlooks and/or bulletins for the Caribbean, which of the following activities have become easier or more difficult for you?" The response number for each question is noted in parentheses on the y-axis.

Finally, a plurality of survey respondents perceived that communication challenges have improved over time. Figure 3 sought respondent views on six similar aspects of communication, including providing specific information, explaining the information, and providing recommendations. In all cases, very few people, at most 17%, perceived the challenges were increasing. A closer look at these results that divides the respondents in groups of forecasters and sectoral stakeholders reveal a larger percent of forecasters perceived that the challenges are increasing compared to sectoral stakeholders, although the percentage of those stating "more difficult" is relatively small and at most 24% (See Appendix 3, Figure A3.1). This difference across groups is perhaps an important detail to explore further because, as we show in Section 2.4, the forecasters appear to be the main communicators of the outlooks.

A widely held view was that information accessibility is no longer a main challenge in the region. Advances in technology and social media help explain this, as noted by one forecaster:

> Forecaster: *[There are] Less barriers, less barriers. Communication is simple with the improvement of telecommunications, social media, more websites. The websites are more friendly, user friendly. And the frequency in which they have meetings, as well. So that's also sort of that's improved.*

2.4 CariCOF Network Character and Influence

In this section, we address two distinct questions in the TOR that relate to the character of the CariCOF network. They are:

1. How has the CariCOF evolved as a knowledge network to contribute to information generation and dissemination?
2. How does the Early Warning Information Systems Across Climate Timescales (EWISACT)s Consortium influence the CariCOF.

2.4.1 The CariCOF Network Evolution

The CariCOF network has at its center CIMH, who acts as the networks principal steward. The production of regional information, the training of national forecasters, and the bridging of resources related to weather and climate from outside the region to the Caribbean emanate from CIMH. The CariCOF network, in relation to these functions, is centralized.

However, the CariCOF is also a network of networks with respect to information dissemination. In addition to CIMH, the consistent actors in the network are the forecasters from the NMHS and stakeholders from the regional sectoral organizations. The CariCOF engages both groups and in the process taps into their collaborators, who largely do not participate in the CariCOF.

The CariCOF often involves other individuals too. They are largely academics, national stakeholders opportunistically attending (and being invited) due to the location of the event, and individuals who facilitate part of the forecaster training of the CariCOF. These individuals are often funded to attend a CariCOF Forecaster Training and/or Forum to advance a specific goal unique to the particular CariCOF convening. Sometimes, the attendance of these participants is used to create win-win opportunities for the CariCOF and the external projects.

The centralized and network-of-networks character was as shown by Guido et al. (2016) and can also be seen in Figure 4 using a subset of the participants at the Guyana CariCOF Forum in May 2024. The analysis for Figure 4 was drawn from the online survey participants who also participated in the 2024 CariCOF Forum in Guyana . These individuals stated the information types they shared with different institutions in the 4 to 6 weeks after they attended the Forum. A total of 25 people responded, 18 of whom were forecasters and 7 were sectoral stakeholders.

Figure 4 is a partial representation of the CariCOF network. It nonetheless shows that the forecasters and sectoral stakeholders shared many different products (the purple circles). In fact, most of the available products presented at the 2024 Guyana CariCOF were shared, and mostly by the forecasters (yellow circles). There was some differentiation in the products shared, however. The Precipitation Outlook (69%) and Hurricane Outlook (65%) were the most frequently shared with “other users,” while the Number of Dry 7-day Spells (19%) was the least shared (Table 2). The emphasis on precipitation products is no doubt related to the wet season. If a similar analysis was completed in the dry season, the results would likely favor other products.

Furthermore, Figure 4 shows that seven of the forecasters are directly sharing the outlooks and bulletins with “Other Users,” naming specific institutions with whom they shared the information in the online survey. However, most of the forecasters are not sharing directly with others, which can be seen as the yellow circles being unconnected to “Other Users.” For these forecasters, it is possible that they are publishing the information on a website or other platform. This suggests some forecasters are actively communicating the information while others are more passively communicating it. Variability in human resources across the NMHS may explain this difference. It takes fewer resources to passively disseminate and one-to-many modes such as social media are less time consuming than two-way interactions. This may be a strategy used by the smaller island nations and could be more rigorously assessed with repeat monitoring.

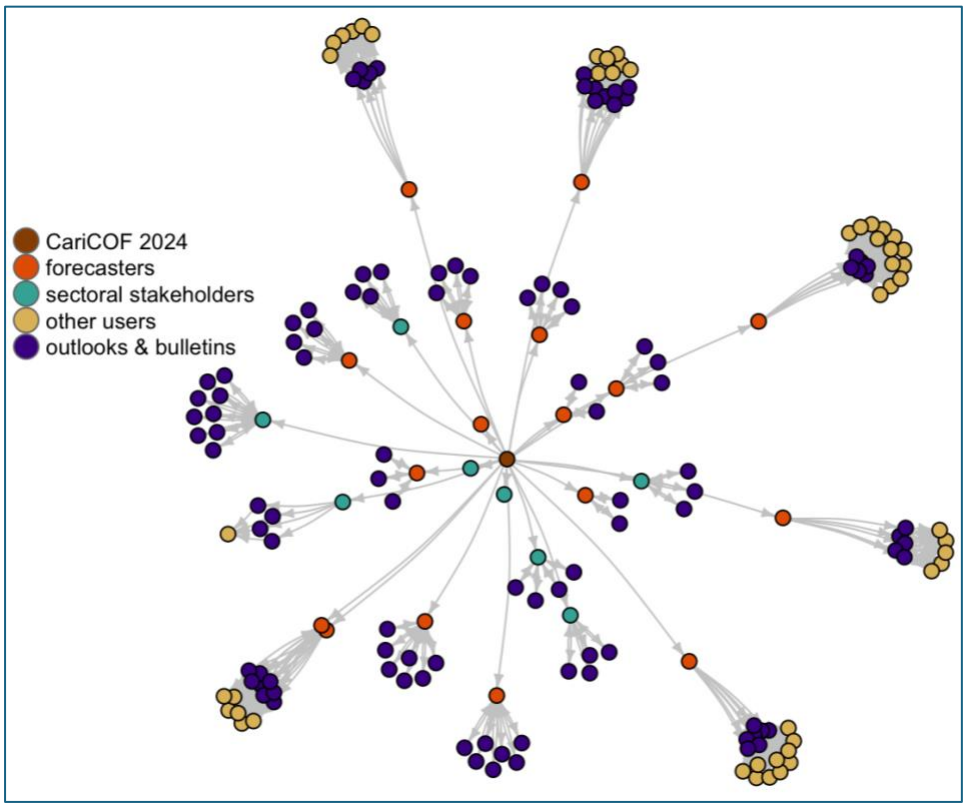

Figure 4. The network is represented by people who attended the CariCOF Forum in Guyana in May 2024 and who completed the online survey. Forecasters, marked in orange, and Sectoral Stakeholders, marked in green, stated in the survey the products they shared in purple and to which institutions ("other users") they shared them, marked in yellow. We do not differentiate types of products shared.

Seasonal Climate Outlooks	**%**
Precipitation Outlook	69
Hurricane Outlook	65
Drought Outlook	54
Nighttime and Daytime Temperature Outlooks	50
Saharan Dust Scenarios	46
Number of Heatwave Days Outlook	38
Number of Excessive Rainfall Events	31
Flash Flood Potential	31
Number of Dry 7-day Spells	19

Table 2. Outlooks presented at the 2024 Guyana CariCOF Forum were shared by participants to others after the event. The percentage shows the proportion of the 25 individuals who shared different climate information products. The 25 people represent those who completed the online survey and who also participated in the 2024 CariCOF Forum in Guyana.

There are other possibilities for this discrepancy too that should not be summarily dismissed. Past intensive interactions between forecasters and stakeholders could have completed much of the interactive work, leading to the possibility of using more efficient but no less effective communication. The public too may be a more knowledgeable consumer, while at the same time the modes of communication have turned heavily in the last decade to social media platforms. On such platforms, multiple people, not just NMHS or direct CariCOF participants, broker the information.

Figure 4 provides an additional insight. The sectoral stakeholders are mostly sharing the information within their own organization. Only one of the seven sectoral stakeholders

connected to “other users.” This raises additional questions. Are the sectoral stakeholders sharing internally only, or are other people within the organization sharing the information to other institutions? Are they putting the information only on their website or not at all? We suspect that at least some of the sectoral stakeholders are in fact sharing the information with their own networks, but our data is unable to draw out this conclusion. It is also possible that people only share information outside their network during specific seasons or events.

A more concerted and sustained monitoring of the network would be instructive on several levels. It would provide a more comprehensive picture of the organizations within the knowledge system and the penetration of the information. For example, there are likely examples, if not many examples, of the information having an important influence on policy and decision-making, like the following example from a Jamaican Parliamentary meeting:

> CariCOF Decision-maker: *I think two months ago, a [parliamentarian] brought a rainfall outlook map to a meeting with the Jamaican Prime Minister, stood up—I watched this on Twitter—and held up the map*[4].

In addition, future network monitoring could identify the properties of the networks, revealing central actors who are brokers in the network capable of facilitating the information flow and increasing the cohesion of the community. This could help CIMH target specific individuals or organizations for invitation to the CariCOF forums or be critical informants in feedback on the information. The network module we developed and used in the online survey is presented in Appendix 2. It could easily be replicated after future CariCOF forums.

2.4.2 Who Participates in the CariCOF Forums

The participants at the CariCOF Forums represent diverse sectors and nations. The CariCOF has from its beginning sought engagement across the five priority sectors of water, agriculture, disaster risk management (DRM), energy, and health for the Global Framework for Climate Services (GFCS); tourism was added as a sixth due to its importance in the Caribbean. Water, agriculture, and DRM have persistently been participating in the CariCOF Forum since 2014, while tourism and energy less so (Figure 5). Differences in participation at the dry and wet CariCOF Forums are evident, as expected. The dry season pulls in the water and agricultural sectors more heavily, while the wet season has emphasized the disaster risk management community (Figure 5).

The nations that are part of the CariCOF have different official languages and lingua franca. The most common is English, but several participant nations' official languages are Spanish (e.g., Cuba, Curacao, Dominican Republic), Dutch (e.g., Aruba, Sint Maarten), and French (e.g., Martinique, Haiti). Some examples of lingua franca in the region are Sranan Tongo in Suriname and Haitian Creole in Haiti.

[4] you can view this event on twitter: https://x.com/cimhbb/status/1779936655308206187?s=46

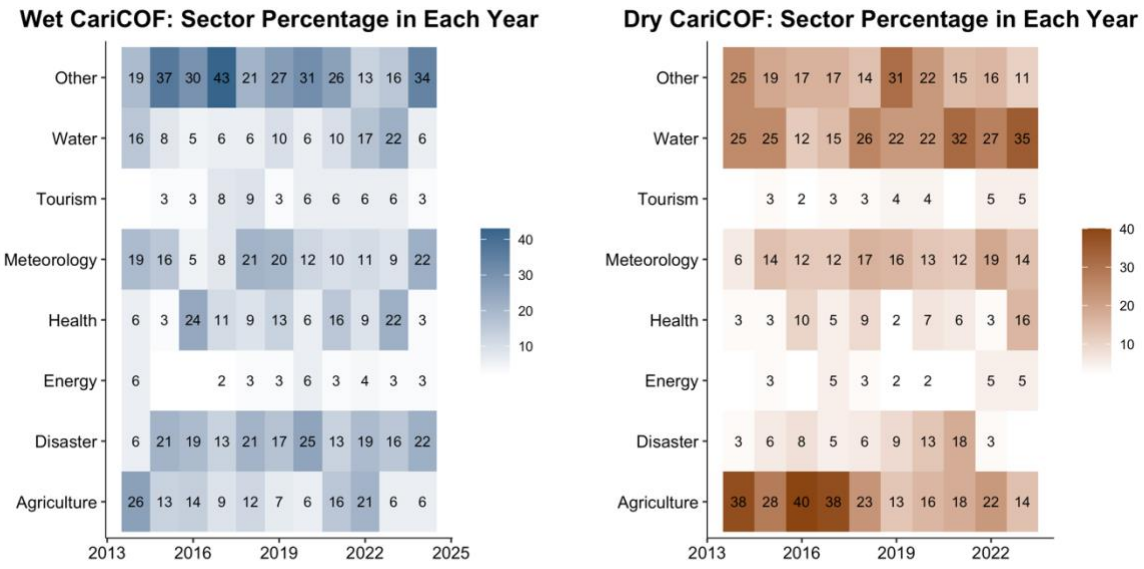

Figure 5. Sectoral representation at the CariCOF Forums between 2014 and 2022 for the wet (left) and dry (right) seasons. The numbers in the boxes represent the percentage of the participants at each CariCOF Forum who represented the different sectors. The "other" category includes seven distinct categories (academic, economic development, fisheries, media, national security, other, and urban planning). We highlight in this figure the six main sectors as well as Meteorology to account for the large fraction of the participants who are forecasters working at the NMHS.

The CariCOF network has focused on both stability in participation and bringing in new voices. Figure 6 shows the percent of participants who attended each CariCOF Forum for the first time. Sectoral stakeholders consistently have had higher first-time attendee percentages than forecasters. Often greater than 40% of the stakeholder participants at any given CariCOF Forum are first-time attendees. For the sectoral stakeholders, there was a general declining trend between 2014 to 2020 and a reversal post-2020 (aligning with the onset of the COVID-19 global pandemic). On the other hand, the forecasters have been relatively constant with about 25% first-time attendees.

There are benefits to both persistent and new attendees. Stability among the forecasters is important because the in-person training is often additive, stacking knowledge about forecasting and the use of the technical CPT, but also training when new products are introduced. Additionally, persistent participation helps to build a stronger community of forecasters in the region that can rely on the network to seek expert support when needed as one forecaster stated in an interview:

> Forecaster | *I do contact other people if I need data or if there is something I'm doing and I'm not finding the results. I can contact them [other forecasters]. What are you doing about this? Do you experience the same issues? It's a foundation.*

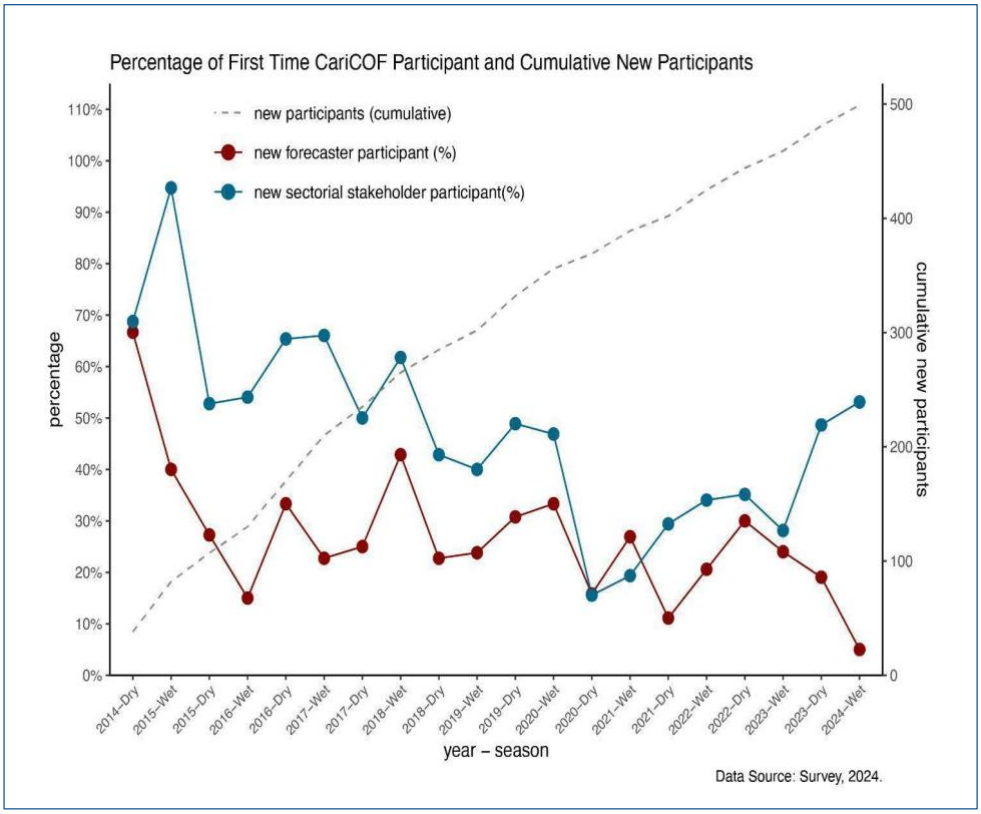

Figure 6. The number of new participants has constantly increased over the CariCOFs (dashed line). New participants from sectoral stakeholders (blue line) have increased more consistently than those from the forecasters (red line).

Stability also works to create champions who can be advocates for and advance climate services within their own national bureaucracies. The presence of significant resource limitations at national levels is a hindrance that is partially offset by the motivation of individuals acting on behalf of a cause. Repeat attendance helps strengthen ideological and social connections. This idea of a champion was expressed by CariCOF decision-makers and among the sectoral stakeholders. The following quote illustrates this perspective.

> Sectoral Stakeholder: *I think the information has penetrated a lot of the sectors. I know well for water and agriculture it has. For health, it has to a certain extent [because] I was a champion. I guess there are some things that have to be done because I tell you there needs to be a champion.*

Among the sectoral stakeholders, those involved in regional organizations were often repeat participants of the CariCOF Forums, whereas the new sectoral stakeholders were in large part from the host country of the Forum. New voices are important to raise awareness, build an understanding of new product opportunities, share experiences, and create new collaborations, all of which are expressed objectives of the CariCOF. One interviewee emphasized this by stating:

> Sectoral Stakeholder: *CariCOF has been very instrumental in bringing the different stakeholders to the table.*

New voices are also important to evolve the areas of focus. The CariCOF has in part acted as a bridge between the global climate and meteorological science communities and the nations in the region. For example, the CariCOF began to focus on heat in 2016, reflecting the increase of heat

extremes in the region. Peer review publications addressing the topics of "heat impacts," "heat early warning systems", or "extreme heat forecasts," for example, have been on a accelerating trajectory, with 21 publications published in 2015 and 48 in 2022[5]. The same can be said for the CariCOF's recent initiation of subseasonal forecasting. Longstanding CariCOF participants have noted the benefits of change.

> Sectoral Stakeholder: *What has been good is that they've been bringing more specialists on board to help with actually providing different kinds of information, heat stress information, and so that was almost there. And also more on the hydro. I found that over the years we've gotten more expertise, more experts and different hazards are being highlighted.*

> Forecaster: *It [the CariCOF] tackles whatever situation is going on. It's like, now we are in this thing of heat, and it is becoming a serious concern. So you tend to see them focus on heat and broaden your mind, educate you, provide you products or information about the heat.*

More growth in the network is also necessary. As seen in Figure 5, tourism and energy remain less represented at the CariCOF Forums. Increased engagement with these sectors were expressed as a frontier and point of emphasis by CariCOF decision-makers and members of the EWISACTs. What is clear is that the CariCOF network has expanded through time. Between 2014 and 2024, 518 individuals have attended at least one CariCOF Forum (Figure 6).

To summarize, the CariCOF network has grown in new participants while at the same time it has sought repeated engagement, particularly with forecasters. The CariCOF has expanded its focus, tracking emergent issues that resonate with the Caribbean but that have also been echoed in the climate science discourse more generally. This has brought in new expertise to the region. There are, however, areas for additional expansion, particularly in energy and tourism sectors.

With this network backdrop, we turn to the question of how the network, and changes to the network, affect the creation and dissemination of climate information.

2.4.3 How the EWISACTs Influences the CariCOF

The Sectoral Early Warning Information Across Timescales (EWISACTs) is a governance mechanism to facilitate the development and testing of sectoral products based on forecasting models, the integration of these climate products into decision support systems, and the strengthening of the capacities of sector partners to provide and use climate information (Mahon et al., 2018). It began in 2015 in a CIMH initiative and consists of representatives from organizations that have a regional, Caribbean-wide mandate in the sectors of health, energy, tourism, agriculture and food security, water, disaster risk reduction, and climate. EWISACTs consists of eight partner organizations and five additional "observers,"[6] as of 2022.

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[5] These numbers were returned from Scopus literature database query of keyword, titles, and abstracts made on August 30, 2024. Creating a free account is necessary to see the query results.

[6] The partner organizations include: CDEMA, CARDI, CTO, CHTA, CSGM, CCCCC, the Caribbean Centre for Renewable Energy and Energy Efficiency, the Caribbean Water and Wastewater Association, University of West Indies, and CARPHA. The five observers include AACARI, PAHO, OECS Commission, CARICOM Secretariat, and GWP-C

The relationship between the EWISACTs and CariCOF is mutually beneficial. The CariCOF contributes to two of the five goals of the EWISACTs: "enhance user interface mechanisms at regional, national and sectoral levels" and "strengthen capacity development and enabling environment for the provision and use of climate services at regional, national and sectoral levels" (EWISACTS, 2022)[7]. There is also an openness to exchange data among the members, and the CariCOF helps define and prioritize the development of climate early warning information.

The EWISACTs also influences the efficacy and trajectory of the CariCOF in three primary ways. First, the EWISACTS has helped bring a continued presence of sectoral actors to the CariCOF. For the majority of the CariCOF Forums, five of the six priority sectors have been present (Figure 7). Agriculture has had a continuous presence since 2014, and health has attended all but one CariCOF Forum since then. Historically, even prior to 2014, the sectoral stakeholders and forecasters at the national levels (and in CIMH) have had more experience working with agriculture, water, and disaster risk management. The health, tourism, and energy sectors are relatively newer partners. Their participation in the CariCOF has strengthened relationships between and among them. This can be seen in the evolution of tailored climate products. Currently, there are three bulletins focused on agriculture, health, and tourism that are each co-produced with EWISACTs members. Those members help identify what is relevant information, include sectoral implications of the forecast, and help craft language that would best resonate within the sector. Further, CariCOF participants from several nations, recognizing the importance of the customized bulletins developed by EWISACTs as well as their limitation as a regional product, have implemented sector bulletins in their own nations.

The injection of sectoral perspectives into the climate products and CariCOF Forum discussions marks the second main contribution of the EWISACTs members to the CariCOF. In discussions and participatory activities hosted at the CariCOF Forums, EWISACTs members provide ground-truthing that helps rationalize the usefulness of existing information or cautions overselling it. They also provide feedback on sectoral information needs.

While EWISACTs participation feeds into technical information production, the members are awarded the benefits of education and awareness. This relates to the third main influence of EWISACTs on the CariCOF: EWISACTs members provide a pathway for disseminating climate information across sectoral networks. These regional organizations are effective conduits for information dissemination because their long-standing relationships have built trust, and they have well-established ways for sharing the information. The EWISACTs members are therefore best positioned to be effective messengers and brokers. Over the years, they have helped alter and customized the bulletins to improve their communication and relevance.

[7] We came to this conclusion by looking at the performance measures that will be used to determine success. A third goal–"improved quality of climate information and services through enhanced social science and interdisciplinary research"—would seem to also align with the CariCOF. However, the performance measures do not fit with CariCOF objectives.

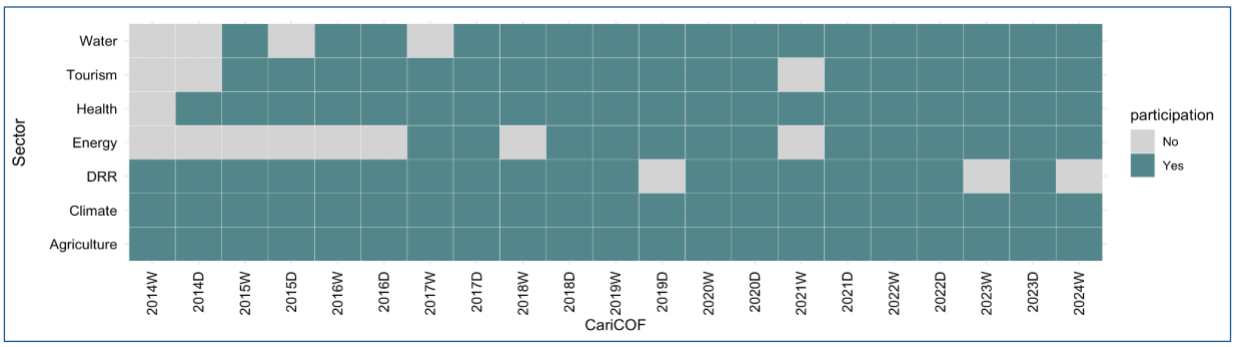

Figure 7. Participation of EWISACTs sectoral representatives at each of the CariCOF forums since2014.

2.5 Technical Information: Diversity, Quality, and Credibility

In this section, we address two distinct questions in the TOR that relate to the character of the technical information. They are:

1. How is the CariCOF diversifying climate products for applications and contexts?
2. How is the CariCOF improving the quality and credibility of climate information?

It can be difficult to separate information produced in the CariCOF from information produced by CIMH in other initiatives and for other purposes. For example, on CIMH's website (under the Regional Climate Center heading) "CariCOF Outlooks" are separate from an "SPI Outlook" and "Forecast Verifications[8]." The forecast verifications are comparisons of observed conditions with the temperature and precipitation outlook produced by the CariCOF. Similarly, as advised by CIMH, the bulletins should not be considered *only* a CariCOF product.

Based on consultation with CIMH, we have restricted the CariCOF products to the Outlooks and Bulletins in Table 3. These products that are used in the CariCOF in some way and/or have been informed by or developed by, in collaboration with, or for the CariCOF. We have also included four analytical tools that are used and influenced by the CariCOF.

2.5.1 Diversity

The CariCOF has developed or informed the development of nine seasonal (and seasonal-to-subseasonal) climate outlooks, six bulletins, and four software analysis tools (Table 3). The outlooks are not a solitary product about future climate conditions. Rather, they are embedded within a packet of climate information that also includes recent past conditions, current conditions, historical averages of the season of interest, and potential impacts related to the outlook. In totality, the information contextualizes the anticipated future conditions. The outlooks are produced either by the CPT or CariCOF Outlook Generator (CAROGEN). The bulletins differ from the outlooks in their sectoral focus and inclusion of information beyond climate. For example, the health bulletin adds health implications and health resources.

The CariCOF product line has grown since 2014, as shown in Figure 8, and evolved. Some of the outlooks provide information at specific points in each country, such as the heatwave outlook. Others provide outlooks for large areas defined by polygons, such as the precipitation outlook.

[8] https://rcc.cimh.edu.bb/climate-outlooks/

The outlooks are also both deterministic and probabilistic. The deterministic outlooks provide an expected range of values–as in the number of "wet" days in a season. The probabilistic forecasts show the probability that conditions will fall in a value range, such as in the conventional tercile precipitation and temperature outlooks. Both the scale of presentation and the type of forecast (deterministic vs probabilistic) can help address known barriers and lead to more useful information for a broader audience.

The product diversity is perceived by many as important because without the CariCOF the level of product development would be far lower. This is best stated by one forecaster:

> Forecaster | *I don't think, without this CariCOF, that I would sit down and would have ever been able to produce these products.*

The value of an increasing product line, however, is not unquestioned. A drive to introduce new products means less time is allocated during the training for forecasters to revisit past forecast techniques. With 25% of the forecasters representing new attendees each CariCOF (Figure 6), it is fair to question both the value and format of the training for these individuals. It was clear at the 2024 Guyana CariCOF forecaster training that there exists a large knowledge spectrum about the CPT tool, which requires considerable knowledge about statistics, analysis procedures, and the CPT GUI operation. The training itself could experiment with other forms of instruction such as think-pair-share or concurrent sessions for different experience levels.

Table 3. Outlooks, bulletins, and software tools developed, at least in part, in the CariCOF or tools that are used to create CariCOF products. The "seasonal to sub-seasonal" outlooks began in 2023 and include precipitation, extreme precipitation, dry-days, and temperature. Sub-seasonal heat-wave outlooks are in preparation for the CariCOF in November 2024.

Outlooks	**Bulletins**	**Software Analysis Tools**
1. Temperature Outlook 2. Heat Outlook 3. Precipitation Outlook 4. Wet Days and Wet Spells Outlook 5. Dry Spells Outlook 6. Flash Flood Potential Outlook 7. Atlantic Hurricane Season Outlook 8. Drought Outlook 9. Seasonal to Sub-seasonal	1. Agro-Climatic Bulletin 2. Health-Climatic Bulletin 3. Tourism-Climatic Bulletin 4. Coral Reef Watch 5. Drought Bulletin 6. CariCOF Climate Outlook Newsletter	1. Caribbean Dewetra Platform 2. Caribbean Climate Impacts Database (CCID) 3. CariCOF Outlook Generator (CAROGEN) 4. Climate Predictability Tool (CPT)

Moreover, creating an outlook requires choosing the important factors to include in the model. One forecaster summarized the expertise required to run CPT in the following way.

> Forecaster | *It is not only click here, and click here, and click here. It is, why? What is behind the click? What are the methods? You will have to configure a number here and coefficient here, but you also need to know why. You need to do your experiments for your country. ….not using just the tool as a black box.*

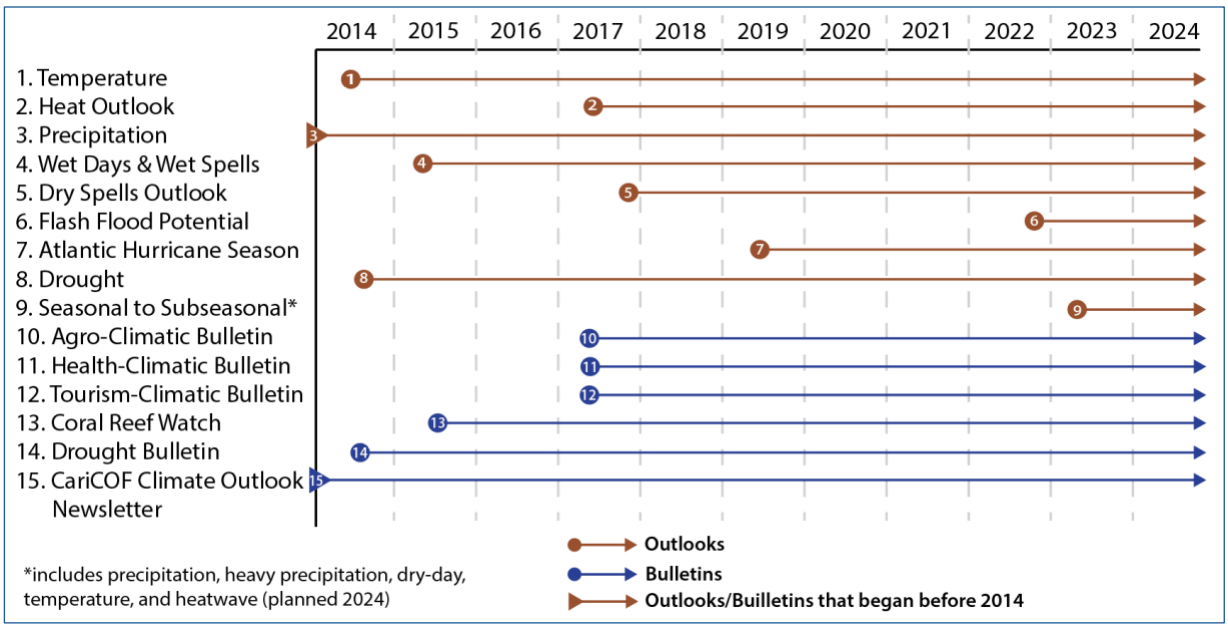

Figure 8. Production timeline of CariCOF seasonal and sub-seasonal outlooks and bulletins.

The emphasis on new products also confronts the reality of limited resources. The CariCOF is a test bed, helping to develop the technical capacity to make products and to generate stakeholder feedback. But the testbed is constrained in three ways. First, products are being developed at the CariCOF for operational settings but are not accompanied by a robust research component. Second, while it might seem ideal to send more products to more stakeholders, it is unclear how much more bandwidth there is at national levels to customize new products. Without this customization, products are often not usable. Third, and related to the second, understanding who uses the products and why has taken a back seat. The activities at the CariCOF provide opportunities for discussion, feedback, and reflection but the time seems insufficient and, importantly, is sampling only a small fraction of the overall users of the information. Broader efforts to evaluate whether the outlooks are useful (to which we consider this analysis) are few and are not keeping pace with product development. An interview stated this as.

> Forecaster | *Like any business, organization, a measure of success is what's new. What I see as [challenging] with this is that there's a constant push to develop new products and not retire old ones.*

It is important to recognize that each nation has constraints and opportunities. Some opportunities include some nations allocating more staff to work as forecasters and CAROGEN enabling the automation of climate information products. At the same time, challenges are evident and these include learning new forecasting methods, data becoming increasingly diverse and complex, and forecasters frequently transitioning to new roles.

2.5.2 Quality and Credibility

Scientific credibility has been defined as “the extent to which science is recognized as a source of reliable knowledge about the world, and not simply as, say, random observations, or an expression of the preferences of a particular interest group” (Bocking, S., 2004. p. 164). Cash et

al. (2003) argued that for science to influence policy, it must be viewed as credible (in addition to being salient and legitimate). We assess credibility based on stakeholders' perceptions of the CariCOF information across dimensions of trust, accuracy, and expertise. Assessing the technical quality of the forecasts with formal statistical methods is beyond the scope of this report. Nonetheless, we note that CIMH has supported scientific verification studies in the past in isolated research activities (in the 2010s). And since 2018, they have also provided verifications on the temperature and precipitation outlooks based on visual inspection of the observed rainfall and temperature compared to the conditions forecasted. Notwithstanding these efforts, it is clear that more formal and routinely produced technical verifications represent a frontier for future CariCOF and/or CIMH work. According to CIMH, technical verifications using established metrics will be automated in future updates of CAROGEN.

Among both forecasters and sectoral stakeholders, the perceived credibility of CariCOF information is very high based on online survey results. In the survey, respondents rated their agreement or disagreement to three questions, which are written verbatim on the y-axis of Figure 9. The results show that 91% (n = 91) of the survey respondents trust at least in part the models and tools used to develop the seasonal climate outlooks and/or bulletins. An even higher percentage, 98% (n = 98) trust the knowledge of the people who develop the seasonal climate outlooks and/or bulletins for the Caribbean. Furthermore, the respondents believe that the information in these products is accurate. Moreover, there is no statistically significant difference when we separate the respondents into forecasters and sectoral stakeholder groups (the values are slightly higher for forecasters than sectoral stakeholders; Appendix 3, Figure A3.2).

The interviews suggest at least two mechanisms that may lead to the high level of perceived scientific credibility: exposure over time and relevancy of the information to the concerns of the information user. The CariCOF has been routinely convened since 2014. For ten years, the information has been circulated and more than 500 people have attended the Forums. This level of exposure has incrementally had an impact.

> Sectoral Stakeholder: *My confidence has grown in the products over the years, and I promote their use, and they also explain within the text about the level of confidence and so on.*

The exposure on the one hand has helped build an understanding of the information and, on the other, has likely allowed people to experiment with it and come to a personal understanding of its value. The CariCOF has also increased the relevance of the information. The sectoral bulletins, the tailored language, the product diversity, the rotation of the venue of the CariCOF to different countries, and the ever-increasing numbers of people having been exposed to the CariCOF all help with relevance. Relevance, in turn, can influence perceived credibility, and vice versa (Cash and Belloy, 2020).

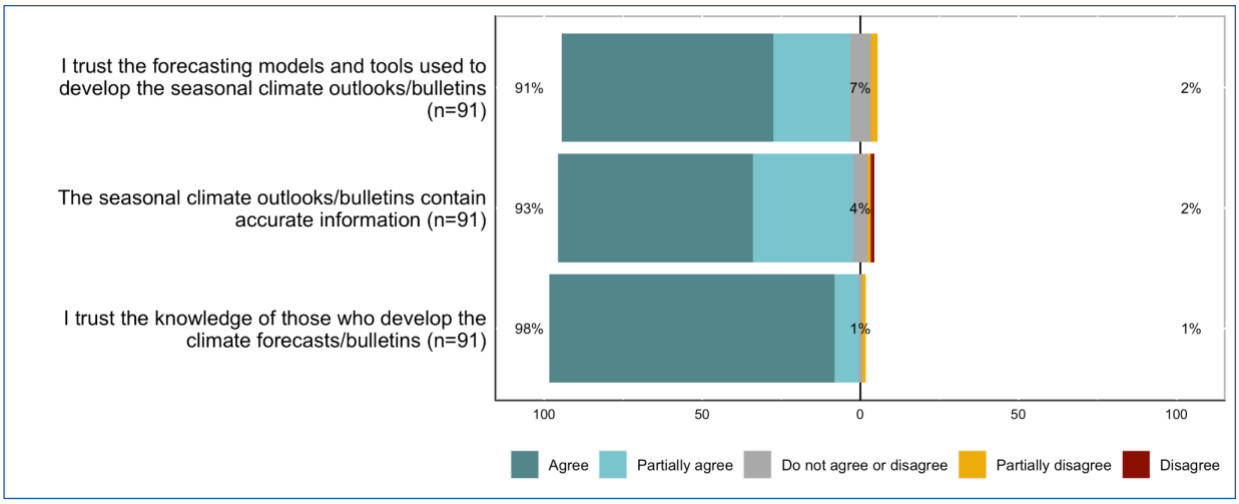

Figure 9. Survey questions that assess the perceived scientific credibility of CariCOF outlooks and/or bulletins. The question asked: "Considering the seasonal climate outlooks and/or bulletins for the Caribbean, to what extent do you agree or disagree with the following questions about the credibility of the information." The number of respondents for each question was 91.

2.6 Information Brokering: Nature, Extent and Influence on Use

Information brokering influences information usability by transforming information in ways that overcome communication barriers to information use (Lemos et al., 2012). In the context of climate outlooks, brokering often takes the form of adding additional climate and climate-related information and graphics, making the technical language more user-friendly, or altering the mode of communication. Brokering leads to more effective information use on one hand and the development of more tailored information on the other. Across diverse research and practice traditions, brokers have been critical for translating information into action (Guido et al., 2016).

The CariCOF includes activities that either explicitly or implicitly enable participants to broker information in their networks. In 2016, Guido et al. found that the in-person Forum facilitates brokering for its participants in three ways. The activities at the events help participants understand the climate and decision-making contexts, learn from interactions with producers and users of information, and have the capacity in time and resources to add value to information.

In this section, we address two distinct questions in the TOR related to information brokering:

1. What is the nature and extent of information brokering and communication activities at the CariCOF?
2. How have information brokering and communication activities at the CariCOF affected the use of climate information, including planning, decision and policymaking?

To answer both questions, we report on an analysis of the CariCOF agendas to show the focus of brokering activities within the Forums and how they have changed over time. We also present online survey results, which reveal what CariCOF participants perceive as effective brokering activities. The interviews provide additional explanations.

2.6.1 The nature and extent of brokering

Prior to the online survey, the research team hosted a session at the 2024 wet season Guyana CariCOF Forum to understand what characteristics of the information favored use. The discussion produced eight concepts, including understandable, accessible, timely, accurate and others. We define these eight concepts in Appendix 3 (Table A3.1). In the online survey, we then queried respondents about which of the eight were important for the information's useability. The two most frequently selected qualities were understandable (70%) and accessible (67%) (Figure 10). However, many of the other characteristics, like timeliness, accuracy, and context, were also frequently selected. Both the diversity and frequency of selection simply emphasize that brokering is a varied act that is influenced by the context.

We assessed the focus on brokering activities at the Forums by examining the activities and the time allocated to the activities at the Forums as described in each Forum's agenda. We recognize that the timelines listed in the agendas only approximate actuality. Nonetheless, even an imprecise measure of duration reveals planning logic and prioritization. Further, the session headings written in the agendas may not convey the full scope of the content nor the full format. However, the headings were descriptive enough to allow for grouping by format, e.g. presentations and discussion, as well as by topics, e.g. risk management and feedback/evaluation (see Table 10 in Methodology). All agenda sessions were included in the analysis except the administrative-type sessions that marshaled the Forum forward by the master of ceremonies, such as the opening remarks, preview of agenda, and closing.

We grouped the activities listed in the agendas into three categories: presentations, discussions, and participatory activities. Each category informs brokering. The participatory activities and the discussion sessions can develop understanding of the decision-making context in which climate information is used and create opportunities to learn from interactions with producers and users. The presentations can support capacity, as some of the presentations are about available tools, and they can build an understanding of the climate and decision-making contexts.

The fraction of time for activities at the CariCOF that involve participatory and discussion activities is slightly less than half of the time allocated on the agendas (Figure 11). We acknowledge that by relying on the agendas, we were unable to account for discussions that may have occurred after a presentation if they were not explicitly mentioned in the agendas. Prior to pausing the Forums during COVID-19, there was a trend towards more presentation time and less interactivity, although there is substantial variability. Since in-person Forums resumed in 2022, there has been more focus on participatory activities. Since 2014, the amount of discussion time–time explicitly allocated on the agenda for discussion, usually in plenary, is approximately 45 minutes in a 7-hour CariCOF Forum. The style of the facilitation of the discussions in Guyana was at times oriented more towards teaching than on listening. Experimenting with different facilitation styles is a potential area for evolution. Likewise increasing the amount of discussion time was broached several times in the interviews, including being stated as:

> Forecaster: *It just seems like there's not enough time during the forum to really have good discussions. There's a lot of information being presented. But I think especially when you have stakeholders here aren't really used to seeing these products or there's a*

> *little bit of a learning curve with understanding the meteorological aspect of it. I think this time we need more time to deal with that stuff*

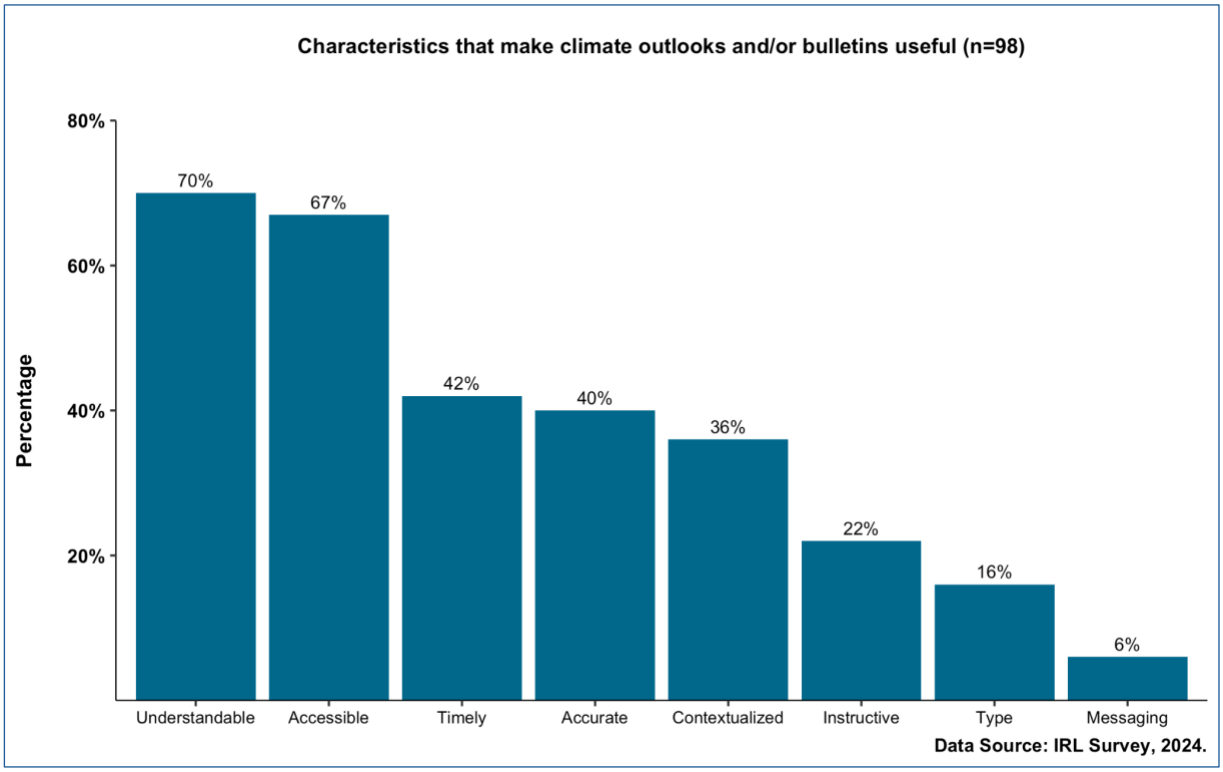

Figure 10. The characteristics of the information that facilitate use. The percentage refers to the number of respondents who selected the characteristic. Respondents could select more than one characteristic. A total of 98 people responded to this online survey question.

The agendas had a total of 289 sessions, excluding the administration-type sessions, with 170 of them being presentations. Nearly all the presentations listed a "facilitator" to deliver the presentation. Only 10 (~6%) of the facilitators were a representative from a stakeholder group (national or regional), while 142 (~84%) were led by CIMH, an NMHS, a university, or another organization focused on climate information production; 18 (~11%) had no facilitator listed. The overwhelming frequency of activities led by climate information producers suggests an opportunity to provide space to stakeholders to share their experiences.

Several insights can be drawn from the allocation of the topics in the agenda (Figure 11; see Table 10 in the Methodology for descriptions of the x-axis categories). First, there has been a persistent focus on presenting and discussing the outlooks. This is expected. These activities advance a main goal of the CariCOF of communicating the outlooks. Second, many of the CariCOF Forums introduce a new outlook or a decision support tool or seek to develop an existing one. Third, there is often a presentation of new climate risk management initiatives in the Caribbean. Fourth, there is no sustained evaluation of the CariCOF. And, finally, the focus on understanding information uses, gaps and needs occurred was more emphasized in the 2014-2018 period than post 2018.

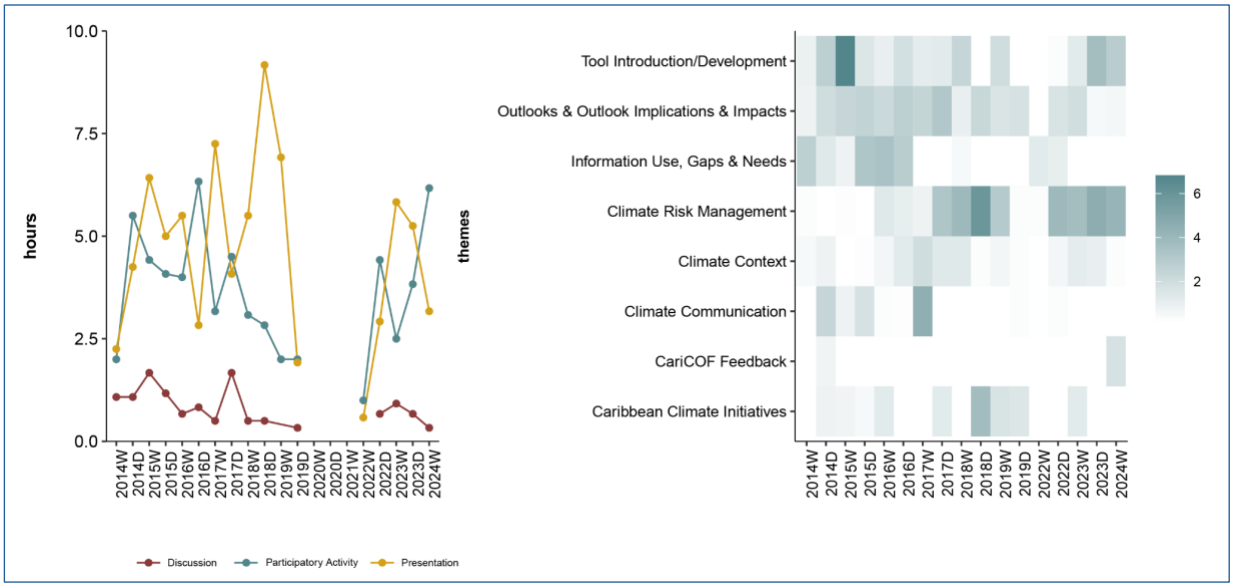

Figure 11. The left figure illustrates the number of hours spent on different CariCOF Forum activities from 2014 to 2024, as indicated by the Forum agendas. More hours have been dedicated to presentations and participatory activities than to discussions. The right figure illustrates the number of hours spent on various themes during CariCOF, with risk management being the most prominent theme, followed by climate context.

2.6.2 How brokering affects the use of climate information

We previously showed the characteristics of the information that people perceive to affect use (Figure 12). Now, we address whether several of these characteristics–the two most frequently cited as being important to facilitate use, "accessible" and "understandable"–manifest in the CariCOF network. Then, in section 2.7, we explain how the information was used.

Two survey questions asked if the respondents themselves could understand and had access to the information, while two survey questions asked about how the respondents perceived accessibility and understanding for others. The perceived understanding of the information is high (Figure 12). But, the perception of personal understanding is higher than the perception of others' understanding. When looking at whether others understand the climate information, about 13% of the respondents agreed and 51% only partially agreed, while another 21% did not agree to some degree. There was a desire for the presentations and activities to address climate literacy, as summarized in this quote.

> Forecaster | *I think we could probably concentrate [at the CariCOF] a little more on passing the science over to stakeholders. You get the sense that people don't fully understand the climate or the different interactions.*

Forecasters and sectoral stakeholders agreed with each of these four statements to a high degree, and there was no statistically significant difference when analyzing the groups individually (Appendix 3, Figure A3.3). Based on the responses, the seasonal climate outlooks and/or bulletins are both accessible and easy to understand for both groups.

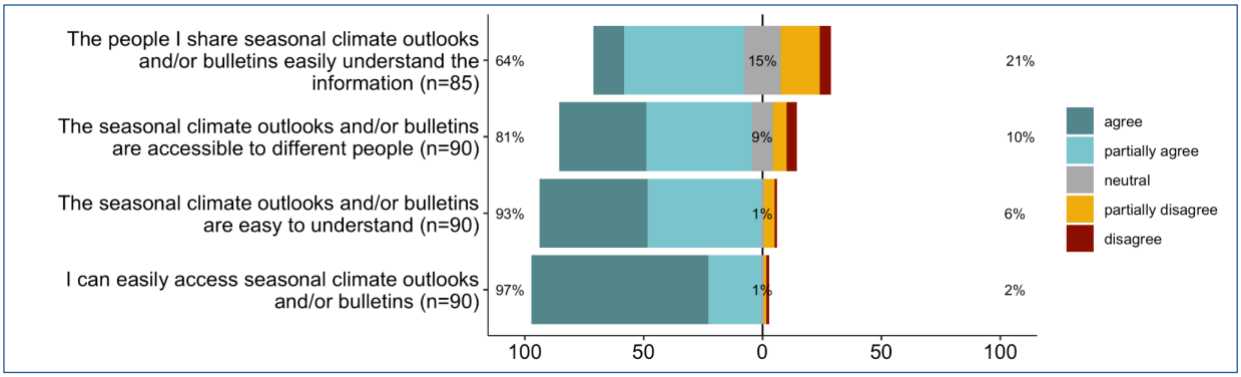

Figure 12. Perceived accessibility and understanding of the information in the climate outlooks and bulletins. The total number of respondents is shown in the y-axis labels and is either 85 or 90.

2.7 CariCOF Information Use

We approached "use" from a broad perspective that focuses on the influence of climate information on decisions and considers benefits related to learning, relationships, and psychological resilience and well-being expressed in one's affect (see methodology). Each of these four dimensions have empirical evidence that supports their function in building resilience to climate events. In fact, the main objectives of the CariCOF, as identified by members in its network (see Section 2.1), highlights the importance of relationships and learning. An assessment of the CariCOF, therefore, needs to focus on these types of uses.

In this section, we address two separate questions in the TOR related to information use:

1. How are CariCOF products used?
2. How does the CariCOF influence the use of climate information?

2.7.1 How CariCOF Products Are Used

We explored "uses" in the participatory workshop session at the Guyana CariCOF Forum in May 2024, in the online survey, and in the interviews. In Appendix 4, we present a full listing of the "uses" cataloged during the participatory workshop sessions to present the diverse uses. The workshop asked for both personal use and how the participants perceived others use the CariCOF information. We summarize the frequency of their responses in Table 4 within our Typology.

Table 4. The number of workshop participants who identified at least one example of how the CariCOF information is used either by themselves or by their colleagues. The total number of respondents was 51 (29 Forecasters and 22 Sectoral Stakeholders). Respondents could note more than one example.

	Decision-making	Learning	Relationships	Affect	Couldn't determine	No Use
Forecasters (n = 29): How other's use	13	10	1	2	6	3
Sectoral Stakeholders (n = 22): How others use	5	6	0	0	9	3
Sectoral Stakeholders (n = 22): Personal use	6	9	0	0	5	4

In the online survey, we also assessed the four types of use in a series of questions. We summarize the results in the following paragraph and include in Appendix 4 a more comprehensive display of the results.

For decision-making, the seasonal climate outlooks and/or bulletins were stated to be used primarily for planning (e.g. for emergency management), followed by policy-making (e.g, policy development to prevent people from building in flooding zones, develop policy for disaster risk management, etc.), and specific activities (e.g., decision-making on infrastructure investments, decision-making on type of seeds to plant) (Figure 13). Only 12% of the respondents stated that they did not use the outlooks or bulletins in some decision-making way. The information is also perceived to be well-suited for organizational decision-making, used by different organizations, and applicable to the organizations' objectives (Appendix 5, Figure A5.1). Participation in the CariCOF Forum appears also to strengthen existing relationships and to forge new ones. Among those who participated in at least one CariCOF Forum since 2014, about 81 and 76% of the forecasters and sectoral stakeholders, respectively, stated their participation led to collaboration with new people who attended the same event (Appendix 5, Figure A5.2). Similarly, about 84 and 96% of the forecasters and sectoral stakeholder participants at the CariCOF Forum, respectively, stated their participation strengthened existing professional relationships (Appendix 5, Figure A5.3). Finally, participation in the CariCOF had a positive effect on affect and learning for both forecasters and sectoral stakeholders. Both groups reported high levels of agreement to questions like: "the information influenced my motivation to address upcoming seasonal climate risks" and "the information influenced my view of the chances that different climate conditions would occur" (Appendix 5, Figure A5.4).

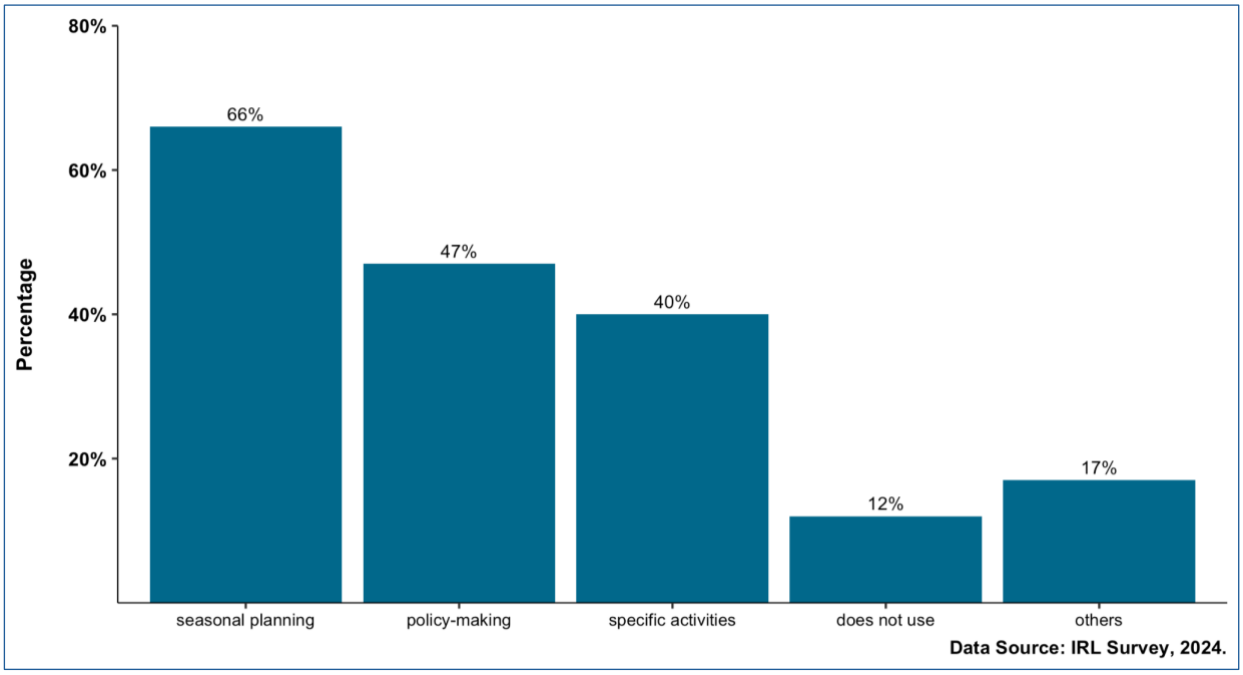

Figure 13. How are the seasonal climate outlooks and/or bulletins for the Caribbean used in your organization? 98 people responded to this question. Note that this question was focusing only on decision-making type of use.

The variety of ways the information requires elaboration of which are used. In the online survey, respondents assessed their current or past use of climate seasonal outlook, climate bulletins, newsletters, or software. Figure 14 shows that the precipitation and drought outlooks are the most frequently used seasonal outlook and that the CariCOF climate outlook newsletter and Caribbean drought bulletin are the two most commonly used bulletins, newsletters, or software.

The CariCOF has had an emphasis on product development. There are currently 19 products in some way associated with the CariCOF (Table 3). At a basic level, the variety of products creates a large menu of information from which stakeholders can choose. Given that sharing CariCOF information is a main way in which participants of the CariCOF use the information, we analyzed the frequency in which the different products were shared by the 2024 Guyana CariCOF Forum participants in the weeks after they attended the Forum. The precipitation outlook (69%) and the hurricane outlook (65%) were the products that more participants of the 2024 Guyana CariCOF shared after the event.

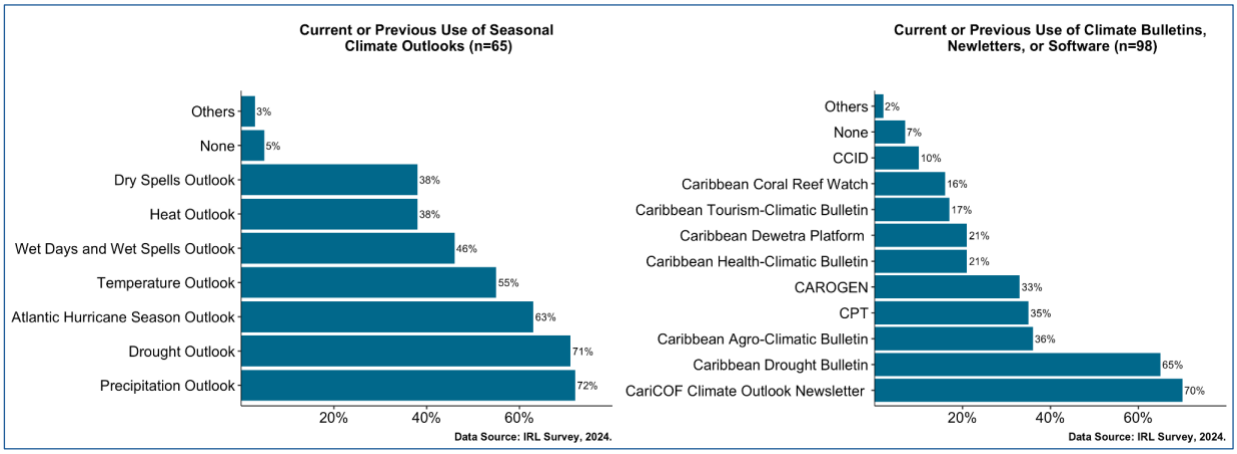

Figure 14. Self-assessments of if seasonal climate outlooks (left) and climatic bulletins and decision-support tools (right) have been used by on-line survey respondents. The number of respondents for each distribution is 65 and 98, respectively. We did not assess two experimental outlooks noted in Table 3: the Seasonal to Sub-seasonal Outlooks and the Flash Flood Potential Outlook.

2.7.2 How Participating in the CariCOF Influences the Use of Climate Information

In section 2.2, we showed the six main objectives of the CariCOF. All of these can affect the use of climate information. For example, research in the climate adaptation and climate risk management have highlighted the importance of developing a knowledge base (Lemos et al., 2012), knowledge networks (Ulibarri et al., 2022), and a portfolio of products (Mason et al., 2022). In the preceding subsection, we showed how the information has been used, noting that sharing the information and planning decisions were most frequently identified.

The salient question in this section is how participating in the CariCOF has informed information use. We asked this question directly in the interviews, but also draw on three other questions asked in the interviews and survey (Table 5). It was clear that the perception of the value of the CariCOF was overwhelmingly positive, both by forecasters and sectoral decision-makers. Even when an interviewee demurred about the CariCOF's value to him or her, they often caveated their response by perceiving the CariCOF to have value to other people. The totality of the evidence suggests that the CariCOF affects use through three pathways.

1. Learning about the outlooks at the CariCOF leads to more effective communication.
2. Engaging stakeholders helps spread the information to subnetworks.
3. Product diversification increases the ability of participants to reach new audiences.

Table 5. Questions in the survey and interviews that assess information use.

Tool	Question
Interview	How does CariCOF participation influence the use of climate information?
Interview	What would happen if there was no CariCOF?
Interview	How has the CariCOF evolved as a knowledge network to contribute to information generation and dissemination?
Survey	"How did you benefit from participating in the CariCOF?" This question was asked to only those who had participated in a CariCOF Forum and respondents could select multiple options.

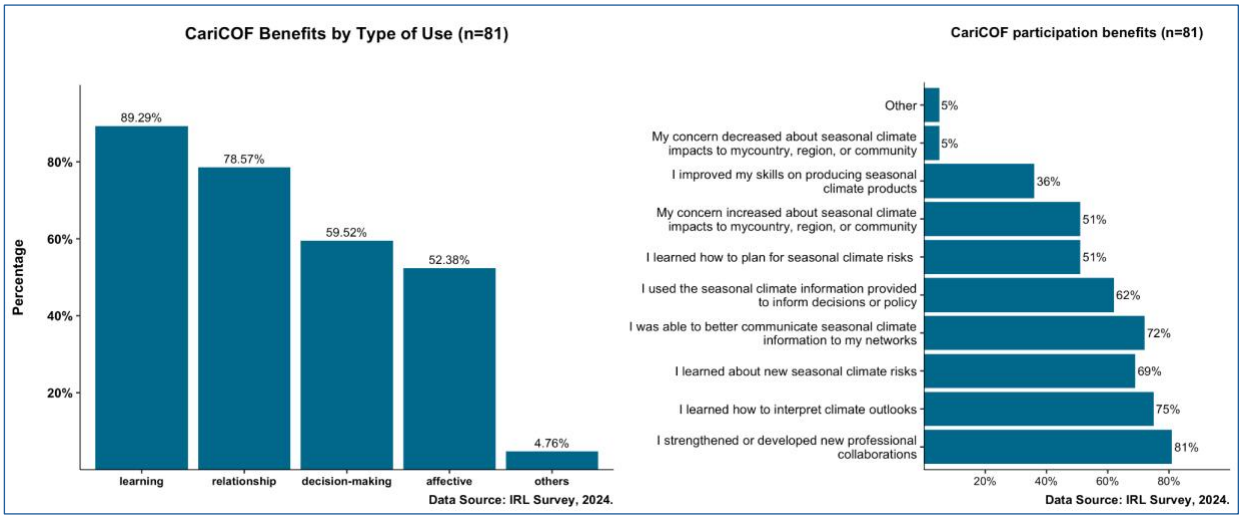

Figure 15. Benefits of the CariCOF (left). Frequencies of selected responses (y-axis) from participants of the online survey to the question: "How did you benefit from participating in the CariCOF? Select all that apply." (right). The individual responses were grouped thematically into our Use Typology categories of decision-making, learning, relationships, and affect. The frequencies report the number of respondents who selected an option that related to the four categories. Our sample for this question is 81. Note that this reports on only those respondents who had attended a CariCOF Forum in the past.

In the online survey, evidence of the influence of the CariCOF can be seen in the benefits that people draw from it. The frequencies across the 10 options emphasize not only the diverse benefits that participants experience, but also that many of the benefits affected more than half the respondents (Figure 15). The two most frequently reported benefits were "I strengthened or developed professional collaborations" and "I learned how to interpret climate outlooks". If we collapse the responses into groups that align with our Use Typology categories of decision-making, learning, relationships, and affect, then it is clearer that learning and relationship strengthening is of primary importance. It is important to note, however, that the survey question did not have an explicit response for "no benefit"; respondents could opt not to answer the question at all, however. While this omission is not ideal, the interviews suggest that the frequency of a "no benefit" response would not have occurred often.

The interviews complemented the results shown in Figure 15, particularly with respect to learning, as described in the following:

> Sectoral Stakeholder: *For us who go to the meeting, that's very helpful when you have the literal expert explaining it [the Outlooks] to you. But when you just send out your bulletin… you don't have that going along with it. So it's not always going to be as easily digested.*

> Sectoral Stakeholder: *And today [in attending the CariCOF for the first time], I've learned a lot because, for example, you look at the diagrams and you're not sure [what they mean]. I was able to have a better understanding of the graphs that I see coming out of CariCOF. I mean, it's [my] lack of knowledge, from my perspective, a lack of exposure.*

Many of the interviews pointed out that learning enabled them to better communicate the information to others. Communication therefore is the link between learning at the CariCOF and information use. This was illustrated in the following quotes.

> Sectoral Stakeholder: *We take the information, break it down and try to disseminate it according to [the] target audience you want to reach. … When I started coming it was hard [to interpret the forecasts], but now, I'm much more familiar with them, not perfect, but much more familiar*

> Forecaster: *When I come here [CariCOF], and I go to training, learn to interpret the maps, and I have to go and relay that information to the stakeholders because the whole purpose of producing the outlooks is to relate to the stakeholders so that they can determine how the outlook would impact the different sectors and what decisions they can then make based on the outlook that we produce.*

Furthermore, in a participatory workshop session the participants identified 59 distinct uses of the climate information (see Appendix 4, Tables A4.1–A4.3). Of the 59, 17 (or 29%) were catalyzed by CariCOF Forum participants sharing the information subsequently, as one interviewee illustrated in the following:

> Sectoral Stakeholder: *...By us participating, we are aware as to what kind of climate related information is available, and we made that available, disseminated to the disaster management coordinators, but they also are directly invited to sit on the CariCOFs as well.*

It is not surprising that communicating the information with others is a central way which leads people to "use" the CariCOF information. It goes without saying that communication is central to the 29 forecasters who participated in the workshop sessions. Moreover, many of the 22 sectoral stakeholders are central nodes in their own networks. This was demonstrated in previous research on the CariCOF published in 2016 (Guido et al., 2016), and remains true today, at least among the Guyana 2024 CariCOF Forum participants.

The interviews also identified an influence on use that was not an option in Figure 15. Importantly, the CariCOF has an objective to develop new information that people can share or

use directly. An approach that seeks more products makes sense in a region with diverse hazards, economies, and cultures like the Caribbean. This was described in the following quotes:

> Sectoral Stakeholder: *...the new information on drought and heat, particularly heat which is a new hazards that we haven't really been paying a lot of attention to.*

> Forecaster: *I don't think without this CariCOF that I would sit down and would have ever been able to produce these products.*

A suite of products is therefore necessary. More products are also likely needed to satisfy newer sectors, like energy and tourism. However, while more options can satisfy a relatively greater number of people, it is also true that more options do not lead to more use. The CariCOF, however, is not only creating and advertising new products (as the diverse objectives reported in Section 2.2 suggest).

2.7.3 Challenges to Information Use

The communication of CariCOF information is an expressed objective and a main benefit that CariCOF participants draw from their attendance. 72% of the online survey respondents identified being able to better communicate the information as a benefit. It is also clear that the information is being shared: 69 and 65% of the Guyana 2024 CariCOF Forum participants subsequently shared the precipitation outlook and hurricane outlook, respectively (Table 2).

However, it was clear from both the interviews and the participatory workshop that it is challenging to concretely stating how the information influences decisions. This is not new. Several review studies on climate services in the past decade have emphasized the need for more evaluative studies on use (Vaughan et al., 2018, Tall et al., 2018). In our sample, there are several examples of people either stating that they don't know how the information is used or that they thought it wasn't used, as illustrated in the following interview.

> Sectoral Stakeholder: *I'm not sure how the other participants do take it [the bulletin] back and how they utilize it. The challenge, though, is monitoring the usage and uptake. We really need to conduct some user-based research to see if it is reaching people?*

Another respondent questioned if trade-offs exist in the creation of new products or derivatives of existing products, or if a focus on fewer products with a higher degree of messaging depth and design is better.

To be clear, use of the CariCOF information is occurring. The salient point however is that a fraction of the people do not know how the information is used. This knowledge gap undermines a main objective of the CariCOF, which is to connect sectoral needs with product development. How can you effectively tailor information if the uses of the information, even if theoretical, are not well known? Lack of understanding use appears more evident among the sectoral stakeholders than forecasters. In this grouping, at least 9 of the 22 people either were unable to state a use of the information or, for the use they did state, it was articulated very ambiguously. In this regard, a thick description of how the information is used remains elusive.

2.8 What is the Role of the CariCOF in Regional Climate Resilience?

To summarize, the results first elaborated on the objectives of the CariCOF. It then problematized the objectives within barriers to communicating seasonal climate information. In this context, a measure of the efficacy of the CariCOF is the extent to which it alleviates barriers. Barriers have been overcome in part via major achievements of the CariCOF, which have been to enhance the ability of Caribbean nations to produce climate outlooks and, in complementarity, to develop new products and services. In fact, the CariCOF is marked by its contribution to 19 products and analytical tools. Beyond the new products, the CariCOF has also strengthened the use of climate information through collaboration, brokering, learning, and trust-building. As a result, the network of more than 500 people who have experienced at least one Forum, nearly unequivocally agreed that the CariCOF is valuable. The evidence is seen in the diverse uses of CariCOF information for decision-making purposes and for strengthening relationships, learning, and emotion effect.

All this brings us to a central question for the CariCOF:

1. What is the role of the CariCOF in regional seasonal climate resilience?

We addressed this question in a participatory session at the Guyana CariCOF, in the interviews, and in the online survey.

At the CariCOF, we facilitated the same 45-minute discussion session with four groups. The participants identified the factors that would bring the Caribbean closer to being resilient to seasonal climate risks and, of those factors identified, which the CariCOF contributed to. Table 6 presents a summary of the eight categories identified, along with several examples of each.

The CariCOF, according to the participants, is playing a role in all eight of the categories. It is also directly influencing some of the funding on climate science, which leads to product development and training. The influence of the CariCOF on policy and planning and developing sectoral climate-smart applications (that go outside of specific climate products) is secondary at best and could be more central in the CariCOF with an explicit focus on these goals.

To seek additional insight on the role of the CariCOF in regional resilience, we inquired if people perceived CariCOF information to prevent losses to occupations, damages to property, or bodily harm. Figure 16 shows that for each question the most frequent response was neutral, but there was also a tilt toward agreement and away from disagreement. There was no statistically significant difference in the frequency of categories between forecaster and sectoral stakeholder groups. However, in all three cases, the forecasters were in more agreement that the information limited losses than the sectoral stakeholders (Appendix 3, Figure A3.4).

These three desired outcomes have high societal value, but they only represent a subset of the outcomes to which climate information can contribute. They also represent outcomes that are hard to measure and undoubtedly result from a variety of influences. Climate information more broadly can improve efficiency and productivity, reduce operational costs, and improve equity in resource allocation, not to mention outcomes related to relationships, learning, and affect. Figure 16 shows that many people perceive the climate information produced by the CariCOF to have a

high social value. Those ambivalent or less optimistic are perhaps drawing attention to a high standard on the influence of climate information implied by this question.

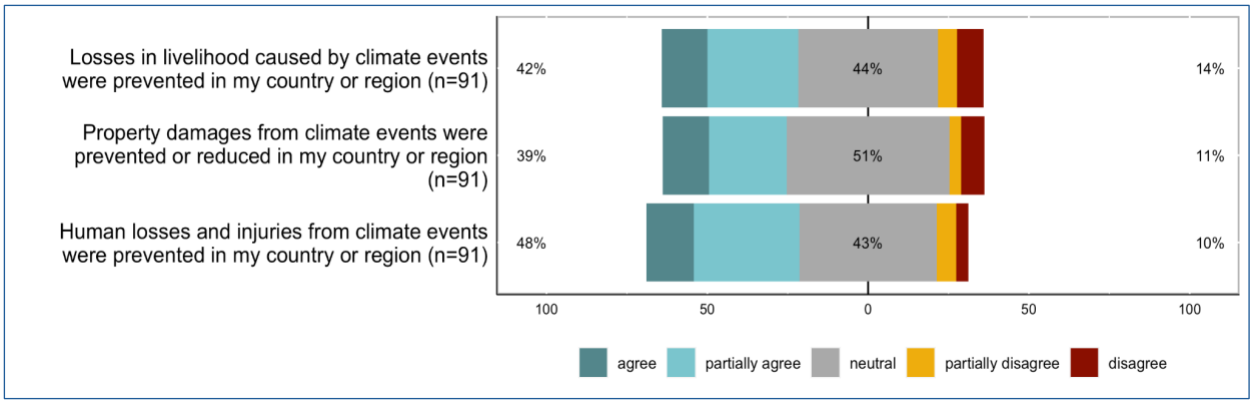

Figure 16. The perceived impact of using climate information. The survey question asked: "To what extent do you agree or disagree with the following statements about the impact of using the seasonal climate outlooks and/or bulletins for the Caribbean." On the y-axis, the questions are paraphrased for brevity. The number of respondents was 91. There was no statistically significant difference between groups of forecasters and sectoral stakeholders.

We take from these results, and those of the workshop, the more favorable view that the CariCOF plays an important role in regional climate resilience. How then, specifically, does the CariCOF advance regional climate resilience?

What should be clear at this point is that the CariCOF has had a direct influence on the use of climate information in decision-making. It also has had an influence on information use in ways related to learning, relationships, and affect, which are themselves foundations for future decision-making. At a basic level, an expanding product line reaches more stakeholders if translational and access mechanisms exist. More products are also accompanied by a CariCOF process that strengthens the understanding of climate information, creates awareness of climate risks, creates and develops professional connections, brokers and tailors information, and continually exposes new forecasters and sectoral stakeholders to the CariCOF. In section 2.1., we identified six common objectives of the CariCOF. Each, and in combination, constitute a package of activities that facilitate information use. We have elaborated on these conditions above.

Beyond its effect on the use of information, the CariCOF influences regional climate resilience in other ways. We have identified five additional pathways through which the CariCOF has, to some degree, advanced regional seasonal climate resilience that were most prominent in the interviews. In no order, they are as follows, and we subsequently elaborate on each:

1. The CariCOF has helped spread a holistic, interdisciplinary risk management approach.
2. The CariCOF has helped spark national-level seasonal risk management.
3. The CariCOF has been a platform to train forecasters; the persistence of the training has created several generations of trained forecasters.
4. The CariCOF has increased awareness of climate impacts and risk management tools.
5. The CariCOF has helped drive a regional agenda for climate resilience.

Table 6. Examples of how the Caribbean could become more resilient to seasonal climate risks.

Category	Examples
Enhance regional coordination and learning	• Increase frequency of regional meetings.
	• Present research-based adaptation solutions in regional Forums.
	• Have learning exchange programs.
	• Use different platforms (Zoom, social media) to connect across the region.
Advance climate science and services	• Improve climate modeling in the region.
	• Have climate services and products that are better fit to user needs.
	• Build capacity to reduce information bottlenecks and speed information delivery.
Educate on climate risks, impacts, and solutions	• Educate governments about seasonal climate risks to make better policy.
	• Educate the public on climate risks.
	• Make climate education part of school curriculums.
	• Educate the public on what to do before, during, and after a severe event.
Invest in and improve early warning and monitoring	• Invest in more instrumentation for data collection.
	• Improve early warning systems.
	• Make accessible and understandable warning messages (including in multiple languages).
	• Make early warning available for multiple risks (drought, hurricane, etc.).
Create climate-aware policy and legislation	• Devise regional climate adaptive building codes to offset heat.
	• Update energy supply systems.
	• Have bespoke building standards fit to context.
	• Update policies and regulations to create legal frameworks for collaboration.
Communicate about climate risks, adaptation, and solutions	• Initiate social media campaigns for early warnings.
	• increase and strengthen intersectoral communication.
	• Draw on country experiences to communicate lessons learned.
	• Share knowledge of effective adaptation actions.
Increase funding and expenditures	• Increase scholarships to train climate specialists.
	• Lower taxes and financial barriers to cooling systems.
	• Increase investment in education related to the climate.
	• Incentivize climate adaptation in households & community (e.g. rebates for rain harvesting).
	• Increased capacity for National Hydrometeorological Services.
Develop sectoral climate-smart applications and planning	• Increase vector control programs.
	• Improve air conditioning (with power back-ups) for schools.
	• Upgrade water and drainage systems.
	• Improve shade houses and heat insulation.
	• Diversify energy sources.

2.8.1 Holistic, Transdisciplinary Risk Management Approach

The CariCOF has become a model for regional collaboration and risk management. The model is transdisciplinary, characterized by an intersectional approach to climate risk management that combines multiple disciplines and that bridges decision-making and research. The CariCOF has thus been an exemplar and has lent itself as a platform to other transdisciplinary initiatives, including the EWISACTs and climate services initiatives at the national level.

With regard to the EWISACTs, the CariCOF has been a venue for the group to meet in-person. The CariCOF has also given the EWISACTs power to influence it. Participation in the meetings and in the CariCOF has convinced some people of the importance and effectiveness of transdisciplinarity. A sectoral stakeholder showcased that influence in an interview, stating:

> Sectoral Stakeholder: *One of my particular activities was developing a climate resilient water safety plan for pilot countries in the Caribbean. Now developing national water safety plans is one of [our] key activities on environmental health. But this was the first time that we introduced the climate element. This was the first time that we really went for an all-out, multi-sectoral approach. This time, we expanded to not only just to water and sewage authorities; the met services were very much there. We had the energy sector, works of transport, agriculture and firemen, disaster management, etc. It's not… how do I say this, technically innovative, but it was an innovative strategy and process. I don't think for any other bit of work we've been able, at least my agency, to bring together so many different stakeholders to sit down and discuss the topic. For me, working with CariCOF and initially engaging with the different stakeholders and hearing their stories and what they can contribute, that sort of gave me more familiarity, or an idea of how to approach the process for my specific work.*

Being an exemplar has been intentional to some degree. The 2024 CariCOF Forum in Guyana, for example, used a multi-hazard scenario planning exercise to help stakeholders become accustomed to working with each other. A CariCOF decision-maker summarized the logic of the exercise as:

> CariCOF Decision-maker: *I would say that [the scenario exercise] mirrors what we intend to have happening at the national level in terms of the dynamic around a National Committee for Climate Services, which are meant to be intersectoral, multi institutional…. That exercise at the CariCOF mimicked that… future potential state for all Caribbean countries that we're working towards. And yes, it will take a long time to gestate, but we are confident that it will happen.*

A separate example of the influence of the CariCOF on multi-sectoral risk management initiatives is its influence on the National Climate Outlook Forums (NCOFs). NCOFS are occurring in a few countries in the Caribbean and offer a way to bring the outlooks and process from a regional scale to a more national level. There were specific agenda sessions at the Forum to discuss NCOFs in 2022, for example. We consider the influence of the CariCOF on the formation of NCOFs a main achievement of the CariCOF. The connection between the CariCOF and NCOFs was noted in an interview.

Forecaster | *I know that the islands do have [National Climate Outlook Forums]. They do because of the CariCOF network. They have people that already [have] implemented national climate forums come and share their experiences.*

2.8.2 National-level Risk Management

The CariCOF is not only a regionally oriented initiative. Rather, it seeks national influence, albeit indirectly. It does so by being a model of comprehensive risk management, training forecasters to create national outlooks, creating a network, and developing analytical tools, like CAROGEN, to help some forecasters generate outlooks. The impact of these activities seem to be more heavily felt by the smaller, less resourced nations, as described below.

Forecaster | *I think if the CariCOF stops, the bigger islands would not, in my opinion, be as affected as the smaller islands because they have built their capacity to a certain extent.*

Sectoral Stakeholder | *I think that for some countries who are using the information, that they will lose that early warning, early planning potential [if the CariCOF stopped functioning].*

There has also been a move to focus more on national level risk management in the Forums beginning in about 2018. Some agenda sessions include: “Advancing sector-specific climate information at the national level” (2018 and 2019), “Options for National Committees for Climate Services: Progress, Current Status and Future Challenge” (2022) and “Co-developing climate early warning information for health at regional and national levels” (2023).

2.8.3 Training Several Generations of Seasonal Climate Forecasters

Since 2014, the CariCOF has persistently trained forecasters both at the in-person event and via the routine monthly calls. In that time, at least 151 forecasters have received training at the in-person event, many of whom have attended multiple in-person trainings. This has had an amplifying effect on the transfer of both technical skills and knowledge. Many of those trained have brought the skills and knowledge back to their offices. Of importance, some of those forecasters have advanced in their careers to have more authority and influence. An increase in positional rank may have had an important impact on national level priorities and NMHS standing, although we can only speculate on this connection. What is unequivocal is that the ability to forecast at seasonal timescales, particularly for NMHS offices in smaller countries, can trace a direct path to the CariCOF.

2.8.4 Awareness of Climate Impacts and Risk Management Tools

Since 2014, the in-person CariCOF Forum has dedicated large fractions of its agenda to advancing risk management, specifically by making information more available, improving forecast understanding, stressing communication, and educating on broader climate conditions. More than 500 people have participated in the CariCOF Forum since 2014, not to mention the indirect pathways by which the information and knowledge diffuse through the CariCOF network. In the final accounting, the CariCOF has made substantial progress on helping the region be more knowledgeable about the tools available to make decisions, their use, and the risks that may present themselves.

2.8.5 Influence on a Regional Climate Resilience Agenda

The CariCOF has been a vanguard in the region for seasonal climate resilience. In 2016, it helped bring climate and health vulnerability to a more prominent position in the region by dedicating the CariCOF Forum in Dominica to the topic. Since then, specific climate and health products have been developed and engagement with the health sector has been continuous and large (Figure 5). The CariCOF has also provided a venue for the EWISACTS to meet in person to develop their "Strengthening Climate Services in the Caribbean Through the Sectoral Early Warning Information Systems Across Climate Timescales (EWISACTs): Regional Roadmap and Plan of Action (RPA) 2020-2030" and to participate in the CariCOF; many of the authors on the Roadmap have had a routine presence at the CariCOF Forum.

The CariCOF has also brought topics to the Caribbean that are at the forefront of agendas around the globe, such as heat and sub-seasonal risk. As mentioned, the CariCOF model of transdisciplinarity is being replicated at national and intra-sectoral levels.

We also cannot discount the difficult-to-measure, indirect ways that the CariCOF pushes climate resilience forward. What people hear and learn at the CariCOF gets ingested into the operations of organizations that participate. A Director of a regional organization remarked in an interview that she was hoping to include climate on the agenda of their flagship regional meeting, while another sectoral stakeholder stated the following:

> Sectoral Stakeholder: *I am here listening to a lot of the cries of different member states on how they can improve their contributions of data that drives CariCOF. And it is key that we have this actual knowledge of how the individual countries actually need to enhance their contribution to that regional network. So I am on the ground, listening, hearing that cry and reporting back so that it can be written into projects that we support.*

3. SUMMARY OF KEY RESULTS

In this section, we emphasize some of the results we articulated in the previous section. The key results are presented in the order in which they appear from the previous section.

CariCOF is more than a forum.

The CariCOF is constituted of four interrelated and temporally distinct activities, each of which have their own set of objectives. The activities are:

- A monthly forecast discussion
- A multi-day, invitation-only, and in-person technical training workshop convened often bi-annually
- A multi-day, invitation-only and in-person forum of forecasters and sectoral stakeholders hosted twice a year in the same location as the forecaster training
- The monthly dissemination of climate information products.

The CariCOF has diverse objectives.

There are diverse views on the objectives of the CariCOF. Results from the survey and interviews revealed six commonly held views about the main CariCOF objectives:

- To train forecasters to create and communicate seasonal climate outlooks.
- To create monthly, regional climate information products.
- To assess the utility of new seasonal climate information products.
- To increase understanding about the outlooks and climate impacts, risks, and solutions, including opportunities for new climate information products.
- To create new professional connections and strengthen existing ones.
- To elevate the importance of seasonal climate risk management in the region (and often especially for the host countries).

Communication barriers persist but overall are becoming easier to overcome.

- The main communication barriers involve brokering climate information, including the need for additional explanations and supplementary details; the technical nature of the information; and the lack of tailoring for specific groups.
- Respondents from the survey perceived that their communication of climate information reached a limited number of people.
- Communicating climate information has become easier over time for both forecasters and sectoral stakeholders.

The CariCOF has expanded and is diverse.

- The CariCOF network has focused on both stability in participation and bringing in new voices. 500 people have participated in at least one CariCOF in-person event since 2014, with each CariCOF Forum being attended by between 50% and 10% first-time participants in both the forecaster and sectoral stakeholder groups.
- Participants are from different sectors (e.g., agriculture, health, disaster, tourism, energy, climate, academia, water).
- Participants have different official language in their nations (English, Spanish, French, and Dutch).

The CariCOF network shares the information.

- Based on participants of the wet season Guyana CariCOF Forum in May 2024, forecasters are sharing the information to diverse sectors, while sectoral stakeholders are sharing with external organizations less.
- Results from the online survey revealed that 78.1% of the 97 respondents had communicated seasonal climate outlooks and/or bulletins among their professional networks.
- Sustained monitoring of the network would provide a more comprehensive picture of the organizations within the network and the penetration of the information.

EWISACTs and CariCOF relationship has been of mutual benefit.

- The EWISACTs has influenced the CariCOF in three main ways. Members have brought continued presence of sectoral actors, helped inject sectoral perspectives into the design of climate products, and provided a pathway for disseminating climate information across sectoral networks.
- The CariCOF has helped advance EWISACTs goals and define and prioritize the agenda for climate early warning information development.

Diverse Climate Products.

- CariCOF has developed or contributed to the development of 19 outlooks, bulletins, newsletters, and/or analytical.
- The product diversity is perceived both positively and negatively. On the one hand, the level of product development would be far lower without the CariCOF and has addressed known barriers and lead to more useful information for a broader audience. On the other hand, the emphasis on new products confronts the reality of limited resources.

The quality and credibility of CariCOF climate products are high.

- Forecasters and sectoral stakeholders have a positive perception of the scientific credibility of CariCOF products. 91% of the online survey respondents trust (at least in part) the models and tools used to develop the seasonal climate outlooks and/or bulletins, and 98% trust the knowledge of the people who develop the outlooks and/or bulletins.
- The high level of perceived scientific credibility may have been influenced by exposure to the information over time and relevancy of the information.

Information brokering activities deemed important are access and comprehension.

- The two most frequently stated aspects of information brokering are that the information should be understandable and accessible.
- Overall, respondents perceived that users have access to the information and understand the climate products.
- Understanding has also improved among participants but a greater engagement with the science behind the information products is desired by some participants.

Activities at the Forum.

- Presentations at the Forum have been allocated more total time than participatory activities and discussions, with the latter receiving roughly 10% of the time.
- Increasing the duration and style of discussions was suggested as an area for evolution.
- A large fraction of the activities is led by climate information producers, which suggests an opportunity for more space to be allocated to sectoral stakeholders to share their experiences.
- Most of the Forums have introduced new outlooks or decision support tools, or organized activities that seek to advance the development of existing outlooks or tools.
- There is no sustained evaluation of the CariCOF.
- The focus on understanding information uses, gaps and needs occurred more in the first half of the CariCOF history than the latter half.

The use of CariCOF information is varied.

- The CariCOF information is being used for decision-making and to foster relationships, learning, and improve emotional fortitude.
- The two most common outlooks used by online survey respondents were the precipitation outlook, followed by the drought outlook.
- Two most common bulletins/newsletters used were the CariCOF Climate Outlook Newsletter followed by the Caribbean Drought Bulletin.

- Workshop participants identified decision-making and learning as the most common ways that CariCOF information is used. In the survey, the most common decision-making type of use was identified as seasonal planning.
- The ways CariCOF informed the use of climate information are: learning about outlooks leads to more effective communication, engaging sectoral stakeholders helps spread climate information through their networks, and product diversification increases the ability of participants to reach new audiences.
- Concretely stating how the information influenced decisions remains challenging.

The CariCOF contributes to regional climate resilience through six pathways.

- The CariCOF has affected regional resilience in six ways: i) facilitating information use in the region; ii) enhancing of a holistic and interdisciplinary approach for risk management; iii) helping spark national-level seasonal risk management; iv) strengthening capacity of forecasters in the region; increasing awareness of climate impacts and risk management tools; v) has been a platform to train forecasters; and vi) supporting the development of regional agenda for climate resilience.
- The CariCOF's technical support is most beneficial to smaller island nations where human, technical, and economic capacities are more limited.

4. OPPORTUNITIES FOR CARICOF EVOLUTION

The CariCOF is a "living lab", as sectoral stakeholders affectionately described it. Since 2014, the types of outlooks have evolved, different Caribbean initiatives have interacted with the CariCOF, and participatory activities, like the CariCOF theater and multi-hazard tournament, have been introduced to address different risk management themes.

In the spirit of growth, the totality of our results sheds light on opportunities for the CariCOF to evolve. The following opportunities relate to three complimentary themes: strategic planning, monitoring and evaluation, and forum form and format. As is abundantly clear, the CariCOF is valued, unequivocally. The following opportunities are meant to spark innovation and not to be prescriptions.

4.1 Strategic Planning

4.1.1 Develop a CariCOF roadmap.

Despite uncertainty in funding, the CariCOF has provided continuous regional training, coordination, and leadership since 2012. It represents a main mechanism for seasonal climate risk management in the Caribbean. The influence of the CariCOF in risk management is evidenced by the high number of distinct objectives it advances. We identified at least six, which could easily have been split into more. The variety of the objectives is both a strength and weakness. The strength manifests in a holistic climate risk management approach, which requires being multi-faceted and engaging in new activities as science, people, and regional priorities evolve. The weakness relates to trying to achieve multiple objectives in limited time, particularly during the in-person events. In this respect, the CariCOF risks being a "kilometer-wide and a centimeter deep." Notwithstanding its long history and multiple objectives, the CariCOF does not have a clearly articulated, agreed-upon vision.

Much like the EWISACTs developed a roadmap for early warning in the Caribbean, the CariCOF could undertake a similar planning exercise, possibly guided by EWISACTs members, to articulate primary objectives and coordinate activities to achieve them. The objectives, nor the roadmap, need to be fixed. Rather, they could be revisited periodically to accommodate shifting priorities. There are several advantages of this exercise. First, transparency in the objectives and roadmap could help to manage participants' expectations and, thus, limit misperceptions. Second, a roadmap could help layer activities in ways that build on each other; this seems to be occurring to some degree with the forecaster training but is less visible in the Forum. A roadmap would further allow the CariCOF to develop key performance indicators and implement monitoring and evaluation that could help make a case for funding.

4.1.2 Capitalize more on the moment.

The Forum is a significant event for the host country, which rotates with each convening. Political dignitaries often provide remarks at the Forum, media covers it, and local resource managers and other stakeholders attend. There is a production element of the CariCOF that draws attention to the seasonal outlooks in the host country. The attention garnered in the host country begs the question: *how can the CariCOF capitalize on the Forum moment to capture the attention in non-host countries?*

This question takes inspiration from participants at the 2024 Guyana CariCOF Forum and interviews which both highlighted the need to become savvier with communication technologies, in particular video, and to think strategically about messaging. The presentation of the outlooks on the morning of the first day of the Forum is one session to leverage.

The seasonal outlooks are a main attraction for the media and for seasonal risk managers. The outlooks are both regional and national in form, and therefore their presentations could be offered in a hybrid format (online and in-person) and designed to draw broader attention. Being hybrid could extend the participation to more participants across the Caribbean. There could be creative usage of time so that different countries could participate. While internet connectivity and bandwidth could present limitations, there are perhaps new and economical solutions like Star Link, which is not subscription based, provides high data transfer rates, and is available in many Caribbean islands or will be by 2025[9]. Alternatively, the presentation of the Outlooks could be designed with videos in mind. It could be recorded and uploaded to websites. It could be designed to feature short sessions on certain countries or groups of countries to facilitate post-event distribution via social media. This would allow forecasters and sectoral stakeholders who were not able to participate in-person to watch the short recordings of the sessions of their interest.

4.1.3 Reconcile trade-offs in the CariCOF approach.

There have been intentional decisions to grow the CariCOF information product line and to simultaneously engage a recurring group of participants and to expose new individuals to the CariCOF. These decisions are justifiable. Funders expect continued product development and science advances to create new opportunities. Repeat attendance solidifies knowledge and allows

[9] https://www.starlink.com/map

for more advanced techniques, while new participants are needed to replace turnover and for reaching new audiences. These decisions have become the status quo CariCOF approach and in so doing they have also created trade-offs.

We elaborate on three prominent trade-offs related to attendance, product development, and depth of engagement. Our intention is not to argue change is needed. Rather, it is to make explicit the trade-offs so that future strategic planning could confront them, if desired.

- *Who attends*. Both seasoned participants and new attendees are invited to the Forecaster Training and Forum and there is a greater emphasis in inviting new attendees among the sectoral stakeholders. An audience with varying degrees of topical knowledge creates challenges. For the Forecaster Training, progress is hindered by the need to teach topics covered in the past. For sectoral stakeholders, new attendees often lack important knowledge about the outlooks, while some seasoned sectoral stakeholders seek greater depth of content. We perceive that the Forecaster Training and the Forum cater more to repeat attendees and could be designed to accommodate varying levels of climate knowledge. For example, parallel sessions could be offered during the Forecaster Training, and a similar approach could be applied in the Forum for interpreting climate outlooks or other relevant climate topics.
- *More products.* An emphasis on new products creates two trade-offs. First, it limits the resources available to alter existing products. While the CariCOF is in part a test-bed that introduces new products at the Forum, there is less capacity (or desire) to refine existing outlooks. There were comments about the need to revise products and, related, to better understand use to justify their continued inclusion. A second trade-off occurs from the added burden more products create for their stewardship at the national levels. New products themselves require efforts to inform (and educate) the public. Any added burden would be most acutely felt in the smaller Caribbean nations.
- *Breadth*. The topics of focus in the Forum are varied and, given the short duration of the Forum, do not reach the depth that some participants desire. Participants expressed a desire for greater emphasis on discussions and a deeper focus on the meaning and science behind the outlooks. Layering activities over several CariCOF Forums can help create depth, but this caters more to repeat attendees. Given the diversity of CariCOF Forum participants, addressing trade-offs in depth and breadth can be achieved, in part, by managing expectations. Currently, there is not a commonly held view of the purpose of the CariCOF. However, a clear and written articulation of the CariCOF purpose could avoid misaligned expectations. Furthermore, parallel sessions could provide options to satisfy different expectations.

4.2 Monitoring and Evaluation

4.2.1 Learn about the CariCOF.

Although some monitoring and evaluation (M&E) of the CariCOF has occurred, it is not routine and could be expanded. M&E of the CariCOF would be in service of improving the Forecaster Discussions and Training, Forum, and Dissemination of the Outlooks by tracking progress and impact and gathering feedback from participants. In fact, the CariCOF is a climate service. It could therefore be held to the standard of effective climate services, which calls for interactions to generate feedback to “tailor” and “co-produce” information. In this context, we see three

opportunities to improve M&E of the CariCOF: i) use anonymous forms of feedback, ii) increase frequency of feedback, and iii) make written feedback an expectation of participation in the Forum.

- *Anonymous feedback:* The space for feedback of the CariCOF is generally confined to verbal forms during Forums, such as in plenary discussion. The discussions are often facilitated by the hosts which, in combination with being public, limit unbiased responses. Anonymous approaches such as online surveys or written surveys completed in-person could supplement the open forms. The instruments used to collect feedback, however, need to guarantee anonymity.
- *More frequent feedback*. Feedback could be collected at the end of each CariCOF (or afterwards online) and/or for those activities of specific interest, after the activity. There is currently no formal mechanism for routinely collecting feedback.
- *Feedback as part of expectation of CariCOF participation in the CariCOF.* Both anonymous and more frequent feedback could be accomplished by making feedback an explicit expectation for participation. An expectation would help ensure that the feedback is representative.

4.2.2 Monitor "use" in its varied manifestations.

While we report on the ways CariCOF information is used, there were only a few detailed examples of how climate information is used for decision-making. The uses that were identified came easier when talking about other people or hypothetical situations. While the level of detail on use was lacking, there was also a tendency to construe use primarily in terms of decision-making (e.g., using climate information to decide when to plant crops or allocate resources for risk management). However, we demonstrated that the CariCOF's influence on regional climate resilience goes beyond simply informing climate risk management activities. Rather, our results illustrate that CariCOF participants also benefit from the CariCOF through strengthening learning and relationships. Therefore, there remains an opportunity to collect concrete examples of use–both with a focus on decision-making and broader uses. Such detailed feedback could help evaluate the existing climate products, inform decisions about customization, and broach new ideas for product derivatives. This information could help demonstrate the societal impact of the CariCOF.

4.2.3 Frequent monitoring of the network.

The CariCOF network is large and ever evolving. We produced a snapshot of the network (Figure 4) to complement the snapshot reported on in Guido et al. (2016). More continuous monitoring, however, could provide actionable programmatic insight and be used to generate a full accounting of the benefits of the CariCOF.

Frequent monitoring of the network would generate longitudinal data that would identify the frequency at which different products (and product types) are shared as well as how they are shared and with whom. This information would provide a more complete picture of how risk management information is shared across the network, revealing sectoral or institutional participation gaps that could be used to target Forum (or other) invitations. Additionally, greater knowledge about which products are shared could help prioritize and customize products, while also informing discussion about potential retirement of some products. Network monitoring is also useful for thinking about the impacts of the CariCOF beyond the outlooks and bulletins

themselves. It is clear that the CariCOF affects activities like the development of meetings (e.g., NCOFs), meeting agendas, and project-based collaborations. In other words, the CariCOF network is not simply a conduit to share information. It is a conduit for more holistic climate risk management. Mapping the activity-based interactions within the network could further show how the CariCOF supports regional climate resilience, and thus be valuable information for funders, regional decision-makers, and Regional Climate Outlook Forums hosted elsewhere.

Network monitoring need not be burdensome. The tool we developed can be completed in approximately ten minutes by participants, for example. (We provide our tool in Appendix 2.) Furthermore, requiring the completion of a survey or monitoring tool could be an expectation for participation in the Forum.

4.3 CariCOF Form and Format

The CariCOF has a focus on learning. The Forecaster Training provides skills and the Forecaster Discussion and the Forum share and discuss seasonal risk information among forecasters and sectoral stakeholders. There are several opportunities for the CariCOF to accentuate the learning that occurs, primarily by creating more space for sectoral stakeholder participation and interactions between sectoral stakeholders and forecasters.

4.3.1 Training for sectoral stakeholders.

The CariCOF trains forecasters, but no such training exists for sectoral stakeholders. There is an opportunity to develop training activities for sectoral stakeholders. A sectoral stakeholder training could focus on interpreting the forecasts, risk communication, demystifying how forecasts are made, or on broader climate science topics. While some of these topics have been covered in past Forums, there are new sectoral stakeholder participants each CariCOF, and repeat attendees have also suggested deeper dives into some of these topics.

The training could advance the social learning at the CariCOF Forums by placing sectoral stakeholders in a better position to converse with the forecasters. It could advance the impact of the CariCOF by increasing sectoral stakeholders' ability to interpret and explain the forecasts subsequently to their networks. Training could occur in a session within the current two-day Forum agenda or be developed as a separate component. Depending on resources, this could take the form of virtual training and/or concurrent, parallel training to the Forecaster Training.

4.3.2 Training on communication and information brokering.

The sectoral stakeholders and forecasters who attend the CariCOF often communicate the information within their networks. The communication landscape is also quickly evolving with new tools like AI generated text, video, photos, infographics, and new social media platforms and trends. Beyond the mechanics of transmitting information is the science of risk communication, which draws insights from cognitive, behavioral, and social sciences.

Can the CariCOF help advance the ability to effectively communicate climate information? We heard that communication was an especially salient topic and ripe for future CariCOF training sessions. Topics for training could include formatting information for effective dissemination on social media, the communication of forecast uncertainty, the identification of effective modes of communication, and strategies to message information for different sectoral uses. There has been

an emphasis on communication in past Forums, but this issue is prime for periodic refreshes and/or an on-going series of sessions. Coupling these sessions with video and hybrid recordings could lead to an ever-green web resource.

4.3.3 Create space at the Forum for sectoral stakeholders to share more experiences.

The most common CariCOF session type has been presentations. Most of these presentations have been delivered by forecasters, CIMH, research organizations, or another climate information producer group. Sectoral stakeholders, meanwhile, were usually able to share their perspectives, knowledge, and experiences only during discussion or other interactive sessions, which have been allocated much less agenda space. Therefore, there is an opportunity to expand the voices at the Forum and enable stakeholders to share their national experiences. Such a format would help improve understanding sectoral information use and gaps. This has occurred to a limited extent in the past but could be made a more prominent or regular occurrence.

4.3.4 Increase time for discussions after presentations.

A large fraction of the Forum time is allocated for presentations. Far less time is allocated for discussions. Furthermore, presentations often run longer than planned and consequently time is most often taken from the discussions to keep on schedule. Allocating more time for discussions could offer several benefits, including an exchange of national experiences, clarifications that lead to a deeper understanding of topics, and feedback that can inform future Forums.

4.3.5 Addressing multilingual participation.

The Caribbean is culturally diverse and while most participants at the Forum speak English, the official language or lingua franca of some participants is also Spanish, Dutch, Sranan Tongo, Haitian Creole in Haiti, and French. With the Forum conducted in English, some participants have difficulty following the activities and participating in the discussions. The Forum could deploy some strategies to improve multilingual meetings. These include: using technology with real-time translation or captioning, like Zoom or Microsoft Teams; setting clear language guidelines that encourage presenters and participants to speak slowly, clearly, and to avoid jargon; creating smaller breakout groups based on language preferences; allowing participants to provide written feedback on some activities in their language of preference when appropriate; and sharing recordings of sessions afterwards to allow participants to review at their own pace.

4.3.6 Explore climate risk management activities

There is an opportunity to develop sessions at the Forum that make climate risk management activities central. Historically, the Forum seeks to increase awareness of and tools for climate risk management. In so doing, the primary question asked by the CariCOF has been: *How can seasonal climate information contribute to climate risk management?*

A complementary approach could develop sessions focused on the activities being implemented (or that are needed) to prepare for the dry and wet seasons, heat waves, climate change, etc. Inquiry then can be made about the role of climate information in supporting those activities. In this construction, the primary question becomes: *How can climate risk management be supported by climate information?*

This orientation is subtle but nonetheless instructive for the main objectives of the CariCOF. First, it allows for conversations to focus on concrete actions–on what people do–and not on hypothetical situations of what people would do or should do. An orientation on activities would still accomplish the goals of identifying new information needs and more effective ways to tailor information. Second, such an orientation could diversify the presenters and lead to new training activities; a focus on activities requires stakeholders to share their experiences. Finally, a focus on activities could advance holistic risk management in the Caribbean, particularly in the fields of compound hazard planning and adaptation. The CariCOF is well-positioned to deepen an understanding of how risk management interrelates among sectors and how weather and climate tools aid compound hazard planning and adaptation.

5. METHODOLOGY

5.1 Frameworks for Collecting and Analyzing Data

We assessed the use of CariCOF information from a comprehensive perspective that includes a focus on decision-making objectives as well as less tangible forms of use. Most research on climate services literature have traditionally emphasized "instrumental" goals, which are those that lead to direct and tangible outputs, like changing crop varieties or altering water supply schedules. However, it is also clear that these objectives do not account for benefits related to learning and reasoning, social cohesion and collaboration, and psychological well-being. Benefits related to social, cognitive, and affective uses are well chronicled in other literatures like those in development resilience, public health, and climate adaptation. There have also been a few studies on climate services that have noted the need for a broader view of use (Bremer et al., 2022; Roncoli et al., 2009). We take the view in this report that a full accounting of the benefits of climate information requires understanding how it affects decision-making, relationships, learning, and affect, or emotional. states. We define in Table 7 our "Use Typology", and we operationalized its analysis in both the online survey and participatory exercises at the Guyana CariCOF Forum in May 2024.

Table 7. A typology of how climate information is used.

Type	Definition	Examples
Decision-making	Uses of information in planning or informing specific activities that often relate to economic, resource management, and well-begin outcomes. These activities attempt to help people be prepared, make decisions, adjust strategies, and prevent losses.	• altering farming decisions such as planting specific crop varieties • water supply management activities
Relation-ships	The information is used to bring people together for purposes like strengthening and increasing professional networks and incentivizing collaboration.	• Farmer fields schools • National Climate Outlook Forums
Learning	Uses of information that build awareness, advance learning, and increase knowledge and skills.	• learning a new forecasting tool • learning the cause and effect of climate dynamics
Affect	Uses of information that affect one's emotional states in the form of, for example, feeling less anxious about the season ahead.	• Farmers have reported feeling "hesitant," "reassurance" and "hope" from rainfall predictions that have influenced their farm practices.

5.2 Data Collection

We employed a mixed-methods approach for this study, in which we integrated an online survey, interviews, participatory workshop, and document analysis. We targeted different key informants for each of our research activities. Table 8 and Table 9 describe the tools we used, the group of the key informants that were involved, and the total number of participants.

Table 8. Description of the key informants that were involved in the study.

Group	Key Informant Description
Group 1	CariCOF decision-makers who design and implement the CariCOF
Group 2	Forecasters who work at the National Hydrometeorological Service (NHMS)
Group 3	Sectoral Stakeholders who are not forecasters at NHMS
Group 4	Forecasters and stakeholders at the Guyana CariCOF. This group incorporates some people who would also be in Groups 2 and 3.

Table 9. Description of the research tool, the key informant groups, and the number of key informants involved in the process of collecting the data.

Research Tool	Informant Group	Number
Interview	Group 1, 2 and 3	27
Online survey	Group 2 and 3	123
Participatory workshop activities at the Guyana CariCOF	Group 4	59
Participant observation by the research team	Group 4	NA

Interview. We designed and conducted semi-structured interviews with key informants from Groups 1 and 4. Interview questions were slightly different based on the key informant group and the key informants represented. Each interview took around 30 to 40 minutes and was conducted in English, except for one interview that was conducted in Spanish. All interviews were conducted in 2024, and all of the interviewees were at the 2024 Guyana CariCOF Forum. Some of the interviews were conducted during the 2024 Guyana CariCOF and some were conducted online. Interviews were audio recorded, transcribed, and, when conducted in Spanish, translated to English. They were also de-identified.

Survey. We designed and distributed an online survey using Qualtrics software. We constructed a list of 913 unique emails using information provided by the CIMH. That information included participant lists from all previous CariCOF Forums and two email listservs that CIMH's uses to distribute the CariCOF Newsletter and a separate Drought Newsletter. We sent three emails via Qualtrics asking for voluntary participation. The first email was sent on July 17, 2024. Of the 913 emails, 765 were to active accounts. The second and third emails were sent on July 31, 2024, and August 7, 2024, respectively, to individuals who had not completed the survey to date. We offered a $100 gift card to each of three randomly selected individuals who completed the survey and provided their email address. A total of 123 individuals completed the survey, representing a 16% response rate.

The survey was written in English, with all questions being multiple-choice format. We pre-tested the survey to evaluate its length and comprehensibility, and we modified it based on the feedback we got. Based on several pre-tests by volunteers of a near-final survey, we estimated the survey required approximately 15 minutes to complete. The Qualtrics data reports that about 40% of the respondents who answered all questions completed the survey in 20 minutes or less (participants could partially complete the survey and return to it later).

Participatory Workshop Activities at the Guyana CariCOF Forum. We hosted two concurrent activities at the Guyana CariCOF on the second day of the Forum. We split into two groups, engaged in the session for approximately 45 minutes, and then rotated groups (for a total of 90 minutes). All participants participated in both sessions. The sessions were facilitated by the

authors of this report. The topics of the sessions were: “the use of seasonal climate information” and “resilience to seasonal climate risks in the Caribbean.” We describe each of these sessions separately. The results from the sessions helped to identify the response options for several questions in the online survey.

Session A: The use of seasonal climate information. While participants consisted of both forecasters and sectoral stakeholders, we altered the assignment slightly for each group. First, all participants were asked to complete a worksheet. On their respective worksheets, both sectoral stakeholders and forecasters were asked to share specific examples of how their collaborators have used a CariCOF product in their work. Sectoral stakeholders were also asked for examples of how they themselves or their organizations had used a CariCOF product in their work while forecasters were asked for examples of how they had considered end-users in their design of climate information products. We asked participants to be as specific and detailed as possible, including sharing which CariCOF product(s) their responses referenced. We allotted 15 minutes to complete this assignment.

Then, reflecting on the written uses of the information, each participant wrote on separate notecards what they viewed as important characteristics that make climate information usable. They were instructed to write one characteristic per notecard and were not limited in the number of notecards they could write. These notecards were posted on flip charts that could be viewed by all session participants. Color-coded note cards allowed the research team to distinguish responses from forecasters and sectoral stakeholder groups. We allotted 10 minutes for this assignment.

Once all participants had posted their notecards on the wall, they were asked to review the responses posted by the whole group. Participants were then asked to place a colorful adhesive dot next to the three notecards that they felt named the most important characteristics that make climate information usable. We allotted 10 minutes for this assignment.

The final 10 minutes of the session required participants to share their perceptions of the importance of different uses of climate information based on our Use Typology–decision-making, relationships, learning, and affect; we used different names during the workshop: instrumental, social, cognitive, and affective. To do so, each filled out a worksheet answering the following questions:

- Climate information can be used to increase sectoral preparedness for climate risks or influence decision-making related to upcoming climate and weather conditions. These are “instrumental uses” for climate information. How important are instrumental uses for climate information on a scale of 1 to 5 (5 is most important)?
- Cognitive/Learning uses for climate information relate to reasoning and learning driven by the climate information. Evidence for cognitive/learning uses of climate information include changes perceptions and evidence of acquisition of new knowledge. How important are “cognitive/learning uses” for climate information on a scale of 1 to 5 (5 is most important)?
- Climate information can be used to intentionally support building relationships, create resource bridges, develop trust and reciprocity, and foster inclusivity. These are “social

uses" of climate information. How important are "social uses" for climate information on a scale of 1 to 5 (5 is most important)?

- Receiving climate information can be used for emotional purposes such as decreasing anxiety or increasing feelings of belonging, inclusion, and feelings of control (or agency). These are "affective uses" for climate information. How important are "affective uses" for climate information on a scale of 1 to 5 (5 is most important)?
- Please write any other reflections.

Session B: Resilience to seasonal climate risks in the Caribbean. The goal of this session was to understand the issues at the forefront of building seasonal climate resilience in the Caribbean and if and how the CariCOF helps address them. The session was discussion-oriented and progressed through three questions. Notes were recorded on flip chart paper by the facilitator or a volunteer scribe.

1. Imagine a Caribbean that is resilient to seasonal climate risks. What are the issues the region needs to address to arrive at a resilient Caribbean?
2. Which of the issues does the CariCOF help address?
3. Are there other issues that advance seasonal resilience the CariCOF addresses but that have not been mentioned?

Participant Observation at the 2024 Guyana CariCOF in-person events. The author team observed and participated in activities in both the Forecaster Training and Forum. This included informal conversations with participants and organizers. Each team member recorded notes and reflections on their experiences.

Document gathering. We assembled a database of the individuals who participated in the in-person CariCOF Forums between May 2014 and May 2024 and, during 2020-2021, who participated in the virtually convened Forum. Information from a total of 22 CariCOFs was amassed. CIMH provided us with the registration lists from each CariCOF Forum. The lists often included names, email addresses, country, and organization. When there was missing data in these fields, the research team filled in it, when possible, often using Google. The research team also created a "sector" field, which in most situations was easy to complete referencing the organization and/or email address. In other cases, Google was used to identify which sector the individual worked in. We used this database to analyze participation at the CariCOF Forums over time.

We also gathered all available agendas from the previous Forums.

5.3 Data Analysis

Thematic Coding. The research questions guided our thematic coding of the interviews and of the participant observation data.

Document Analysis. Our document analysis included content analysis of the agendas for all CariCOF Forums. We reviewed each of the session titles, durations, and facilitators. The headings were descriptive enough to allow for the sessions to be coded into themes which were

compiled into an excel spreadsheet for further analysis; a member of the author team has participated in six CariCOF since 2014 which aided this exercise. We define the topics in Table 10.

Table 10. Definitions of the themes we used in the content analysis of the Forum agendas. Themes were based on a review of the session titles.

Theme	Definition
Climate Risk Management	Activities that present and/or discuss climate risk management generally
Climate Context	Activities that present and/or discuss hydrometeorological phenomena
Information Use, Gaps and Needs	Activities focused on understanding how climate and weather information is used, what information and tools are needed and why which includes inquiry into decision-making rationale
Outlooks & Outlook Implications & Impacts	Activities that discuss outlooks and/or their implications and impacts
Caribbean Climate Initiatives	Introduction and/or progress of risk management initiatives in the Caribbean
Administration	Administrative presentations, including welcome remarks, agenda presentations, keynote addresses, recap presentations, etc.; these also include project and/or initiative introductory presentations
CariCOF Feedback	Activities that provide feedback on the Forum
Climate Communication	Activities focused on improving the communication of weather and climate information or on risk communication more generally
Unknown	Unknown
Tool Introduction or Development	Activities that present a new decision support tools or outlooks

We also reviewed published literature on the CariCOF and RCOFs, available and relevant gray literature, and relevant peer review publications on climate services. These documents are identified throughout the document when referenced.

Descriptive Statistics. We conducted descriptive statistics of the survey questions that could support our research questions. In some cases, we use statistical tests to assess differences between the responses of forecasters and sectoral stakeholders.

Data Visualization. We conducted data visualization of the online survey, participant list, and agenda dataset. These included different types of plots, such as line plots and heatmaps.

5.4 Survey Demographics

Most survey respondents are from sectoral stakeholder (67.0%). When looking into the sector of survey respondents, most are from Meteorology and/or Climate (40.7%), followed by Water and Agriculture (both 13.0%) (Table 11). In terms of organization, most of the respondents are from governmental organizations (62.32%), followed by intergovernmental organizations (12.3%) and academic institutions (11.3%) (Table 12). The survey respondents worked in 19 separate Caribbean islands and a plurality of the respondents represent organizations that work in multiple

Caribbean countries (16.8%) (Figure 17). The nations of Jamaica and Dominica were represented to a higher degree than other nations.

Table 11. Sectoral representation of the survey respondents.

Sector	Percentage
Meteorology and/or Climate	40.7
Water	13.0
Agriculture	13.0
Disaster Risk Management	10.2
Academic	8.3
Health	5.6
Tourism	1.9
Media	1.9
Economic Development	1.9
Others	3.7

Table 12. Organizational representation of the survey respondents.

Organization	Percentage
Governmental	62.3
Intergovernmental	12.3
Academic institutions	11.3
Non-governmental	5.7
Private sector	4.7
Professional associations	0.9
Others	3.8

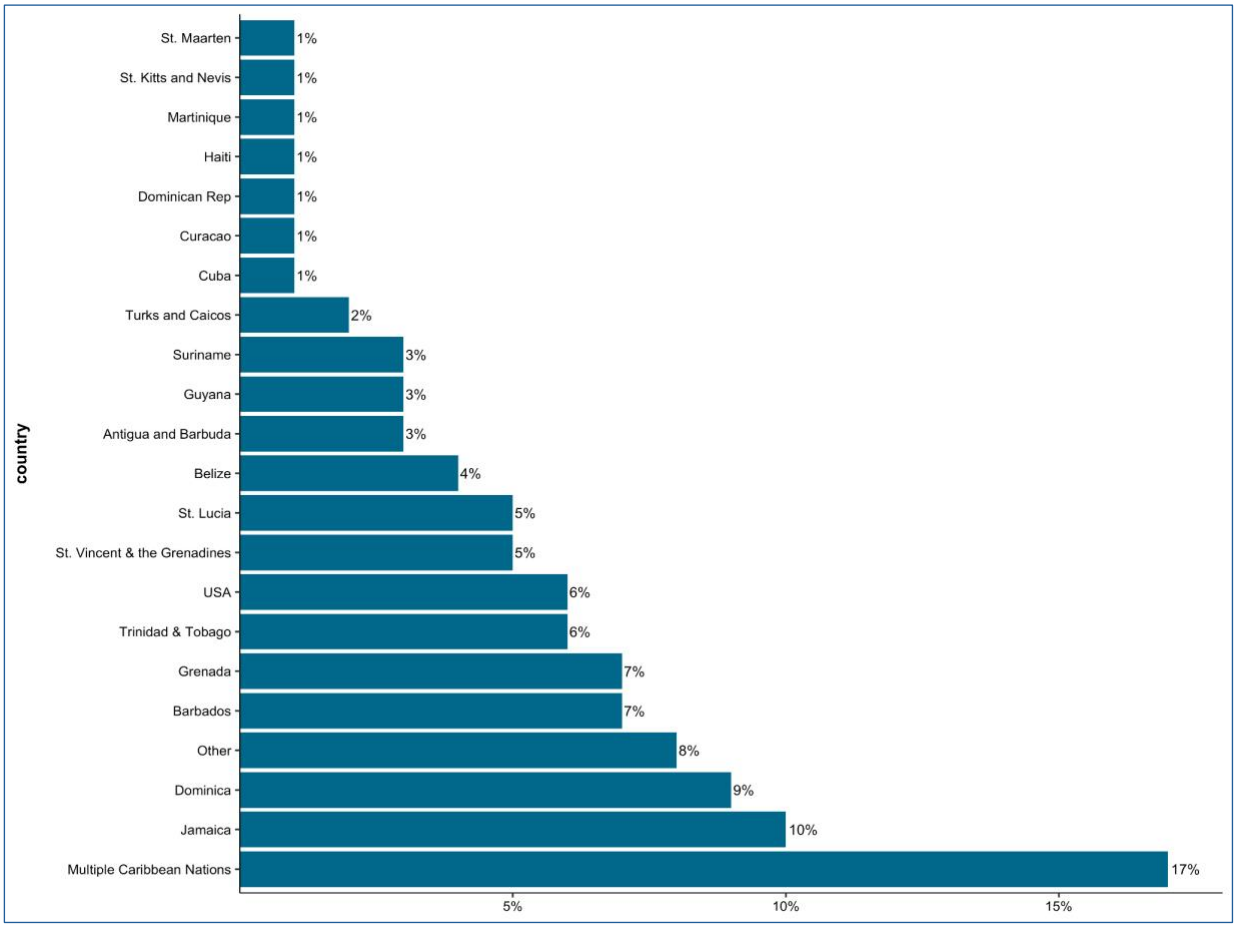

Figure 17. National and regional focus of the organizations represented by survey respondents.

5.5 Limitations

The results are subject to several limitations of the study methodology. First, the number of people we interviewed could not account for the complete diversity of participants who have attended the CariCOF. This is particularly true for the sectoral stakeholders. For example, we did not interview media representatives. Furthermore, we interviewed mostly the participants who attended the 2024 Wet/Hurricane Season CariCOF Forum in Guyana. This was in part a function of being efficient with our time and resources, given the short duration to complete the assessment. Because the focus of the wet/hurricane CariCOF is different that the dry CariCOF, our results are skewed away from drought-related issues. Additionally, we targeted participants who had participated in more than one CariCOF[10]. Who we interviewed likely has introduce some bias into our results and more heavily reflect the perspectives of more frequent participants compared to first-time participants.

Second, the online survey results were limited by the participants we were able to reach via email. Like the interviewers, we do not claim the data is completely representative of the full CariCOF network, at least in terms of sectoral and country level representation. On the other hand, we feel more confident that the forecast views from both the online survey and interviews are representative, given the high fraction of total forecasters with whom we interacted. From the database of emails of all previous CariCOF participants (n = 913), 16% of the email addresses (n = 148) were no longer active. As a result, this subgroup of previous participants of the CariCOF were excluded from the survey, and their perspectives on the evolution of the CariCOF could not be captured. Further, of our initial survey sample of CariCOF participants with active emails (n = 765), the response rate was 16%. While this number is within the normal percentages of online survey response rates, it represents only a subset of the CariCOF participants.

Third, IRB protocols require that participants can voluntarily answer questions. The ability to skip questions reduced the number of responses for certain survey questions.

Fourth, our review of the published documents and the agendas depended upon the focus, completeness, accuracy, and alignment of those works with the objectives of this study. For example, the agendas we analyzed were written before each forum and thus the actual amount of time spent on each activity and the topics could have changed. Even if this occurred, we felt that the agendas were useful to analyze because they revealed the intentions of the CariCOF organizers. Further, the information included in each agenda was not always consistent, with a few omitting names of facilitators or the length of sessions. While this was infrequent, it still poses a limitation of the agenda analysis.

We were clear-eyed of each these limitations when forming our interpretations of the data. We do not suspect that the conclusions we have drawn would changes significantly if more people were interviewed or more individuals responded to the on-line survey apart from the depiction of the network. We do feel that the network characterization would be enhanced with more continuous monitoring, and we stated as much.

[10] CIMH guided the selection of interviewees, highlighting priority participants from among te 2024 Wet/Hurricane Season CariCOF Forum in Guyana.

6. APPENDICES

Appendix 1. Barriers to the Use of Climate Information

Table 1.1 presents barriers to the use of climate information that have been identified in the peer-reviewed literature. These, along with the interviews, informed the construction of a question in the online survey on barriers presented in Section 2.3.

Table 1.1. Common barriers that limit the use of climate information published in peer-review articles.

Barrier	Reference
Unequal access to information	Broad et al. 2002; Roncoli et al. 2001
Insufficient delivery systems	Ziervogel and Downing 2004
Misunderstandings of the forecasts	Ogallo et al. 2008
Difficulty comprehending the technical language	Stern and Easterling 1999
Spatial scale of climate information does not match user needs	Lemos et al. 2002; Luseno et al. 2003
Climate information is not fit to the users' reality	Vogel and O'Brien 2006
Institutions that lead national climate services often have inadequate human resources	Guido et al. 2022
The information is not actionable for management	Boon et al. 2022
Perceived inaccuracy of the information	Mase and Prokopy 2017
National climate services often have inadequate technical resources	Mahon et al. 2019; Lamptey et al. 2024
Information is unintentionally exclusionary, particularly across gender lines	Carr et al. 2017
Socioeconomics limit acting on the information	Glantz 1977; Eakin et al. 2014
Using models of knowledge co-production that focus more on the process than the outcomes	Lemos et al. 2018
Inadequate long-term data across a variety of climate and weather variables	Mahon et al. 2019
Perceived climate change eroding the trust in seasonal and weather forecast accuracy	Guido et al. 2021

Appendix 2. Network Survey Tool

We implemented this Network Survey Tool using Qualtrics Survey Software.

Q. What is the name of the organization you work for? [Open Response]

Q. Which sector best represents your organization? [Academic, Agriculture, Disaster Risk Management, Economic Development, Energy, Fisheries, Health, Media, Meteorology/Climate, National Security, Tourism, Urban Planning, Water, Other.]

Q. Which country or region does your organization you work for represent? [Multiple Caribbean Nations, Antigua & Barbuda, Aruba, Bahamas, Barbados, Belize, Cayman Islands, Cuba, Curacao, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Martinique, Netherlands Antilles, St. Kitts and Nevis, St. Lucia, St. Maarten, St. Vincent & the Grenadines, Trinidad & Tobago, Turks & Caicos, Suriname, USA, Other]

Q. At the CariCOF, the following outlooks for the wet season were presented. Please select all the seasonal climate outlooks that you shared with other individuals or institutions in the time since you attended the CariCOF in Guyana?

• Nighttime & Daytime Temp. Outlooks • Number of Heatwave Days Outlook • Drought Outlook • Number of Dry 7-day Spells • Precipitation Outlook	• Number of Excessive Rainfall Events • Flash Flood Potential • Hurricane Outlook • Saharan Dust Scenarios • I did not share any outlooks

*The respondent completes the following table for each product shared. The respondent can input more than one institution, and for each institution, the respondent designates a sector.

Q. Please list all the institutions that you shared the outlooks with and the sectors that best represent each institution.

Institution Name	**Sectoral focus of institution**
[Open Response]	Academic, Agriculture, Disaster Risk Management, Economic Development, Energy, Fisheries, Health, Media, Meteorology/Climate, National Security, Tourism, Urban Planning, Water, Other.

Q. When you shared the seasonal climate outlooks with other people or institutions, did you do any of the following? [Select all that apply]

- Explained the technical meaning of the information
- Included data or information to contextualize the information
- Provided information about possible impacts
- Provided information or recommendation on how to prepare for possible impacts
- Explained how to get more information
- I did not do anything. I shared the information as it was.
- Other

Q. Why did you not share the outlooks? [Open Response]

Appendix 3. Supplemental Figures and Tables

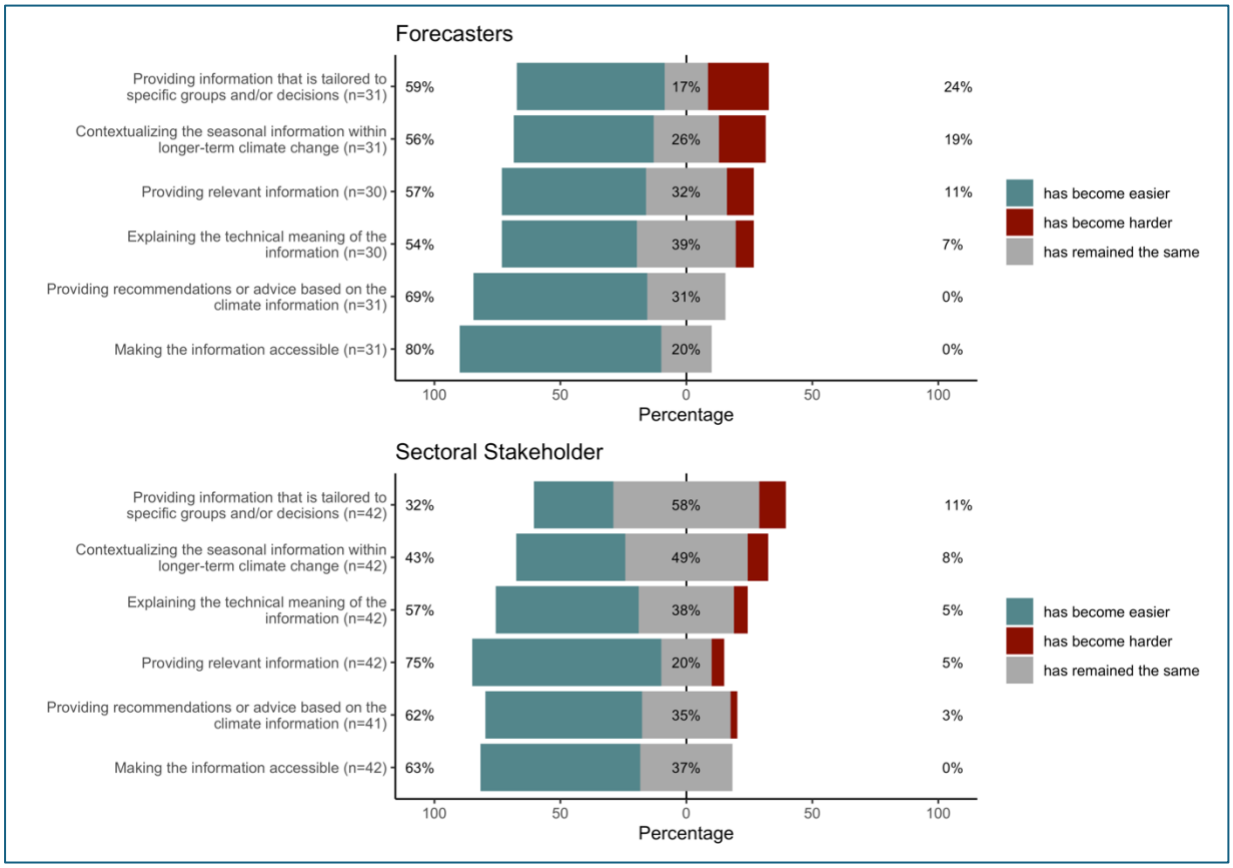

Figure A3.1. The figure juxtaposes responses from two distinct groups–forecasters and sectoral stakeholders–to the question: "Based on your experiences over time with communicating or sharing the seasonal climate outlooks and/or bulletins for the Caribbean, which of the following activities have become easier or more difficult for you?" The questions are written, verbatim, in the y-axis labels. This same figure is presented in Section 2.3 for the full sample.

A t-test was used to assess statistical differences between forecaster and stakeholder responses. The range of values are between 1 to 3, with 1 being "has become easier" and 3 being "has become harder". There was no statistically significant difference between the groups for all six questions.

	Q1. "Providing relevant information"		Q2. "Providing information that is tailored…"		Q3. "Making the information accessible"		Q4. "Explaining the technical meaning of the information"		Q5. "Providing recommendations or advice based on the climate information"		Q6. "Contextualizing the seasonal information within longer-term climate change"	
	F	SH	F	SH	F	SH	F	SH	F	SH	F	SH
Mean	1.70	1.43	1.81	2.00	1.29	1.43	1.70	1.79	1.48	1.66	1.94	1.93
Std. Dev.	0.92	0.80	1.01	0.88	064	0.63	0.88	1.00	0.81	0.94	1.09	0.97
t	1.31		-0.85		-0.92		-0.39		-0.85		0.028	

degree of freedom	57.26	59.40	64.01	67.03	68.69	60.24
p-value	0.20	0.40	0.36	0.70	0.40	0.98
CI (95%)	-0.145, 0.69	-0.65, 0.26	-0.44, 0.16	-0.53, 0.36	-0.59, 0.24	-49, 0.50

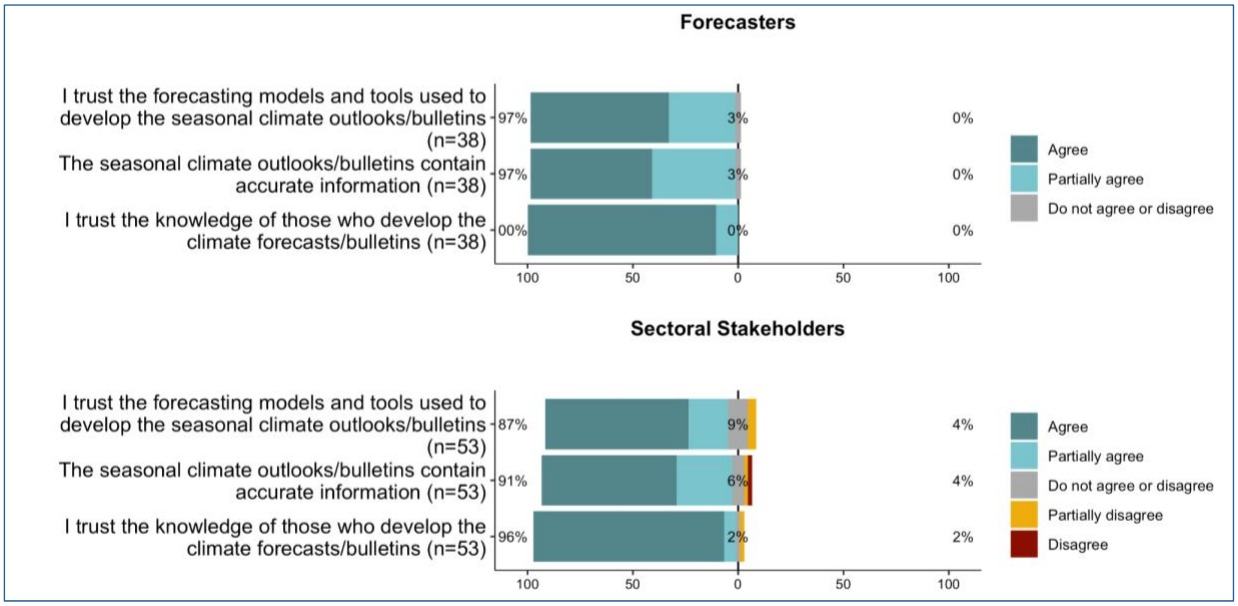

Figure A3.2. Perceived scientific credibility of CariCOF outlooks and bulletins by groups of stakeholders and forecasters. The question asked: "Considering the seasonal climate outlooks and/or bulletins for the Caribbean, to what extent do you agree or disagree with the following questions about the credibility of the information." The questions are slightly paraphrased for brevity in the y-axis labels. The number of respondents for the forecasters was 38 and for the stakeholders was 53. There was no statistically significant difference between groups of forecasters and respondents. See table that follows.

A t-test was used to assess statistical differences between forecaster and stakeholder responses. The range of values are between 1 to 5, with 1 being equal to agree and 5 to disagree. There was no statistically significant difference between the groups for all three questions.

	Q1. Trust in the forecasting models….		Q2. "...contain accurate information."		Q3. Trust the knowledge of forecasters.	
	Forecaster	Stakeholder	Forecaster	Stakeholder	Forecaster	Stakeholder
Mean	1.10	1.51	1.45	1.51	1.37	1.49
Std. Dev.	0.21	0.53	0.55	0.85	0.54	0.82
t	0.51		0.42		0.85	
degree of freedom	85.87		88.39		88.43	
p-value	0.61		0.67		0.40	
CI (95%)	-0.13, 0.22		-0.23, 0.35		-0.16, 0.41	

Table A3.1. Characteristics that make seasonal climate outlooks and/or bulletins of the Caribbean useful and their definitions. These terms were based on characteristics pointed out by forecasters and sectoral stakeholder participants during the in-person workshop in 2024 Guyana CariCOF Forum.

Terms	Survey definition
Accessible	Seasonal climate outlooks and/or bulletins are easy to access/get because they are available in platforms and locations that allow access for different users.
Accurate	Focuses on the technical quality of the climate information, inclusive of concepts of accuracy, geographic scale, consistency, credibility, and reliability.
Context-ualized	Seasonal climate outlooks and/or bulletins are put into context with complementary information that increases its meaning to the user-group.
Instructive	Seasonal climate outlooks and/or bulletins are presented in ways that build user capacity to understand and respond to forecasts.
Messaging	Seasonal climate outlooks and/or bulletins are attention-grabbing and spark user interest.
Timely	Seasonal climate outlooks and/or bulletins are provided at the right time for people to use the info.
Type	Seasonal climate outlooks and/or bulletins provide information of specific physical hydro-climate conditions (e.g., wind speed, precipitation).
Understand-able	Seasonal climate outlooks and/or bulletins are easy and clear for different users to understand (e.g., simple language). The design makes it easier to understand (e.g., colors, font size, etc.).

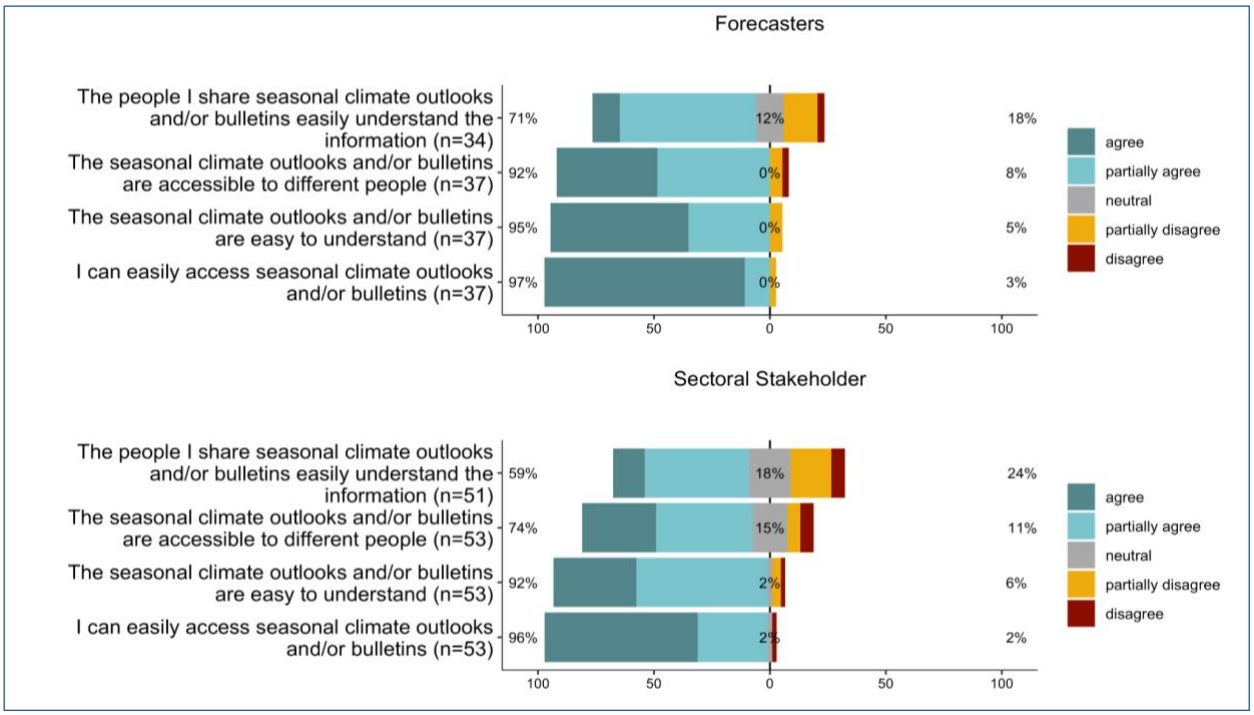

Figure A3.3. Perceived access and accessibility of the information. The specific survey question asked: "Considering the seasonal climate outlooks and/or bulletins for the Caribbean, to what extent do you agree or disagree with the following questions about the access of the information." The questions are written, verbatim, in the y-axis labels. The number of respondents for the forecasters was 38 and for the sectoral stakeholders was 53. There was no statistically significant difference between groups of forecasters and sectoral stakeholders. See table that follows.

A t-test was used to assess significance. The range of values are between 1 to 5 (1=agree, 5= disagree). There was no statistically significant difference between the groups for all questions.

	Q1."The people I share… easy to understand"		Q2. "...are accessible to different people."		Q3. "...are easy to understand."		Q4. "...I can easily access."	
	Fore-caster	Stake-holder	Fore-caster	Stake-holder	Fore-caster	Stake-holder	Fore-caster	Stake-holder
Mean	1.51	1.79	1.76	2.11	1.19	1.42	2.38	2.57
Std. Dev.	0.77	0.82	0.93	1.10	0.57	0.72	0.99	1.12
t	-1.65		-1.66,		-1.66		-0.81	
degree of freedom	80.54		84.99		85.52		76.69	
p-value	0.10		0.10		0.10		0.42	
CI (95%)	-0.62, 0.05		-0.78, 0.07		-0.50, 0.04		-0.65, 0.27	

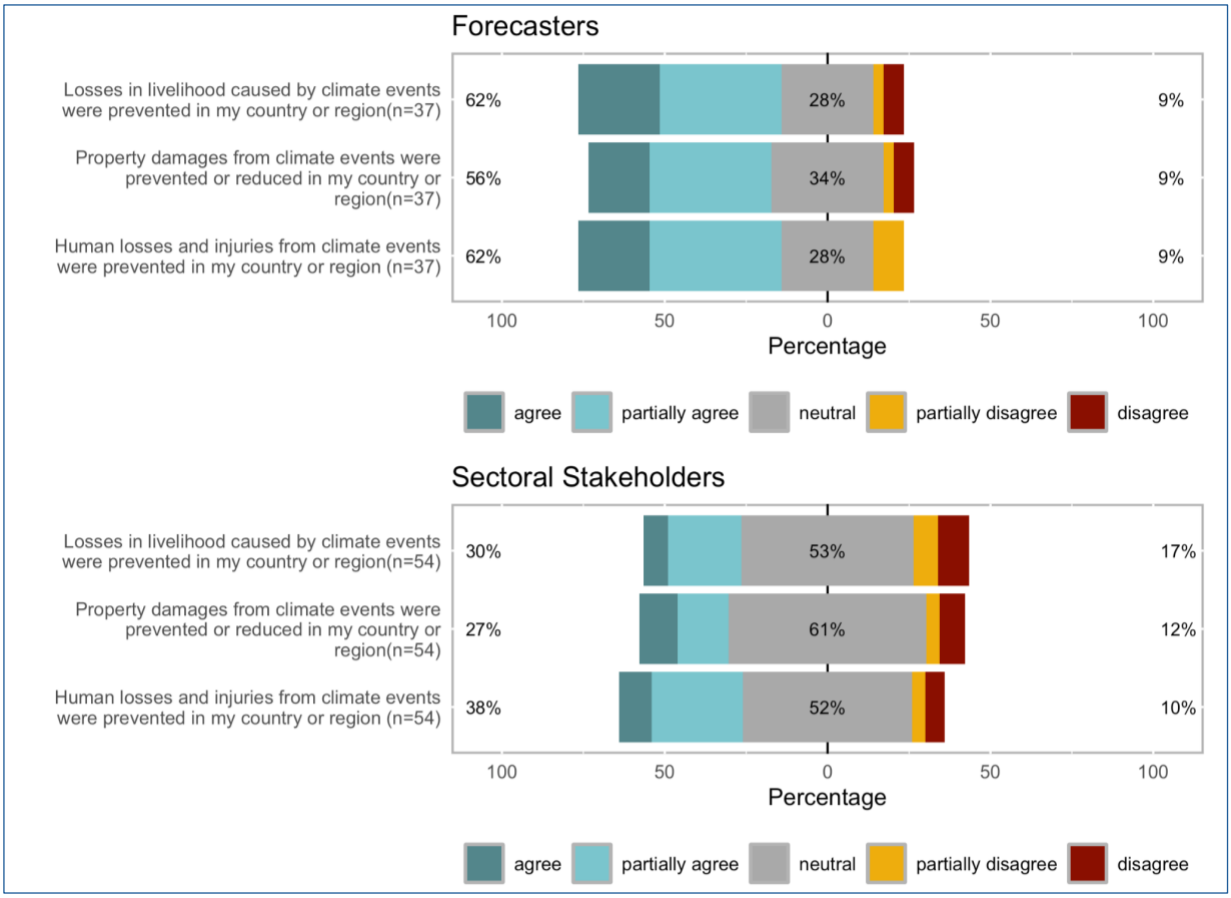

Figure A3.4. The perceived impact of using climate information. The specific survey question asked: "To what extent do you agree or disagree with the following statements about the impact of using the seasonal climate outlooks and/or bulletins for the Caribbean." The questions are paraphrased for brevity in the y-axis labels. The number of respondents for the forecasters and sectoral stakeholders was 37 and 54, respectively. There was no statistically significant difference between the groups.

A t-test was used to assess statistical differences between forecaster and stakeholder responses. The range of values are between 1 to 5 (1=agree, 5= disagree). There was no statistically significant difference between the groups for all questions.

	Q1. “Human losses and injuries…”		Q2. “Property damages …”		Q3. “Losses in livelihood”	
	F	SH	F	SH	F	SH
Mean	2.76	2.93	2.89	2.98	2.78`	2.94
Std. Dev.	1.55	1.26	1.58	1.21	1.64	1.07
t	-0.55		-0.29		-0.53	
degree of freedom	66.47		63.64		56.94	
p-value	0.59		0.77		0.60	
CI (95%)	-0.78, 0.44		-.070, 0.52		-0.77, 0.45	

Appendix 4. Examples of the Use of Information Produced by the CariCOF

For purposes of this research, climate information that is specifically associated with the CariCOF are the seasonal and sub-seasonal climate outlooks and the sectoral bulletins. The tables below only include examples of use that were unambiguous, as determined by the research team. For the examples of how the sectoral stakeholder participants personally used the information, there were 5 individuals who provided information that did not clearly state use of climate information. Some of those 5 individuals simply left the question blank. Another 4 individuals stated that they did not perceive that the information was used by others. For the examples of how the sectoral stakeholder *and* forecaster participants perceived the use of the information by others, there were 15 individuals who provided information that did not clearly state use of climate information. Some of those 15 individuals simply left the question blank. Another 6 individuals stated that they did not perceive the information was used by others.

Table A4.1. Sectoral stakeholders who participated in the workshop stated examples where they personally use, or have used, the information produced by the CariCOF. We categorized these into our Use Typology. Data was collected during a participatory exercise at the CariCOF Forum in Guyana in May 2024. The workshop session was led by the research team. Data came from 13 individuals.

Sectoral Stakeholder Personal Use of the Information	Type
Seasonal/weather forecasts help to foresee hurricane season, and this helps us to create plans to respond and recover, if impacted.	Decision-making
Drought information shared with farmers, some of whom have used the information to adjust their planting schedules, change their choice of crop, and change the variety of the crop planted.	Decision-making
Information is used for disaster risk management, including activating emergency operating centers, clearing culverts, preparing emergency shelters, replenishing emergency supplies, and maintaining early warning systems and generators.	Decision-making
Rainfall, heat and drought forecasts are used for agriculture planning.	Decision-making
Extract information from drought bulletin to inform implementation of projects and to design interventions	Decision-making
Forecasts on rain and temperature used in the planning of agricultural experiments, specifically for climate smart agriculture that tests crop varieties and management strategies.	Decision-making
We circulate the Drought Bulletin monthly to our members and partners.	Learning
We circulate the Tourism Bulletin.	Learning
Used to create risk maps for the up-coming Cricket World Cup.	Learning
We used the Sahara Dust forecasts to develop a bulletin on the projected impacts of Sahara Dust events for electrical generation and system operations. This allowed near term planning.	Learning
Used for DRM, including public education and outreach activities.	Learning
We share information with the public via our website.	Learning
Used in early warning to the public on upcoming and current weather impacts such as from flash flood, tropical cyclones, or heat waves.	Learning
Products used in a manuscript for a section on the Caribbean in the Bulletin of the Meteorological Society's (BAMS) State of the Climate Reports.	Learning
We extract information from the drought bulletin to inform policy makers.	Learning

Table A4.2. Stated examples of how the forecaster workshop participants perceive their collaborators use, or have used, the information produced by the CariCOF. We categorized these into our Use Typology. Data was collected during a participatory exercise at the CariCOF Forum in Guyana in May 2024. The workshop session was led by the research team. Data comes for 21 individuals.

Forecasters Examples of the Perceived Use of Information	Type
The information is used in the creation of a farmer's bulletin.	Decision-making
We use the bulletin to help us to make our sub-seasonal forecast every four months.	Decision-making
Information is used for planning in the water and agriculture sectors such as to create risk reduction response plans for floods and to identify evacuation of personnel from vulnerable places.	Decision-making
Used to inform messages (in METARS and SYNOP) to differentiate regular haze from dust haze.	Decision-making
Maps are used to create downscaled seasonal rainfall and temperature forecasts on 3- to 6-month periods.	Decision-making
Used for planning for water and agriculture.	Decision-making
Helps to determine code to use, the haze or dust code, in synoptic observations.	Decision-making
We recently started to produce an agrometeorological bulletin, the inspiration of which came about from participating in the CariCOF.	Decision-making
We have used the drought forecasts in local bulletins especially when collaborating in the water sector.	Decision-making
Farmers use it to decide which crops to plant and the type and amount of fertilizer that apply.	Decision-making
Stakeholder engagement from CariCOF led to the development of weather-scale products for dust.	Decision-making
The Water Authority uses precipitation, wet spells, and drought outlooks for drought planning and to determine turbidity sources for aquifers.	Decision-making
In the energy sector, outlooks are used to track how temperature affects load on the system.	Decision-making
Temperature forecasts create dengue outlooks by the Health Ministry.	Decision-making
Rainfall outlooks used by agriculture to prepare for planting season.	Decision-making
In agriculture, climate forecasts inform decisions on planting and harvest schedule, types of variety, and pest and disease control measures.	Decision-making
We use the flood forecasts to make early warnings for floods.	Learning
For health, the information is used for awareness on dengue risk.	Learning
Use CariCOF information to inform down-scaling regional information to a national level.	Learning
Heatwave forecasts are used to communicate extreme forecast events to the energy sector.	Learning
To compare with other products.	Learning

Seasonal forecasts are used to confirm national forecasts.	Learning
Useful for water conservation, and the information provides early warning for vulnerable communities.	Learning
CariCOF products are used as general information to reinforce locally relevant information.	Learning
Used it to issue a special warning bulletin.	Learning
Health department uses heat wave and temperature products for warning the public of the upcoming hot season.	Learning
Share information to members of government so they know directly about drought events.	Learning
National Climate Outlook forums are hosted annually for different climate sensitive sectors and include the use of CariCOF Outlooks like wet days, dry spells, rainfall, and temperature.	Relation-ships
Information is shared with stakeholders to build their confidence in local forecasts and bulletins.	Affective
Hurricane forecasts and wet and dry season outlooks are used to give more confidence on the local outlook generated by the meteorological services, and then the national outlooks are sent to agencies like the local media, and disaster preparedness office.	Affective

Table A4.3. Stated examples of how the sectoral stakeholder workshop participants perceive their collaborators use, or have used, the information produced by the CariCOF. We categorized these into our Use Typology. Data was collected during a participatory exercise at the CariCOF Forum in Guyana in May 2024. The workshop session was led by the research team. Data comes for 10 individuals.

Examples of the Perceived Use of Information	**Type**
Some farmers have used the information to adjust their planting schedules, change their crop types, and change the variety of the crops planted.	Decision-making
Used primarily by hotels to support readiness and planning for hurricanes.	Decision-making
Used at the beginning of hurricane or sargassum seasons for budgetary planning.	Decision-making
The storm and hurricane forecasts are used to plan and develop the Caribbean Sisterer Assistance Programme for helping affected utilities with restoration.	Decision-making
CariCOF information was used for vector control on the local University campus.	Decision-making
Farmers, researchers, and their stakeholders utilize forecasts and reports to plan their operations.	Decision-making
Use CariCOF data to produce health bulletins which are shared with member countries, including as alerts and recommendations for action.	Learning
Share CariCOF information to stakeholders at a national meeting.	Learning
The information was shared with farmers through the extension system.	Learning
CariCOF information has been used for student learning in local agricultural department at Univ.	Learning
Information is used in research on new vector control measures for mosquitos.	Learning
Issue heatwave advisory.	Learning
Products used in the Caribbean's contribution to the annual BAMS State of the Climate.	Learning
Used in engagement with media regarding extreme events like drought or excess heat.	Learning

Appendix 5. Examples of the Use of the Outlooks and Bulletins.

Decision-making Uses

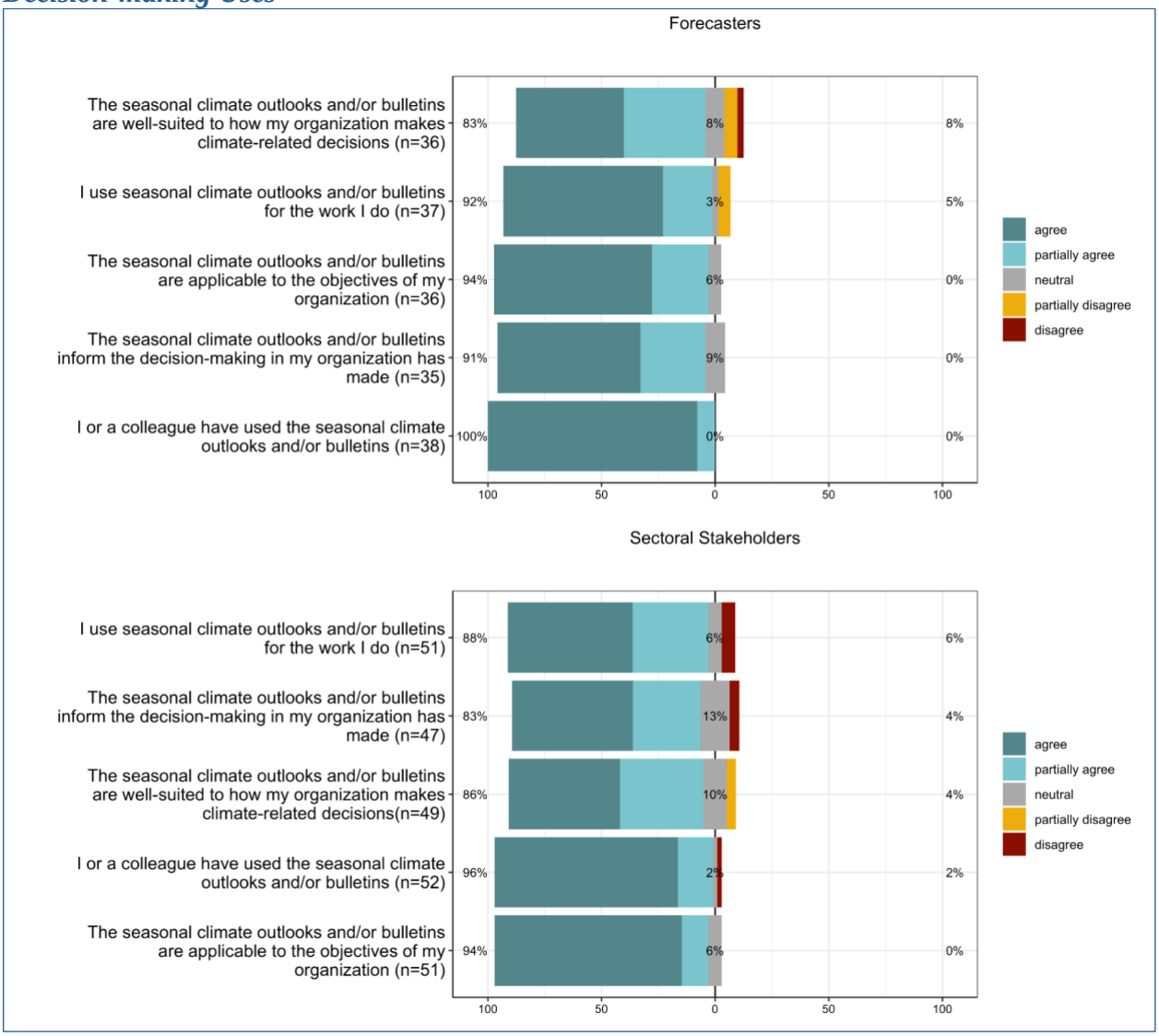

Figure A5.1. Comparison of forecaster and sectoral stakeholder responses related to the degree of agreement for several questions that relate to decision-making. F = forecasters and SH = stakeholders.

A t-test was used to assess statistical differences between forecaster and stakeholder responses. The range of values are between 1 to 5 (1=agree, 5= disagree). There was no statistically significant difference between the groups for all questions.

	Q1.". I or a colleague have used sc outlooks/bulletins"		Q2. "sc outlooks/bulletins inform the decision(s)..."		Q3. "sc outlooks/bulletins applicable to their organization's objectives."		Q4. "I use sc outlooks/bulletins applicable to their work."		Q5. "sc outlooks/bulletins… well-suited to how my organization makes climate related decisions."	
	F	SH	F	SH	F	SH	F	SH	F	SH
n	38	52	35	47	36	51	37	51	36	49
Mean	1.08	1.27	1.46	1.72	1.36	1.24	1.43	1.69	1.81	1.69
Std. Dev.	0.27	0.69	0.66	0.99	0.59	0.56	0.80	1.03	1.01	0.83
t	-1.81		1.46		-1.00		1.30		-0.054	
degree of freedom	70.79		79.03		71.95		85.54		65.99	
p-value	0.08		0.15		0.32		0.20		0.59	
CI (95%)	-0.40, 0.02		-0.10, 0.63		-0.38, 0.12		-0.13, 0.64		-0.52, 0.30	

Relationship Uses

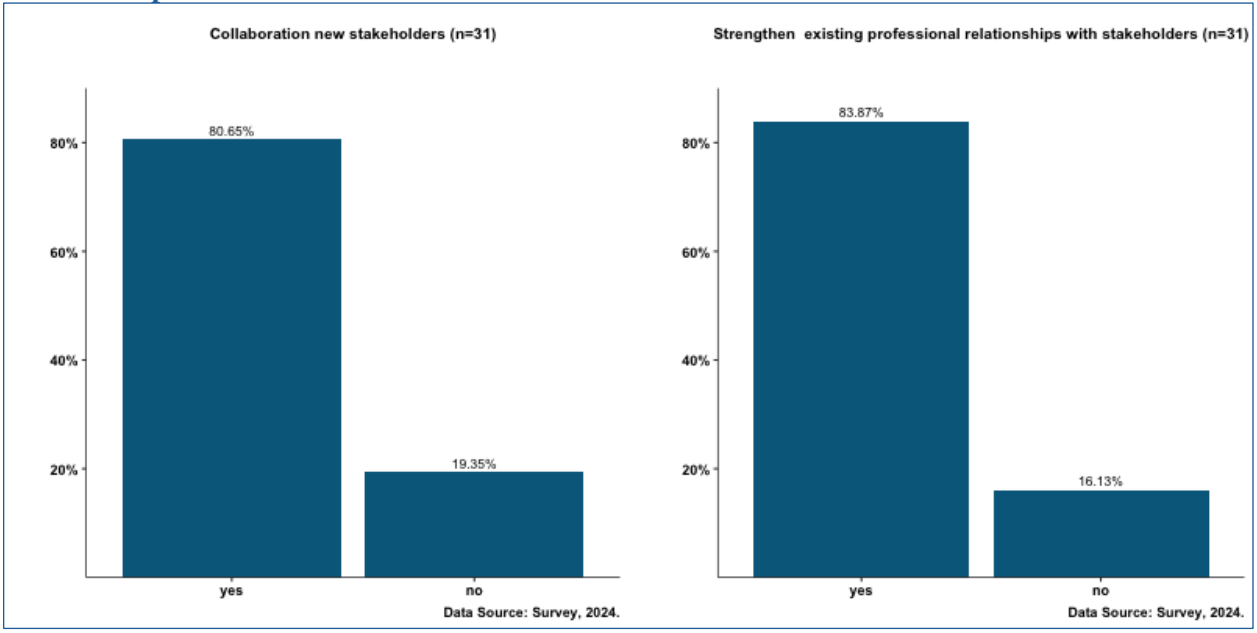

Figure A5.2. Forecasters (n=31).

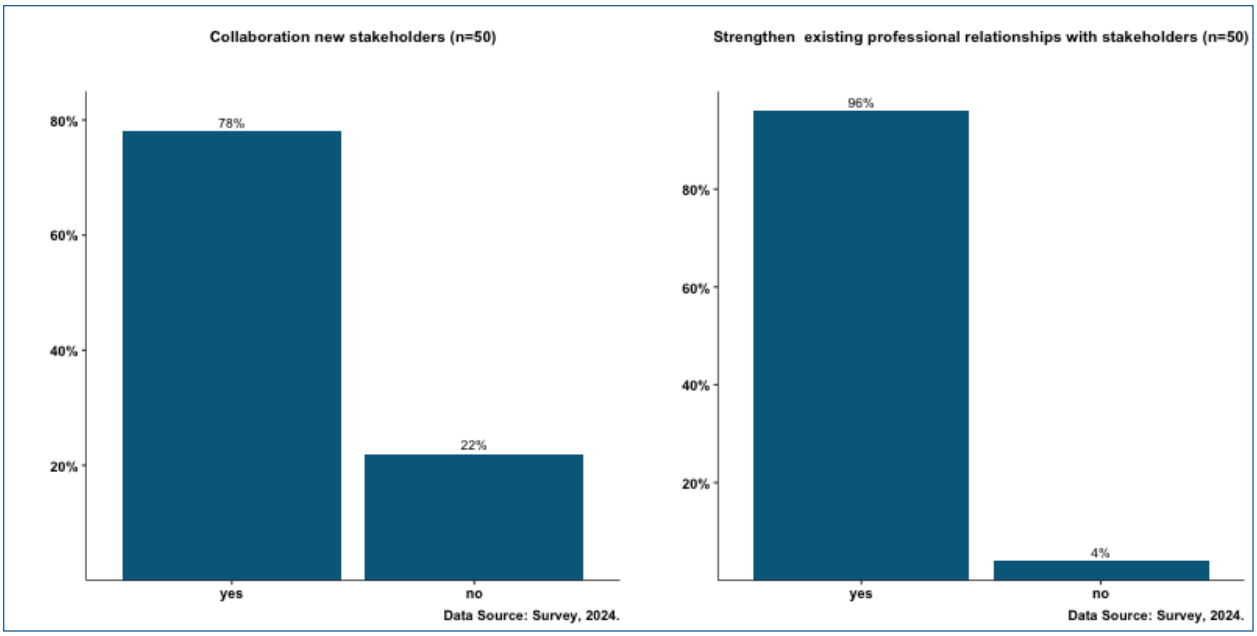

Figure A5.3. Sectoral stakeholders (n=50)

Uses of Climate Information Related to Learning and Affect.

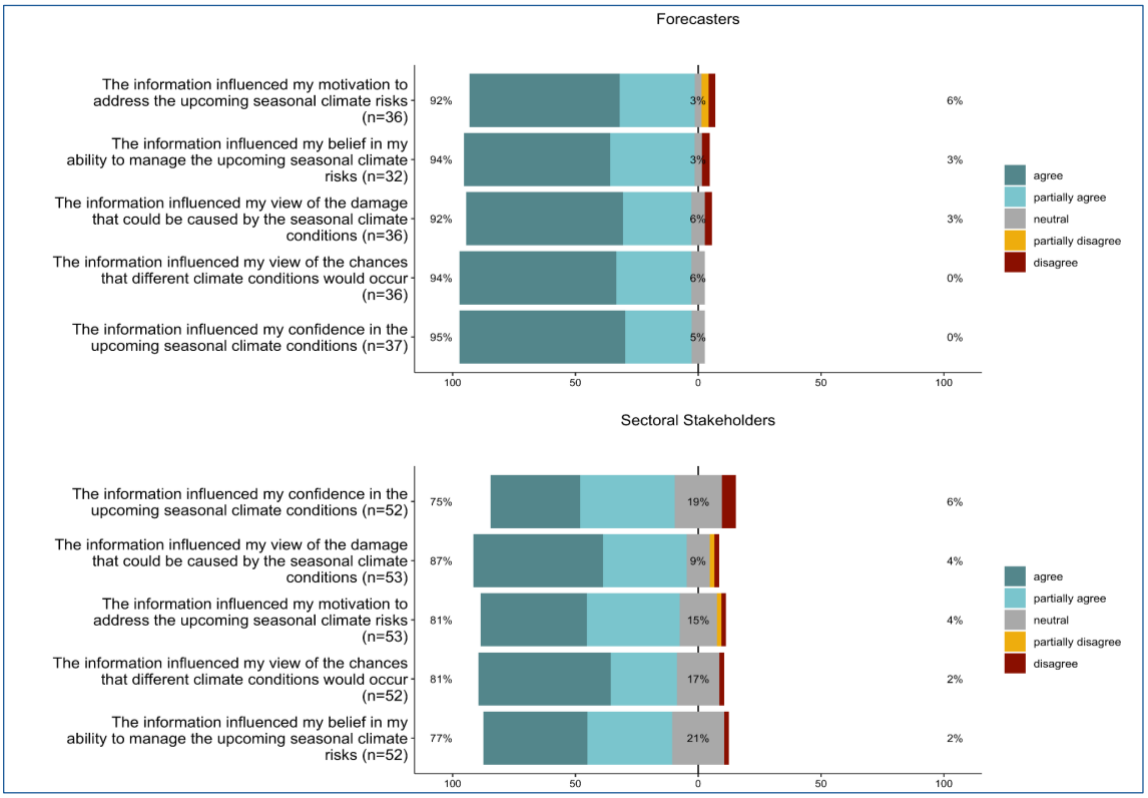

Figure A5.4. Comparison of forecaster and sectoral stakeholder responses related to the degree of agreement for several questions that relate to learning and affect. F = forecasters and SH = stakeholders.

A t-test was used to assess statistical differences between forecaster and stakeholder responses. The range of values are between 1 to 5 (1=agree, 5= disagree). There was no statistically significant difference between the groups for questions 2 to 5. However, for Q1, responses from stakeholder and forecaster are statically different.

	Q1."influenced confidence…."		Q2. "view of damage…."		Q3. "Influenced motivation…."		Q4. "view of chances…."		Q5. "ability to manage…."	
	F	SH	F	SH	F	SH	F	SH	F	SH
Mean	1.34	2.14	1.62	1.74	1.68	1.89	1.54	1.77	2.14	2.00
Std. Dev.	0.60	1.28	1.11	1.05	1.16	1.06	0.96	1.07	1.73	1.18)
t	3.86		0.51		0.89		1.08		-0.41	
degree of freedom	79.93		74.39		72.88		82.45		58.51	
p-value	0.00		0.61		0.37		p = 0.28		0.68	
CI (95%)	0.37, 1.17		-0.34, 0.58		-0.26, 0.69		-0.20, 0.66		-0.79, 0.52	

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