Developing a Communication and Information-Sharing Plan for the Caribbean Climate Adaptation Network

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Abstract

Climate change is causing severe worldwide effects and the Caribbean region is especially vulnerable. The Caribbean Climate Adaptation Network (CCAN) was established in 2022 to increase climate resiliency efforts in Puerto Rico and the U.S. Virgin Islands, but its geographically dispersed and interdisciplinary nature creates significant communication challenges. To address this issue, we conducted semi-structured interviews with nine NOAA CAP teams and seven CCAN team members. Additionally, we facilitated an in-person discussion and a survey with the entire CCAN team. Based on our qualitative and quantitative data, we identified effective internal and external communication strategies and software. Using the information gathered, we developed a communication plan for the CCAN.

Acknowledgments

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We would like to thank all CCAN members that participated in our interviews and survey for their time and detailed responses, allowing us to complete our project.

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Executive Summary

Background

Climate change is causing devastating effects worldwide, with particular vulnerability observed in Puerto Rico and the U.S. Virgin Islands. The intensity and severity of hurricanes are increasing worldwide because of climate change-related factors, including rising ocean temperatures, sea level rise, and changes in atmospheric patterns. As a "hot spot" for climate change risk, the Caribbean region requires urgent attention and support. The Caribbean Climate Adaptation Network (CCAN) is a region-wide network of professionals coordinating climate resiliency efforts across the Caribbean. The CCAN was established in 2022 with funding from the National Oceanic and Atmospheric Administration (NOAA) Climate Adaptation Partnerships (CAP) program, which supports communities in building lasting climate change resilience. It will begin working in 2023 to help climate change mitigation and adaptation governance efforts by bringing together key stakeholders.

The CCAN faces a significant challenge in coordinating collaboration among its members. With more than fifteen researchers spanning over ten institutions and the potential involvement of hundreds of community partners, an effective communication system is crucial to maximize efficiency. Climate change adaptation is a complex issue requiring contributions from multiple disciplines, yet building bridges between them can be challenging. An effective communication system is necessary to disseminate information throughout the CCAN and to external stakeholders and to build trust between scientists, risk forecasters, government agencies, non-governmental organizations, and communities. By addressing these communication challenges, the CCAN can progress in tackling the wicked problem of climate change adaptation in the Caribbean.

Methods

Our project developed a communication plan that CCAN members and outside entities can use to better share information to support resiliency efforts. To achieve this goal, our team completed three main objectives:

1. Explored how other established NOAA CAP teams communicate, what platforms they utilize, and lessons they have for the CCAN team.
2. Determined how CCAN members are used to communicating from past experiences, what technologies and platforms they are comfortable with, and lessons learned from working with other interdisciplinary and geographically dispersed teams.
3. Developed a communication plan for the CCAN.

We conducted semi-structured interviews with nine out of eleven NOAA CAP teams and seven CCAN members over Zoom that lasted between 25 and 50 minutes. The interviews were recorded and then transcribed. During the interviews, one team member facilitated, two took notes, and two prodded (assisted the interviewer with bolding questions already asked and highlighting questions to ask next).

We used grounded theory to analyze our interview transcripts and notes. Our three categories for NOAA CAP interviews were organizational structure, internal communication, and external communication. Our three categories for CCAN members were CCAN role and goals, experience with interdisciplinary and geographically dispersed teams, and experience with internal and external communication. We created user personas representing a typical NOAA CAP lead PI's needs, expectations, goals, and frustrations.

After analyzing the qualitative data, we presented our findings at the first CCAN Planning Meeting in San Juan, Puerto Rico, from February 1st – February 3rd. We led a discussion about preferred communication platforms, meeting frequency, and external

organizational communication and took notes of CCAN members' concerns and preferences based on the discussion. Finally, we conducted a survey to gather CCAN members' preferences on communication platforms and strategies.

Key Findings

NOAA CAP teams shared their main communication insights related to organizational structure, internal communication, and external communication. Best practices include having a dedicated communications manager to support internal structure, external outreach, and overall organization. For internal communication, consistent meetings, familiar internal communication tools, and a singular data storage platform were effective. For external communication, active social media, updated websites, and mailing lists were effective. Finally, understanding the communication preferences of partners and having a translator or native speaker when needed was essential.

The CCAN's preferred internal communication method was email, while Google Drive was the preferred file storage platform. For meetings, the team preferred quarterly or monthly meetings for everyone and bi-weekly or monthly meetings for working groups and sub-teams. When communicating externally, the team suggested tailoring communication methods to partners' preferences, such as relying on the radio or social media. Language barriers were not seen as significant since most principal investigators were bilingual. To support the CCAN's communication efforts in the future, our team created a digital communication plan that draws on the qualitative and quantitative data we collected.

A Communication Plan to the CCAN

Our team developed a communication plan for the CCAN to enhance its internal communication strategies. This plan briefly describes our team's research and is separated into two sections: Meetings and Communication Software. The Meetings section recommends meeting frequency for the overall CCAN and sub-teams. It also explains how to schedule meetings using Outlook Calendar and Zoom.

The Communication Software section recommends using the software most beneficial for the CCAN (Email, WhatsApp, and Google Drive) and explains its purpose. It also includes directions for creating Outlook Email lists and WhatsApp groups and how to integrate new teams that will likely arise during the CCAN's work. Furthermore, it includes instructions on navigating the Google Drive and setting up restrictions when sharing documents and research.

1 Introduction

For up to 328 days, many Puerto Rican residents lived without electricity after Hurricane Maria devastated the island. The hurricane caused over 3,000 fatalities and over $90 billion in property damage (Baldwin & Begnaud, 2018; National Oceanic and Atmospheric Administration, 2018). Communities throughout Puerto Rico felt the aftereffects of Hurricane Maria harshly. One powerful account of the conditions post-Maria came from residents of the Jardines de Francia building in the San Juan neighborhood of Hato Rey. Without power and emergency lighting, the smells of rotten food persisted for months without working refrigerators or freezers, and residents had to climb up and down 14 flights of stairs without elevator access. Tenants continually have no running water to drink, do dishes, or flush the toilet after every severe weather disaster (Pérez Sánchez, 2022).

The intensity and severity of hurricanes are increasing worldwide because of climate change-related factors, including rising ocean temperatures, sea level rise, and changes in atmospheric patterns (Kang & Elsner, 2015). Climate change is causing devastating effects worldwide, with particular vulnerability observed in Puerto Rico and the U.S. Virgin Islands (USVI), as the Caribbean is a "hot spot" for climate change risk and vulnerability (Giorgi, 2006). Research has made it clear that climate change-related threats to people and infrastructure are rising (McPhillips et al., 2018), and Puerto Rican government structures have proven ineffective in disaster response (Rodríguez-Díaz, 2018).

Several community initiatives and non-governmental organizations (NGOs) have stepped in to support places like Puerto Rico, where these governance gaps exist. One such example is the Caribbean Climate Adaptation Network (CCAN), a region-wide network of professionals working to coordinate climate resiliency efforts across the Caribbean. The CCAN was established in 2022 with funding from the National Oceanic and Atmospheric Administration (NOAA) Climate Adaptation Partnerships (CAP) program, which supports communities in building lasting climate change resilience. It will begin working in 2023 to help climate change mitigation and adaptation governance efforts by bringing together key stakeholders.

The CCAN's overarching goal is to form a regional knowledge-action network of researchers and stakeholders to evaluate needs, provide technical-scientific expertise, facilitate communication, and build cross-regional connections and capacity. They aim to evaluate existing strategies and improve governance through a co-production process that efficiently implements adaptive designs in Puerto Rico and the USVI (Méndez-Lázaro, 2022). To achieve these goals, they plan to bring together stakeholders at a macro-level (regional networks and federal agencies), meso-level (territories), and micro-level (communities and local governments).

A significant challenge in coordinating collaboration across the diverse CCAN team is establishing an effective communication system that informs members and increases team efficiency. The CCAN spans across over ten institutions with more than fifteen researchers, and they will potentially work with hundreds of community partners. While there is extensive research on how teams effectively communicate (Hills, 2014; Hall et al., 2019; Butchibabu et al., 2016; Tiferes & Bisantz, 2018), lessons have yet to be applied to interdisciplinary climate change adaptation teams. Climate change adaptation is a 'wicked' problem that necessitates contributions from all disciplines, and building bridges between multiple disciplines is often challenging. As natural disasters continue to become more extreme in the Caribbean, more effective communication and information sharing is one step towards helping Puerto Rico and the USVI before, during, and after severe weather disasters.

Our project developed a communication plan that the CCAN can use to better support resiliency efforts through improved information sharing. We divided our project into three objectives. First, we explored how the other eleven established NOAA CAP teams communicate, what platforms they utilize, and any communication structures they already have in place. Second, we determined how CCAN members are used to communicating from past experiences, what technologies and platforms they are comfortable with, and any lessons learned from experience working in interdisciplinary and geographically dispersed teams. Last, we developed a communication plan for the CCAN.

The following background section discusses climate change and disaster management strategies in Puerto Rico and

the USVI, the CCAN, and the struggles that interdisciplinary and geographically dispersed teams face. We then discuss our methodology, which includes semi-structured interviews with members of other NOAA CAP projects and CCAN members, a presentation at the CCAN Planning Meeting based on initial ideas generated by our interviews, and an exit survey asking for CCAN members' communication preferences. This research project developed an effective communication plan for the CCAN to support climate change resiliency across an especially vulnerable region.

2 Background

2.1 Climate Change

2.1.1 Climate Change and its Effects on Puerto Rico

Our Earth has been slowly but consistently warming over the last 50 years as its average lower atmosphere and surface temperature have increased by one degree. This effect is due to heat-trapping gases, otherwise known as greenhouse gases, such as carbon dioxide and methane, being emitted into the atmosphere from human activities, which have increased the amount of carbon dioxide in the atmosphere by 40% since the late 1700s (United States Environmental Protection Agency, 2016). Even if massive reductions in greenhouse gas emissions were to occur globally, the deleterious effects of increased greenhouse gases in the atmosphere already necessitates that communities adapt. Small island states like Puerto Rico are particularly susceptible to the many impacts of climate change, such as rising sea levels and sea temperatures and the increased frequency and intensity of extreme weather events.

The Caribbean Region is getting warmer, and intense heat episodes are becoming more frequent. Heat episodes are especially apparent in urban areas as paved surfaces can absorb, produce, and retain more heat and can raise surrounding temperatures. In 2012 and 2013, Puerto Rico recorded its two hottest summers. During these summers, elevated temperatures significantly increased mortality rates. 66% of the total summer mortality during 2012 and 2013 occurred when the Average Surface Temperature was above the third quartile (Méndez-Lázaro et al., 2016). The adverse health effects were especially apparent for stroke and cardiovascular diseases, as they were the primary cause of death most associated with the increased summer temperatures (Méndez-Lázaro et al., 2016). Elevated temperatures are a significant problem for Puerto Rico as vulnerable populations such as the elderly, children under five, and those below the poverty level have an increased risk of heat exhaustion, heat stroke, and mortality due to extreme heat episodes worsening (Méndez-Lázaro et al., 2017). Puerto Rico's elderly and children under five comprise 29.7% of the population, while in the United States, these populations comprise slightly less than 22.5% (United States Census Bureau, 2021a). In addition,

40.5% of Puerto Ricans live below the poverty line, while only 11.5% of the population lives below the poverty line on the United States mainland (United States Census Bureau, 2021b). Taken together, a sizable percentage of the island is at risk when these extreme heat events occur.

Sea levels in Puerto Rico are also rising. Sea level rise has accelerated from 0.0175 cm/year since 1955 to 0.725 cm/year since 2005 due to northern polar ice melting from global increases in temperature (Jury, 2018). Rising sea levels already cause side effects like coastal erosion, which can destroy coastal infrastructure and negatively impact tourism in crucial places like harbors and hotels. Protecting cultural heritage sites in Puerto Rico from flooding due to rising sea levels will be an ongoing problem. Today's highest high tides have already flooded 27 sites. In comparison, high tides will flood 56 sites, assuming a 0.6-meter rise in sea level, and high tides will flood 140 sites by the end of the century, assuming a 1.8-meter rise in sea level (Ezcurra & Rivera-Collazo, 2018). The short-term effects of these rising sea levels are not as apparent, but in the long term, Puerto Rico will eventually have to plan a retreat towards the island's center as the edges slowly get swallowed by the sea.

Many hurricanes have affected Puerto Rico in the past, as seen in Figure 1. Still, hurricanes in the Atlantic region have become increasingly destructive because of the effects of climate change. One impact of climate change is rising sea temperatures in the Caribbean area, as seen in Figure 2. Sea surface temperatures correlate with weaker wind shear within the Caribbean, making the atmosphere more conducive to stronger storms (Kossin, 2017). Because of this, tropical storms may intensify more quickly. Kossin (2018) shows that these storms tend to move more slowly through the Atlantic due to anthropogenic warming, causing a general weakening in tropical circulation during the summertime leading to more destruction. The Atlantic Hurricane season in 2017 was amongst the worst the island has ever seen, with six hurricanes above category three and Hurricane Maria delivering one of the most devastating storms in the island's history (Seara et al., 2020). Hurricane Irma, a category-five hurricane, had hit just two weeks before, and while Puerto Rico was still recovering, Hurricane Maria struck land on September 20, 2017. Hurricane

Maria was another category-five storm, and the country's infrastructure simply could not handle the storm. The hurricane primarily affected the electrical lines and water supply system. The storm damaged 80% of the electrical grid in Puerto Rico, leaving thousands of Puerto Rican citizens without power, potable water, and communication systems (Pérez & Mazzei, 2022). Puerto Ricans often had no idea when vital services would be restored without communication systems. Even four months post-hurricane, 40% of the population and 40% of schools were without electricity, and 10% of the population was still without water (García-López, 2018).

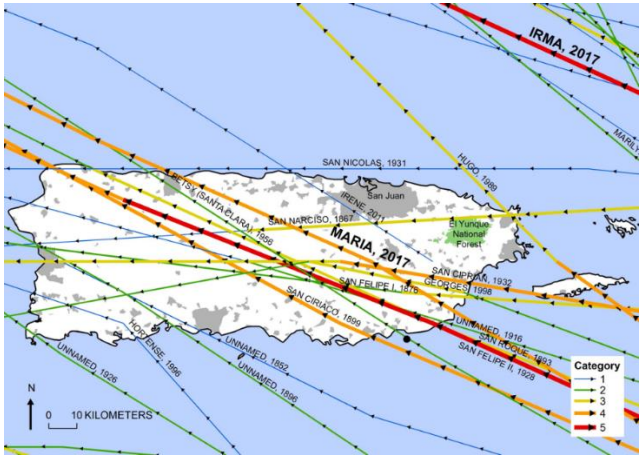

Figure 1: Major hurricanes have hit Puerto Rico on these trajectories since 1896 (Murphy et al., 2017).

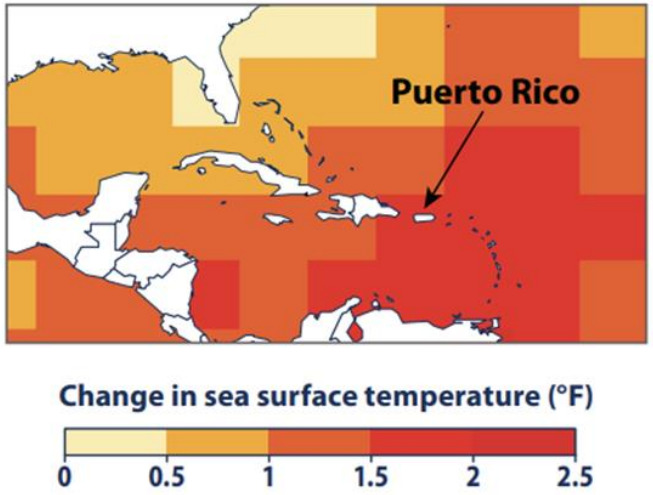

Figure 2: Puerto Rico's Sea surface temperature has increased dramatically since 1901 (United States Environmental Protection Agency, 2016)

The aftermath of Hurricane Maria had significant economic consequences for Puerto Rico, especially in the agricultural sector. Hurricane Maria destroyed approximately 80% of the crops in Puerto Rico, including all plantain and banana crops and about 50% of the coffee crop. Furthermore, more than two million poultry and thousands of cows were lost (García-López, 2018). This mass destruction of produce resulted in $200 million in damages and $1.8 billion in

infrastructure damage. Hurricane Maria exposed Puerto Rico's lack of preparedness for severe weather events and highlighted the need for infrastructure that can withstand increasingly severe weather events.

2.1.2 Emerging Actions and Adaptations

Given the realities of climate change, Puerto Ricans must find ways to reduce their risk and adapt to the increasingly challenging conditions they face. One action many Puerto Ricans have taken is out-migration. Puerto Rico saw an 11.8% decrease in population from 2010-2020, partially due to out-migration from weather phenomena caused by climate change (United States Census Bureau, 2021a). Where out-migration is not desired or impossible, Puerto Ricans must look toward adaptation measures to be better prepared for future climate change effects. Perhaps unsurprisingly, many people are more willing to act after natural disasters. For example, the University of Puerto Rico and the National Weather Service-San Juan Office have collaborated over the past few years to develop standard definitions of extreme heat episodes, heat-related mortality, and heat early warning systems (Méndez-Lázaro et al., 2015). This effort serves as a crucial first step to address and mitigate the impacts of extreme heat events. Without clear definitions, it is difficult to combat the issue effectively.

Hurricane Maria destroyed many docks, boats, and shorelines in Puerto Rico's fishing community. Of 78.3% of farmers on the island who were surveyed regarding how Hurricane Maria interrupted their fishing, 59% stated customer loss, 53% stated fishing capital (vessel, engine, gear, and equipment) loss, and 32% stated damage to coastal infrastructure (Agar et al., 2020). After experiencing Hurricane Maria, fishers showed higher awareness and concern about climate change and how it will affect their livelihoods in the future (Seara et al., 2020). While only 10% of fishers relocated all or part of their fishing operations, most of the reported changes involved switching landing and marketing locations because of damage to infrastructure. Fishers have begun adapting to the adverse challenges they face and are just one group in Puerto Rico to do so.

The farming community in Puerto Rico is another example. 49% of farmers studied after Hurricane Maria reported adopting at least one new agricultural practice or

management strategy to prepare for future events. On average, farmers adopted 2.5 new practices. The most common practices were integrated management of diseases (24.4%), crop rotation (21.2%), and diversification of crops (19.6%) (Rodríguez-Cruz & Niles, 2021). By taking proactive steps to prepare for the impacts of climate change, Puerto Rican farmers will reduce the adverse effects of extreme weather events and other climate-related phenomena.

Adaptation is crucial to overcome climate change's effects, especially extreme weather phenomena. Adaptation was the focus of many Puerto Rican communities and groups across the island after Hurricane Maria as they looked to rebuild a more sustainable, more equitable Puerto Rico (Calderón et al., 2022). These qualities will be essential for overcoming future severe weather events. Many groups are working to adapt to these challenges, but for Puerto Rico to survive and thrive, it will be necessary for more groups to focus on adaptation and preparedness for the impacts of climate change.

2.2 Disaster Management in Puerto Rico

2.2.1 Limitations in Preparation and Response

Puerto Rico experienced a devastating economic crisis between 2006 and 2016, with a 10% drop in its Gross Domestic Product, the loss of a quarter million jobs, a $70 billion debt, and a poverty rate of 40.5% (Park et al., 2017). This crisis resulted in an out-migration of people from the island, high levels of poverty, and inadequate infrastructural maintenance. In 2017, Hurricane Maria exacerbated these issues, resulting in a food shortage crisis, budget cut-offs, and further economic decline (García-López, 2018). Due to its historic economic failures, Puerto Rico systematically lacks the infrastructural maintenance needed to support its citizens adequately.

2.2.2 Insufficient Disaster Relief from Federal Governments

Despite being a United States territory, Puerto Rico receives less disaster response support than the mainland United States For example, despite Hurricane Maria having almost 3,000 more deaths than Hurricanes Harvey and Irma combined, the Federal Emergency Management Agency

provided survivors in Puerto Rico and the USVI $94 million less than survivors in Texas and Florida after the first nine days post-hurricane. Furthermore, within the first nine days, there were 30,000 federal employees in Texas and 16,200 in Florida, but only 10,000 in Puerto Rico (Willison et al., 2019).

Marginalized communities, especially outlying communities on the island, received insufficient support from the government. After Hurricane Maria, many remote communities were left without electricity and clean water for months, leading to health problems associated with a lack of refrigeration (such as diabetes control) and the absence of life-saving treatments for conditions such as severe asthma. Hurricane Maria hit Puerto Rico in September 2017, and poor communities in the Cano Martín Peña region did not receive electricity until mid-December (Roque et al., 2020). Wealthier communities in Puerto Rico, however, received electricity months earlier. Unequal electrical distribution happened again during Hurricane Fiona, as seen in Figure 3. The physical environment of impoverished communities often exposes residents to hazards that threaten their health and well-being. This is often due to these communities' lack of resources, infrastructure, and access to services. As of 2010, 342,000 people lived in floodways or coastal areas subject to storm surges. 49% of the population lived in areas susceptible to landslides, with most coming from poorer communities (Rodríguez-Díaz, 2018). Members of more impoverished communities also had to bathe, wash their clothes, and drink contaminated water due to the insufficient water supply provided by government institutions (Morris et al., 2018).

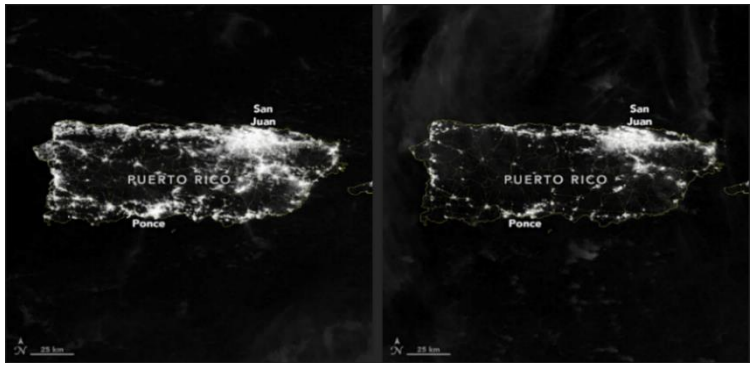

Figure 3: Puerto Rico's electricity grid before and after Hurricane Fiona (Power Outages in Puerto Rico)

Puerto Rico has one of the highest rates of disabled adults living in poverty in the United States and its territories. Disaster care for people with disabilities should be a focal point of hurricane relief, but Puerto Rico does not currently have a

reliable system to support disabled Puerto Ricans. Caregivers are crucial for people with disabilities as they depend on them for assistance, and the electrical outages resulting from hurricanes may jeopardize the equipment they rely on. People with disabilities may also require specialized early warning systems and other physical structures not implemented in the Puerto Rican infrastructure (Morris et al., 2018).

Puerto Rico and the USVI have made changes regarding disaster relief aid. In 2019, the Puerto Rico government passed a bill (Law 33, Senate Bill BS 773) that recognizes climate change as a deadly force that threatens lives and created the Executive Climate Change Adaptation Committee to promote a climate agenda for the island. Unfortunately, all levels of the Puerto Rican government still face issues, including a lack of issue-specific knowledge, which prevents actual change in recovery efforts (Lamba-Nieves et al., 2021).

The USVI Governor signed an executive order on climate change (Executive Order No. 474-2015) in 2015 that set the guidelines for conducting climate change policy, followed by the 2018 Climate Change Vulnerability Assessment. Despite this, as well as the Governor's Hurricane Recovery Task Force 2018 report highlighting the need for climate adaptation recovery efforts, no concrete plans or projects have been implemented. The USVI has not passed any laws that cite climate change, and overall, the government is not accounting for how climate change will affect their island and long-term resiliency goals (Méndez-Lázaro, 2022).

2.2.3 Community Resilience Efforts

Due to insufficient government support, communities working in teams have found ways to improve their situation. For example, a team of scholars performed structured interviews with community leaders from the barrios of Corcovado and Marina to gain insight into how the communities were responding to Hurricane Maria and Hurricane Irma. Respondents said their main challenge was being unable to access their respective communities because of broken trees, poles, and landslides. Communities also suffered significant property damage from destroyed schools and parks and being without electricity for more than 100 days (Roque et al., 2020). The Corcovado community rallied together, gathering resources to provide access outside of its community

and getting significant support from the Presbyterian and Catholic churches (Roque et al., 2020). As a result of the research, the team found that having community leaders offer workshops on writing proposals and effectively communicating their community's needs was extremely useful. While self-organized initiatives across Puerto Rico by NGOs and community-based organizations (CBOs) are commendable, they cannot do everything. To fill this gap, cross-disciplinary research organizations like CCAN are stepping up to help Puerto Rico prepare for natural disasters.

2.3 The Caribbean Climate Adaptation Network

The CCAN is an organization funded under the NOAA CAP program that strives to form a network of scientists, researchers, and stakeholders across Puerto Rico and the USVI to combat the adverse effects of climate change. Specifically, it will evaluate and improve existing strategies and infrastructure to engage in more effective climate adaptation governance (Méndez-Lázaro, 2022). The CCAN is a branch of the NOAA CAP program, which focuses on building lasting and equitable climate change resilience. Including the CCAN, there are twelve nationwide programs, as seen in Figure 4.

The CCAN will accomplish its objectives by utilizing a human-centered design methodology to understand the needs of communities negatively impacted by climate change and support them create more effective disaster risk strategies. The approach involves collaboration between communities, researchers, and agencies to co-create knowledge and strategies, effective communication, and ongoing exchange of ideas between Puerto Rico and the USVI partners. It also includes testing and implementing best practices in the community and regularly evaluating and improving the process through network evaluation. In addition, the CCAN will conduct work across the macro-level (federal agencies), meso-level (territories), and micro-level (community-based organizations and local governments), which is shown in Figure 5 below (Méndez-Lázaro, 2022).

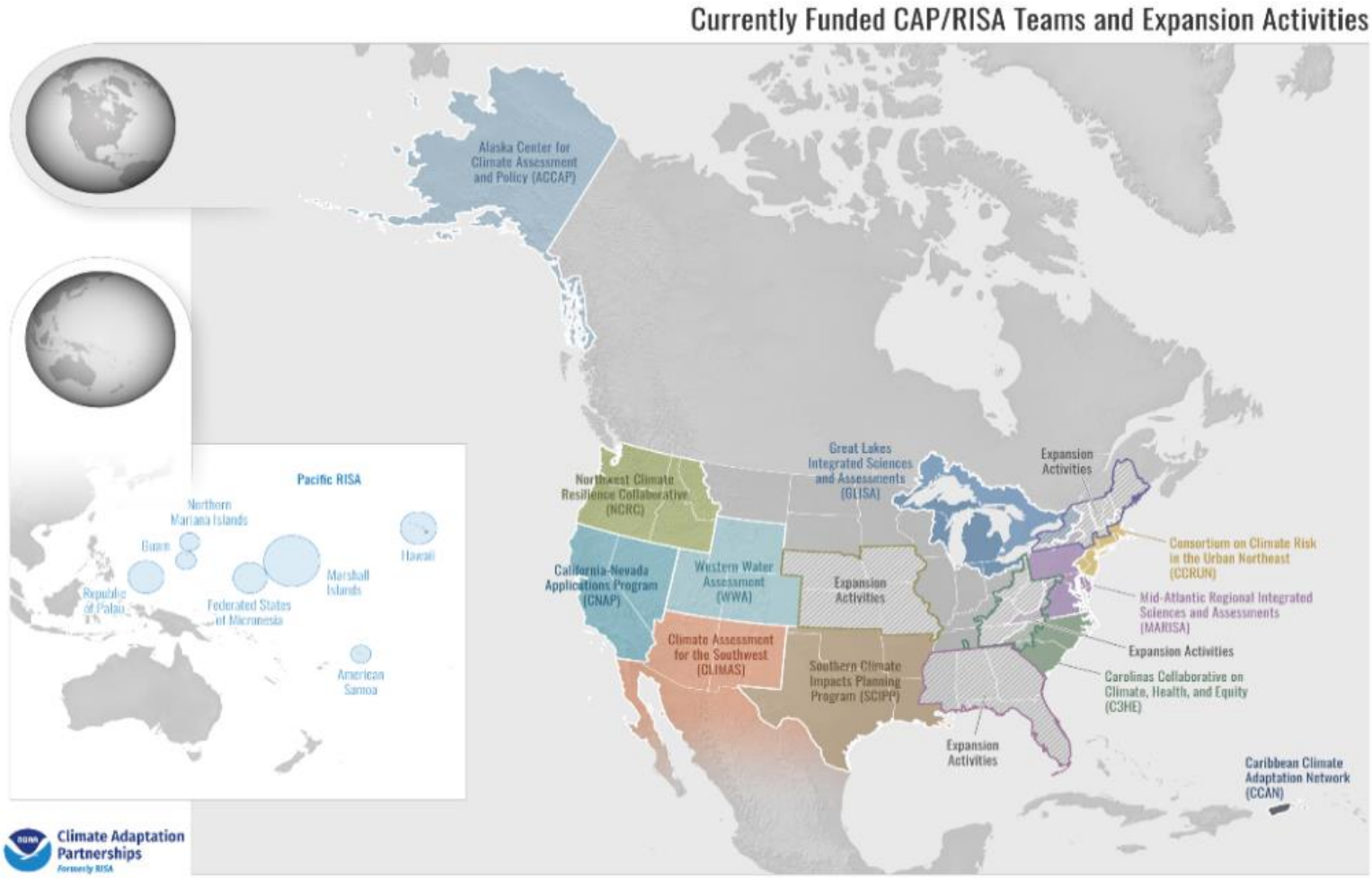

Figure 4: A map of all twelve current NOAA CAP teams (National Oceanic and Atmospheric Administration)

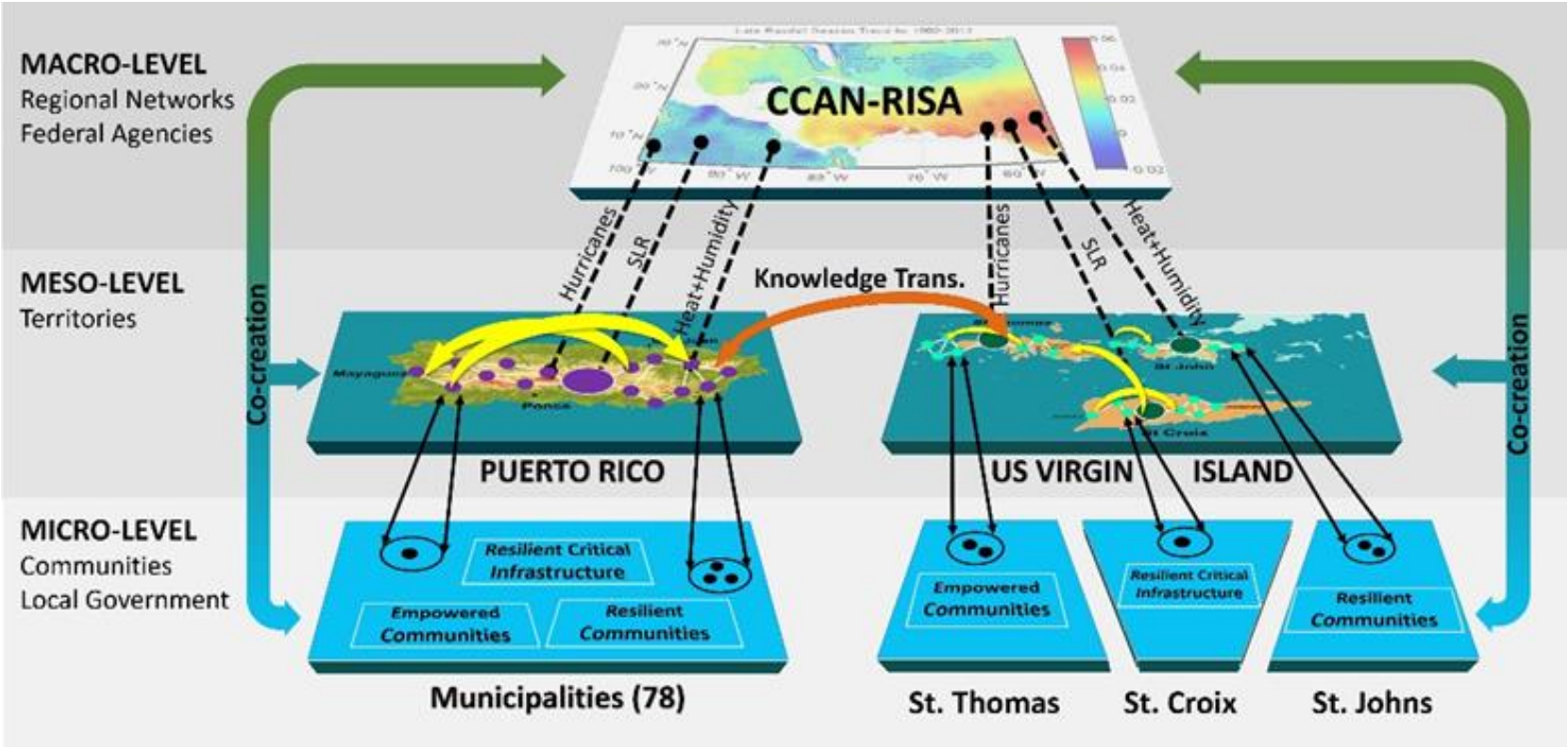

Figure 5: Visual aid of the macro-, meso-, and micro-level approach by the CCAN (Méndez-Lázaro, 2022)

The CCAN is comprised of several teams: the Executive Team (8 members), Management Team (15), Working Groups (26), Outreach Team (6), and Network Evaluation Team (6). The Working Groups are split into three sub-teams: Governance and Decision-Making (6), Social, Ecological, and Technological Systems Hazards and Vulnerabilities (10), and Designing and Fostering Adaptive Capacities (10). Furthermore, an advisory committee of six external partners actively engaged in climate adaptation and community resilience will oversee the project (Méndez-Lázaro, 2022).

The CCAN's initial plan to connect all working parts is to hold network webinars that provide an opportunity for updates on progress and sharing ideas. These are planned to be one-hour virtual sessions and occur bi-monthly or quarterly (Méndez-Lázaro, 2022). A more comprehensive communication plan is needed to efficiently and effectively share information once the team starts its work.

With several involved organizations and stakeholders, establishing trust and utilizing effective communication strategies will determine the trajectory of this project. The Puerto Rican State government, CBOs, NGOs, the Federal government, and the private sector will play a major role in the CCAN. By implementing a robust and reliable communication platform, the CCAN can ensure that all members can access the information and resources needed to contribute to the project's success. The CCAN will primarily rely on communication through technological means, and they may face many of the discussed internal struggles due to being a geographically dispersed interdisciplinary team with members coming from many different societal norms and cultures.

2.4 Communication Strategies Among Geographically Dispersed Teams

Effective communication is essential for teams that require expertise from different fields and for whom members are in different geographic locations (Gibson & Gibbs, 2006). Geographical barriers often cause challenges that can diminish team members' ability to trust and understand each other, but they can also provide unique opportunities for teams to benefit from cultural diversity and varied experiences.

Technological advances have changed communication, but team members’ geographical dispersion remains

challenging for effective workplace interactions and teamwork (Han et al., 2016). Geographically dispersed teams often face challenges related to the different societal norms that team members bring to discussions. These differences can diminish team members' ability to trust and understand each other, hindering the effectiveness of their communication and collaboration (Eisenberg et al., 2019). As a result, effectively managing many of these teams is a struggle, given that they often work on complex problems.

2.5 Summary

Climate change is a major challenge for Puerto Rico and the USVI. It is made worse by the lack of support from the United States government and ineffective disaster risk reduction strategies. The CCAN is addressing this challenge by bringing scientists, researchers, and other stakeholders together to tackle the problem. The need for a sustainable communication plan is also evident, given the dispersed nature of the team and the importance of effective communication for their work.

There are several key reasons why a sustainable communication plan is important for the CCAN. First, it can help team members stay connected and informed, regardless of location. This is particularly important regarding climate change, where timely and accurate information is critical for decision-making. Second, a sustainable communication plan can facilitate collaboration and coordination among team members, essential for achieving the project's goals. Third, a sustainable communication plan can support dissemination of information and knowledge within the team and with external stakeholders. This can help the project build support and partnerships and contribute to the broader effort of supporting climate resiliency in Puerto Rico and the USVI. To conclude, a sustainable communication plan is essential for the CCAN to effectively address the challenges of climate change in Puerto Rico and the USVI.

3 Methodology

Our project developed an effective communication plan that CCAN members can use to better share information to support resiliency efforts. Information from existing NOAA CAP teams and CCAN members regarding effective communication strategies was necessary to develop a plan. We gathered data through semi-structured interviews and discussions with members of other existing NOAA CAP teams and CCAN members before presenting our findings to the CCAN team at their Planning Meeting. We completed the project goal through the following objectives:

1. Explored how other established NOAA CAP teams communicate, what platforms they utilize, and lessons they have for the CCAN team.
2. Determined how CCAN members are used to communicating from past experiences, what technologies and platforms they are comfortable with, and lessons learned from working with other interdisciplinary and geographically dispersed teams.
3. Developed a communication plan for the CCAN.

3.1 NOAA CAP Team Interviews

Including the CCAN, twelve NOAA CAP teams are working in the United States and its territories, researching ways to expand regional capacity to adapt to climate impacts. Our group interviewed nine out of eleven non-CCAN NOAA CAP teams to understand their communication and information sharing plans so we could make recommendations to the new CCAN team. The following research questions served as the basis for our interview questions:

1. What organizational structure do NOAA CAP teams have?
2. How do NOAA CAP teams communicate internally and externally?
3. What technological software do NOAA CAP teams utilize to communicate?

To answer these research questions, our team developed interview questions covering internal organizational structure, communication tools, meeting coordination and frequency, and perceptions of opportunities and barriers. A complete list of our questions can be found in Appendix A.

Our interviews with NOAA CAP teams explored their communication and information-sharing strategies. We chose semi-structured interviews because they provide flexibility, promote conversation, enable our team to learn about topics we had not anticipated, and yield in-depth answers. We used the NOAA website to get the email addresses of each program manager of the other NOAA CAP teams. We sent emails requesting a Zoom interview with either the program manager or someone who works on sharing information with the rest of the team. We also included an invitation to any of their colleagues interested in participating. We provided several proposed times and dates to accommodate busy schedules and confirmed the interview the day before by sending a Zoom link. We maintained an up-to-date Microsoft Excel spreadsheet that tracked the NOAA CAP teams we contacted, their responses, and scheduled interview dates.

For interviews, our team used one interviewer to facilitate the conversation, two notetakers, and two prodders. Prodders bolded questions already answered in the shared interview questions document, highlighted what questions to ask next, and made notes for the interview facilitator. Notetakers wrote notes on separate Microsoft Word documents and compared them to ensure no information was missed. We first read out our preamble, where we introduced ourselves, explained the interview's objective, and asked for permission to record the Zoom call to help with our notetaking. Our team used Otter.ai to transcribe the interview and manually fixed any mistakes.

Our questions began with how their NOAA CAP organization was set up, then moved to their most common internal communication strategies and platforms, how they communicate with outside stakeholders, if they have dealt with language barrier issues in the past, and any shortcomings in their current communication plan.

We took a grounded theory approach to analyze our data. We hand-coded our notes taken during the interview and interview transcription by highlighting words, phrases, and sentences to identify characteristics systematically and objectively in the different NOAA CAP teams' communication structures. We categorized the data by grouping the codes into themes that answered our research questions. We started with several broad coding categories: number of people involved,

organizational structure and job titles, meetings and calls, emails, information and data storage, social media, website, external communication, and limitations. As our team progressed, we further condensed the categories into three main categories: organizational structure, internal communication, and external communication. We compiled brief, compressed versions of our coded data into one document and identified themes highlighting communication advantages and disadvantages across all NOAA CAP teams.

We created a user persona to consolidate and portray the principal investigators (PIs) based on similarities in strategies, strengths, and weaknesses. User personas are business tools that use a semi-fictional character to represent an ideal or current customer (Humphrey, 2017). These personas represented researchers doing similar work to what the CCAN will do in the future and helped our team define valuable strategies for effective communication and potential issues the CCAN may face.

Our main challenge was scheduling interviews with eleven teams over three weeks as program managers had busy schedules. One NOAA CAP team never responded despite multiple follow-up emails, and another could only meet after our proposed timeframe. We mitigated this by reaching out to NOAA CAP teams in December, before we arrived in Puerto Rico, to get a head start on scheduling interviews.

3.2 CCAN Member Interviews

The CCAN is a network comprising researchers from many different universities, regions, disciplines, and cultures. It was, therefore, important to understand how CCAN members currently work and their preferences so that we could best shape the communication plan to their liking. The following research questions served as the basis for our interview questions:

1. How have CCAN members communicated thus far?
2. How have CCAN members communicated in the past on interdisciplinary and geographically dispersed teams?
3. What communication strategies and platforms are CCAN members most comfortable with?

To answer these research questions, our team developed a set of interview questions that covered topics such as their roles and goals on the CCAN and their experience working with interdisciplinary and geographically dispersed teams. A complete list of our questions can be found in Appendix B.

We then conducted semi-structured interviews with seven CCAN members to better understand their communication needs. We focused on reaching out to members from different universities that led each sub-team and were on the overall executive team. Our team reached out to eight CCAN members, and we were able to conduct interviews with seven of them. The other CCAN member reviewed our Planning Meeting presentation instead of an interview. We obtained contact information for the CCAN members from Laura Cabrera-Rivera, the CCAN's lead principal investigators' graduate student. We sent emails requesting an interview over Zoom and proposed several dates and times to work with their schedules. We confirmed the interview the day before by sending a Zoom link. We maintained an up-to-date Microsoft Excel spreadsheet that tracked the CCAN members we contacted, their responses, and scheduled interview dates. We used the same interview protocol described in the NOAA CAP interviews for the CCAN members.

Our interview questions included the participants' role on the CCAN, how the CCAN has been communicating so far, their experience working with interdisciplinary and geographically dispersed teams, what communication strategies and platforms they were comfortable with, and if they have dealt with language barrier issues in the past.

We utilized grounded theory to analyze the data and employed the same analytic approach as the NOAA CAP interviews. We started with five broad categories: CCAN role, past experiences, technologies and strategies, language barriers, and goals for the CCAN. As our team progressed, we condensed the categories to CCAN roles & goals, experience with interdisciplinary and geographically dispersed teams, and past internal and external communication experiences. We compiled brief, compressed versions of our coded data into one document and then identified themes highlighting common goals, communication experience, and overlapping wants and needs for a communication plan between all CCAN members.

Our main challenge for these interviews was that the CCAN was not yet fully established; therefore, the interviewees did not have extensive information to share. As a result, we shifted the focus of our interview to their past experiences to gain insight into their communication preferences, which ended up being similar to how we conducted our NOAA CAP interviews since they shared the same focus.

Another challenge was scheduling interviews with CCAN members over three weeks since many are very involved in their academic institutions. One member canceled our interview three minutes before it was due to start. To address this, we sent several follow-up emails and included Pablo Méndez-Lázaro in the emails, as the CCAN lead PI and our sponsor, to encourage higher response rates.

3.3 CCAN Planning Meeting Forum

On February 1st, our team held a forum at the CCAN Planning Meeting in San Juan, where we presented the communication and information-sharing strategies from our interview analysis. Our presentation can be found in Appendix C. This forum consisted of a 15-minute presentation where our team shared our findings from our initial semi-structured interviews, followed by a 10-minute guided discussion with CCAN members. For this forum, all five teammates initially presented, and during the discussion period two team members served as note takers, two shared our survey's QR code, and one answered participant questions. Our survey can be found in Appendix D. The following research questions served as the basis for the discussion:

1. What are the communication platform preferences for CCAN members?
2. What are the preferences of CCAN members for the frequency of meetings?
3. How does the CCAN plan on communicating with external organizations?

Our team started the presentation by briefly introducing ourselves, our project objective, our research methods, and our data analysis method. We then presented our consolidated user persona based on the interviews with the NOAA CAP teams. The persona represented NOAA CAP PIs and represented many CCAN members, as many members agreed that the user

persona accurately represented them. We then outlined decisions to be made and opened the floor for discussion. We also had a survey where CCAN members could answer with their name, what project teams they are on, information-sharing platform preference, internal communication platform preference, meeting frequency preference, and any other questions or concerns. After the discussion, we presented suggestions for communication strategies based on our research before the meeting. The presentation, discussion, and survey provided qualitative and quantitative data that let us know precisely what CCAN members are looking for in a communication plan.

Our team utilized quantitative data analysis in Microsoft Excel to visualize the data. We first manually cleaned the data in Excel. Then, we created a separate data frame in which we separated CCAN members into multiple data points based on the number of teams to which they belonged. We then used this data frame to create a pivot table where we separated preferences in collaboration software by team. Then, we created another separate data frame from the original dataset, splitting the data points based on the communication software with which the members were comfortable. Our team then made a data frame from the original dataset based on how often the members would like to see the team meet and analyzed it. The final form of data we analyzed was how frequently the teams would like to individually meet. When analyzing this data, we excluded teams not on the grant and members not yet on a team.

Our most significant limitation was only having a tight 25-minute window to present, which led to our discussion being cut short at the end. Another limitation that we faced was when analyzing our survey data. Some members gave lengthy and extensive answers when typing in answers. We overcame this limitation by finding common themes within answers to group them into a singular category.

3.4 Developing the Plan

Our team developed a communication and information-sharing plan for the CCAN based on the quantitative data from the surveys and the qualitative data from the discussion. This data was analyzed using Microsoft Excel pivot tables and pivot charts.

Using this data, we created a written plan as well as a visually appealing plan in the form of an infographic. We created the infographic using Canva. The infographic gave brief information about what software to use, how often the CCAN and sub-teams should meet, and rules and regulations for communicating within the team and providing data visualization from the survey. The written plan held all the same information but in more detail. Additionally, the written plan held instructions on creating new sub-team communication networks as they arise, which included adding the new team to a Microsoft Excel sheet of all teams, creating an email alias, and creating a WhatsApp group for this team.

We presented our deliverables at the CCAN's monthly All Hands meeting on February 28th and gathered further feedback. We then reviewed the feedback and made the necessary plan adjustments before sending our sponsor a finalized version.

4 Findings

Our team gathered valuable insights from interviews with members of NOAA CAP and CCAN, as well as from our presentation, discussion, and survey at the CCAN Planning Meeting. Using this information, we developed a comprehensive communication plan for the CCAN that incorporates effective communication strategies extracted from NOAA CAP teams along with the preferences and needs of CCAN members.

Drawing on qualitative and quantitative data, our team made communication recommendations for the CCAN, designed infographics for internal and external communication, reorganized the CCAN's Google Drive, and created email lists for the CCAN.

4.1 Communication Insights from NOAA CAP Teams

Our interviews revealed that communications managers are vital in supporting NOAA CAP teams by organizing and promoting internal and external outreach. They help enhance team communication skills, but hiring a communications professional can be challenging due to budget constraints. To effectively communicate, teams should have consistent meetings, use a singular data platform, and maintain active social media and updated websites. The most effective websites are updated with current projects and members and offer a way for stakeholders to sign up for a mailing list. External communication should also consider how different communities communicate and be willing to adapt to these communities' preferences.

4.1.1 Communications Manager

Communications managers support NOAA CAP teams with internal structure and external outreach and play a fundamental role in a team's success. Specifically, they can organize meetings, update the website, and coordinate social media posts. They can also assist other members in strengthening their communication skills, such as conducting a traditional media interview or presenting information to the public. Communications managers can come in many forms, such as members with a communications background, student research assistants, or outside hires.

Additionally, most researchers and scientists working on NOAA CAP projects do not have a strong communication

background, making it challenging to collaborate and effectively communicate internally and externally. A NOAA CAP Lead PI supported this stating, “I mean, this has been a struggle for us for a long time. We do not have anyone on our team who has communications expertise, who has training and experience”. A significant roadblock to all teams having a dedicated communications manager is a lack of resources. NOAA CAP teams often operate on tight budgets that do not leave room to pay someone exclusively to handle communication duties. For example, one NOAA CAP Lead PI stated, “So, I think that if I had more resources, I would love to employ a communications professional.”

Three of the nine teams had a communications specialist, with another team having a student acting as a communication assistant. All heavily recommended the position and described it as exceedingly helpful. Of the other five, four specifically mentioned how they wish they were able to commit resources to one. Teams that do not employ one and instead rely on internal members often see their social media become inactive as scientists become too busy with their work and do not leave enough time for work that is not in the job description.

For example, one NOAA CAP Lead PI said, “My one advice to you is making [communication] somebody’s job… The PIs and researchers will get way too busy.” Similarly, a NOAA CAP Lead PI described their social media as, “Yeah, unless you have somebody dedicated to it, it's really hard. It's really hard to find the time.” Another described their communications as, “This has been a struggle for us for a long time, we do not have anyone on our team who has communications expertise, who has training and experience.” Lastly, one team said, “If we had the bandwidth to kind of have someone to handle [communication] that would probably be great. Instead of having a bunch of scientists manage it.”

4.1.2 Communications Workflow

All teams who shared communication plans with us recommended that the CCAN develop and apply their own. These documents provide step-by-step guides on social media posts, website updates, and general topics such as working on distributed teams, working with indigenous, tribal, and rural communities as science communicators, and creating science

communication products. A communication plan, combined with a communications expert, can streamline internal and external information and data sharing throughout the entire team. For example, one NOAA CAP program manager said a communications guide, “Literally maps out how we communicate internally and externally.”

4.1.3 Internal Communication

Consistent meetings, internal communication tool(s) (such as Email, Slack, or WhatsApp), and a singular data storage platform are necessary for a NOAA CAP team to communicate internally. All NOAA CAP teams we interviewed utilize email to distribute information and set up meetings, with one-third additionally using Slack for quicker and more casual messages. Eight out of nine teams also used a singular data-sharing platform, with five choosing Google Drive, two choosing Microsoft Teams, and one choosing Box. Often, teams would use the platform affiliated with the leading university. For example, one NOAA CAP Lead PI noted that the platform matters little if the team uses one singular platform.

Consistent meetings are essential to ensure everyone is involved and keep others accountable. Seven of the nine teams met as an entire organization, either monthly or quarterly, with all teams having weekly or bi-weekly small group meetings. A NOAA CAP Lead PI noted that it was essential to ensure meetings had substance – meeting just to meet is a waste of time for everyone. Teams often used online scheduling tools such as when2meet or Doodle Poll to schedule meetings.

4.1.4 External Communication

Active social media, updated websites, and mailing lists are critical to external communication for NOAA CAP teams. Six of nine NOAA CAP teams were on social media, with all six on Twitter. In addition, four teams were also on Facebook, one on LinkedIn, and another on Instagram.

Twitter has a strong scientific community and is mainly used to disseminate news and events in short, easy-to-read blurbs. NOAA CAP teams would often post updates on research articles, publications, webinars, and even share interesting articles they read that stakeholders might enjoy. It is also a helpful tool to engage with other organizations with similar interests through likes and retweets. Additionally, most

of the younger population is on Twitter, so it is an excellent way to reach them. One NOAA CAP team tried to tweet out original content and retweet something relevant and exciting once a week. Another team aimed to post two to three times a week without overlapping content. Both strategies aimed to satisfy the Twitter algorithm and to maintain balance between constant engagement with followers without flooding their timelines. Overall, this was the most common and effective Twitter strategy.

Unlike Twitter, NOAA CAP teams used Facebook for "bigger" news such as advertising events and conferences and related job postings. There were fewer "live" posts and more "recap" publications. Facebook was also a better platform for sharing many photos. Content would be as needed, and no team mentioned following a posting schedule. One NOAA CAP team said their Facebook saw "minimal engagement." Another team stated that since Twitter was non-existent in their area, Facebook became their primary social media platform. Overall, engagement was much lower on Facebook and other social media platforms compared to Twitter.

Eight of the nine teams also had their own website, while the last had a series of independent web pages that were all associated with the leading university and functioned similarly. The most effective websites were kept up to date with projects, goals, current members, and housed more extensive materials such as annual reports. On websites, there would commonly be a way to sign up for the organization's mailing list or newsletter, where stakeholders could receive personalized updates in their inboxes, from bi-weekly to quarterly frequency.

Having inactive social media or outdated websites was a common struggle for teams. One NOAA CAP Lead PI stated, "Inactive social media is worse than not having it at all." Scientists and researchers would often get too busy with their work and fail to update their external platforms, resulting in outdated resources for stakeholders.

Lastly, when asked about their experience dealing with language barriers, NOAA CAP teams stated that understanding how communities want to communicate and having a translator are necessary when engaging in communities. Communities worldwide communicate differently; a strategy used with one

CBO will not necessarily work with the next. Flexibility and willingness to adapt will build trust and ensure that information reaches the correct people.

4.2 Communication Insights from the CCAN

We based our communication insights from the CCAN on interviews, discussions during the two-day Planning Meeting, a guided discussion that followed a presentation of our team's interviews, and a post-CCAN Planning Meeting survey that we conducted.

4.2.1 Preferred Technologies

We learned that all CCAN members favored using email when communicating internally. In contrast to other platforms like Slack, CCAN members thought it was much more straightforward. During one interview, a CCAN member stated, “I think we would certainly consider Slack as an option if we all could get up to speed on it. I think a lot of the research team are probably more senior people in terms of their academic track record, and so they’re maybe not as used to using it.” After our survey at the Planning Meeting, technological preferences within the CCAN were more conclusive.

From our survey, we concluded that the three software CCAN members preferred were Email, WhatsApp, and Zoom. When combined with the answer of “All have different uses,” these platforms made up 92% of all answers, as seen in Table 1.

Platform	Number of CCAN Members	Percentage of CCAN Members
Email	14	60.87%
Slack	1	4.35%
Teams	1	4.35%
Whatsapp	4	17.39%
Zoom	3	13.04%
Grand Total	**23**	**100.00%**

Table 1: Data of CCAN Members’ Communication Platform Preferences

For file storage, CCAN members emphasized using one singular platform, with more members leaning towards using Google Drive. In our interviews, three members had experience with Microsoft Teams, three had experience with Google Drive, and one had worked extensively with both. After our survey, we concluded that Google Drive would be the best collaboration software for the CCAN, as 82% of CCAN members preferred Google Drive to Microsoft Teams, as seen in Table 2. Furthermore, on a working group basis, every established working group preferred Google Drive compared to Microsoft Teams, as seen in Figure 6.

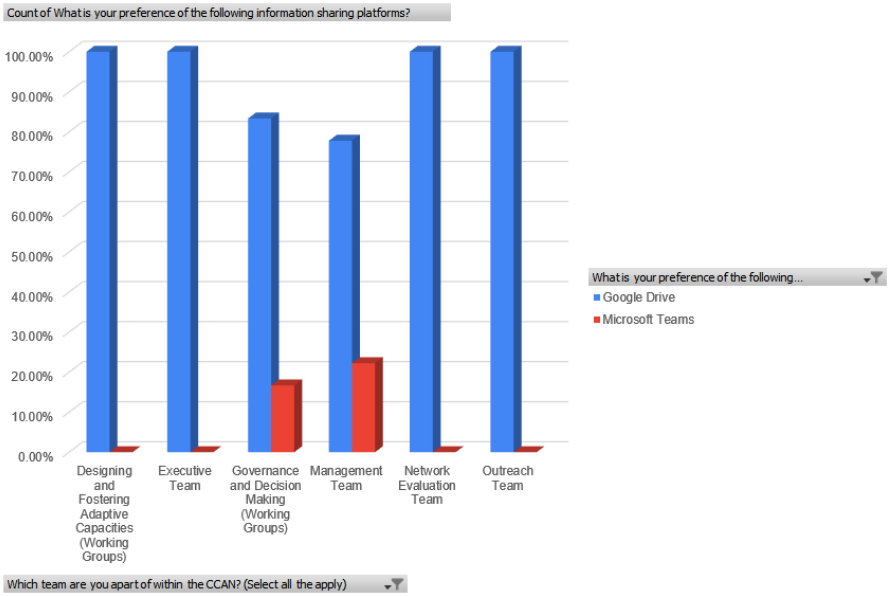

Figure 6: Bar Graph of CCAN Members' Information-Sharing Platform Preferences by Working Group

Platform	Number Of CCAN Members Who Prefer Google Drive vs Microsoft Teams	Percentage of CCAN who prefer Google Drive vs Microsoft Teams
Google Drive	18	81.82%
Microsoft Teams	4	18.18%
Grand Total	**22**	**100.00%**

Table 2: Data of CCAN Members' Information-Sharing Platform Preferences

4.2.2 Meeting Frequency

Regarding meeting frequency, members preferred quarterly meetings between everyone to ensure meetings showed progression and bi-weekly or monthly meetings for smaller groups. One team member noted, “It’s also important that we make sure the meetings are substantive. And we’re not just meeting because we said we’re having a meeting.”

Regarding large full-scale team meetings, Figure 7 shows that ten CCAN members preferred monthly meetings and nine preferred quarterly meetings. Since these two preferences were evenly split, our team believed that bi-monthly meetings amongst the entire team would be best suited for the CCAN. This frequency is the middle ground between the two largest data populations and therefore is a good starting frequency for meetings. Regarding the frequency of subgroup meetings, every subgroup should decide what frequency would work best between bi-weekly and monthly. Some initial data for how often each subgroup preferred to meet can be seen in Table 3.

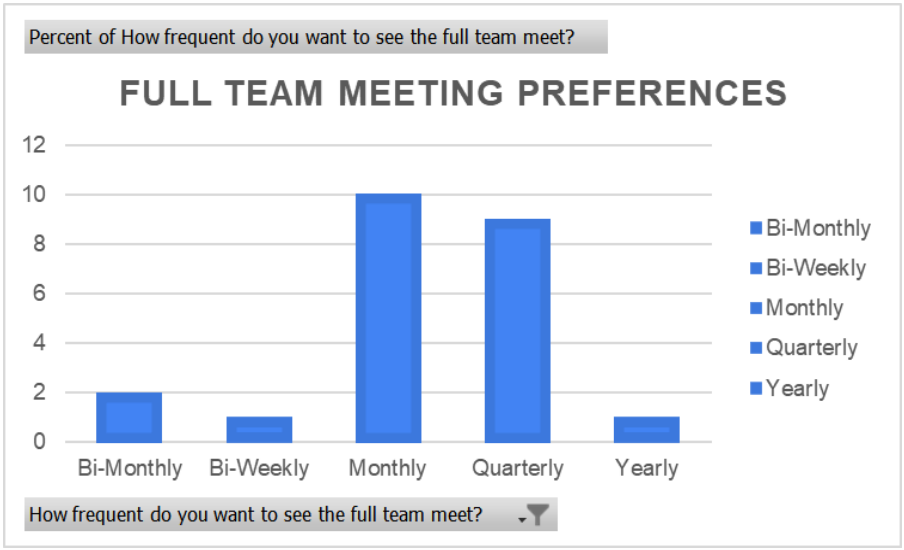

Figure 7: Bar Graph of CCAN Members’ Full Team Meeting Preferences

How frequently would you like to see your project team meet?	Column Labels				
Row Labels	Weekly	Bi-Weekly	Monthly	Bi-Monthly	Flexible
Designing and Fostering Adaptive Capacities (Working Groups)	0.00%	50.00%	50.00%	0.00%	0.00%
Executive Team	50.00%	50.00%	0.00%	0.00%	0.00%
Governance and Decision Making (Working Groups)	16.67%	33.33%	33.33%	0.00%	16.67%
Management Team	11.11%	44.44%	22.22%	11.11%	11.11%
Network Evaluation Team	25.00%	50.00%	0.00%	0.00%	25.00%
Outreach Team	0.00%	33.33%	33.33%	0.00%	33.33%
SETS Hazards and Vulnerabilities (Working Groups)	0.00%	28.57%	42.86%	0.00%	28.57%

Table 3: The Preferred Meeting Frequency of Sub-Group Members

4.2.3 External Communication

Many members suggested asking collaborating partners about their preferred method of communication rather than following a set communication plan. For example, some communities may rely on the radio while others use WhatsApp for their primary source of information. For example, one team member stated, “We’ll need to ask our partners, once we meet them, the people we’re going to work with, how they communicate and what are their needs.”

Language barriers were not a significant concern, as one CCAN member noted that almost all PIs were bilingual, so translating would not be an issue. Others noted that the CCAN would need a translator when meeting with external communities. Members did not discuss translating the CCAN’s potential website and social media.

4.3 CCAN Communication Plan & Structure

We developed a communication plan based on our findings, as shown in Appendix E. The plan outlined different strategies, tactics, and rules that the CCAN members should follow to ensure effective communication with their team and outside stakeholders.

To supplement the plan, we developed an internal communication infographic to display our recommendations in a concise and easy-to-read format, as shown in Appendix F. Furthermore, we created an external infographic to share with communities, giving a brief overview of the CCAN and highlighting their main goals and strategies, as shown in Appendix G. The graphic is available in both English and Spanish.

Additionally, our group accessed the CCAN’s Google Drive and reorganized the structure for better organization, accessibility, collaboration, and productivity. Previously, their Google Drive contained many documents with confusing naming schemes. More folders were created than needed, and a few contained little-to-no substance and purpose. Navigation was a challenge which led to difficulty finding files and contributing to the CCAN. To address this disorganization, our group made five overarching folders that contained all documents: Administrative Information, Meetings & Meeting Minutes, NOAA CAP/RISA Proposal, Resources, and Teams.

The first folder contained everything necessary for the project's commencement, including but not limited to Bio Sketches, Current and Pending Work Supports, Institutional Review Board materials, Letters of Intent, and a spreadsheet our team edited containing members' contact information in a well-organized and easy-to-read format.

The second folder contained meeting information and meeting notes for full team meetings, which included the Planning Meeting and the monthly All Hands meetings. The Planning Meeting subfolder contained all meeting notes, photos, presentations, and the final meeting agenda. The All Hands meeting subfolder contains a subfolder for each meeting, which includes the meeting notes and any other supporting material.

The third folder contained all material relevant to their NOAA CAP/RISA Proposal, including subfolders for NOAA CAP/RISA Proposal Guidelines, Previous Drafts, Proposal Progress Updates, and UPR Panel Feedback and Responses. The final proposal is also included within the folder, but not within another subfolder, to maximize visibility.

The fourth folder contained relevant resources for human-centered design, research papers on relevant topics, and the CCAN's organizational inventory. As members add additional documents, they can create subfolders for organizational help.

The fifth folder contained a subfolder for every sub-team, which contained a folder for meeting materials and minutes and any work the subgroup has done so far. There is also an organizational Google Sheet, created by our group, with lists of every team, who is on it, and their contact information.

Throughout the reorganizational process, we renamed many documents to clearly and concisely describe the document's purpose. One example is the naming scheme of all the members' Bios Sketches. Before, the naming convention was different for all and confusing to navigate. Therefore, we renamed all Bio Sketches following the convention: [Last Name] Bio Sketch [Month/Year].

Finally, since the CCAN was already facing issues with members not being on email chains, we developed email lists for the entire CCAN and individual subgroups. We had Laura

Cabrera-Rivera, the CCAN's lead principal investigators' graduate student, create the email lists on Outlook so they would be affiliated with the University of Puerto Rico and not Worcester Polytechnic Institute. These email lists were designed with the intention of time-saving communication and ensuring that all members are kept in the loop about the latest developments and updates related to the project.

5 Conclusion

Puerto Rico and small islands in the Caribbean face many challenges both directly and indirectly from climate change. The CCAN is a multi-institutional research network that will play an important role in improving climate resiliency. Since members of the CCAN span across geographical and institutional borders, robust communication systems and plans are critical to facilitate success. This research project developed an effective communication plan for the CCAN to support climate change resiliency.

We conducted semi-structured interviews with members of nine NOAA CAP organizations and seven CCAN members to learn about effective communication strategies. We also utilized a forum and structured survey during the CCAN Planning Meeting to learn about CCAN members' preferences for communication. After analyzing the qualitative and quantitative data, we discovered effective and ineffective internal and external communication strategies for NOAA CAP organizations and provided recommendations on how the CCAN should communicate.

5.1 Key Lessons for Effective CCAN Communication

5.1.1 Effective Strategies for Internal Communication

Frequent meetings: Regular meetings with the participation of all team members are essential for promoting accountability and engagement within a NOAA CAP team. All meetings must serve a substantive purpose. Almost all teams organize monthly, or quarterly full-team meetings and weekly or bi-weekly small-group meetings conducted virtually via Zoom.

Single collaboration software: While selecting a particular platform for data sharing is important, it should not overshadow the importance of having a unified platform that the whole team can use.

Internal communication plan: It is equally important to have an internal communication plan with a well-defined workflow, rules, and regulations to stay organized and work efficiently.

5.1.2 Effective Strategies for External Communication

Active social media: Maintaining a strong social media presence is critical in communicating the progress of research projects. All the NOAA CAP organizations interviewed emphasized the importance of social media in keeping stakeholders informed. One team even stated that having no social media presence is better than having an inactive one.

Website: To ensure that stakeholders, including CBOs, NGOs, and other government agencies, stay updated with the latest research findings, it is essential to maintain a regularly updated website.

Mailing lists: Mailing lists are valuable for disseminating newsletters and updates to stakeholders.

Avoid communication disrupters: An outdated website can create obstacles to effective communication, making it difficult for stakeholders to find important information and undermining their confidence in the organization. Flooding mailboxes with emails is a significant deterrent that can result in the stakeholders losing interest and sending the messages to their spam folder. Infrequent communication is detrimental to stakeholder engagement as it can cause the stakeholders to become skeptical and lose trust if they are left in the dark about progress or activities.

5.2 Recommendations for Future Research & Implementation

The CCAN team currently lacks a communication strategy for external communications. A research team could build on our research regarding how other NOAA CAP organizations communicate with external organizations to create a plan or strategy for external communication. One method could include interviewing external communities on their communication preferences. This research could work with the CCAN and the community to connect them and develop a robust plan when communicating with potential partners.

When implementing our plan and a future external communication plan, our team recommends that the CCAN hire a communications coordinator. NOAA CAP teams with communication managers were able to better communicate both internally and externally. If the CCAN cannot hire a communications manager due to a lack of resources, we

recommend that a graduate research student take on the communications manager role. We do not recommend that the PI act as the communications manager as they will likely be busy with other research and work.

Communications plans are essential for research teams, especially large, geographically dispersed teams across organizational borders. Communications plans are often an overlooked component of successful large-scale research collaborations. Our team learned several best practices and implementable strategies while discovering how continued attention and adaptability to communication strategies will be critical during the 5-year CCAN grant.

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Appendix A: NOAA CAP Interviews - Preamble & Questions

Preamble

[Greeting]. My name is [Interviewer Name], and I'll be walking you through the interview today. I also have [Notetaker #1 Name] and [Notetaker #2 Name] here with me, who will be taking notes during our session. We are a research team from Worcester Polytechnic Institute working in Puerto Rico with the new CCAN team and Pablo Medez-Lazaro as the lead principal investigator and one of our sponsors. The CCAN team is new, and we are looking to gain insight into other NOAA CAP teams' plans of communication.

Today's objective is to gain valuable knowledge on how [NOAA CAP Organization] is set up, how the team communicates, and how the team shares information with one another and outside stakeholders. Your participation will be instrumental in helping us gain this knowledge.

Thank you for agreeing to participate in this interview today. It will last between 25 and 50 minutes. Before we start the interview, I would like to ask for your permission to record this interview, which will only be used to help with our note taking. Do I have your permission to record today's interview? [Participant's Answer]

Interview Questions

1. How is the [NOAA CAP Organization] set up?
    a. Is there a hierarchy or organizational chart that your team uses?
    b. Is there a communication plan is place that your team has followed?
    c. Does your team have a communications manager?
2. How often does the [NOAA CAP Organization] meet and who attends these meetings?
    a. How are these meetings set up?
3. What is the most common communication tool(s) for the [NOAA CAP Organization]'s internal communication?
    a. What is typically communicated or shared on the platform?
    b. Who uses the platform? Are there different platforms for different teams?
    c. How comfortable are you using this platform?
    d. What are the advantages and disadvantages of the platform?
4. Does the [NOAA CAP Organization] have an internal storage platform to share information and collaborate?
    a. How is data kept private?

5. What is the most common communication tool(s) for the [NOAA CAP Organization]'s external communication?
    a. What is typically communicated or shared on the platform?
    b. Who uses the platform? Are there different platforms for different teams?
    c. How comfortable are you using this platform?
    d. What are the advantages and disadvantages of the platform?
6. Is there anything you'd like to see improved with [NOAA CAP Organization]'s communication structure?
7. Has the [NOAA CAP Organization] run into any language barriers?
    a. If so, how have you handled them?
    b. Do you have any insight on how the CCAN could overcome language barriers?

Appendix B: CCAN Interviews - Preamble & Questions

Preamble

[Greeting]. My name is [Interviewer Name], and I'll be walking you through the interview today. I also have [Notetaker #1 Name] and [Notetaker #2 Name] here with me, who will be taking notes during our session. We are a research team (IQP Team) from Worcester Polytechnic Institute (WPI) working in Puerto Rico with the new CCAN team and Pablo Medez-Lazaro as the lead principal investigator and one of our sponsors. As you know, the CCAN team is new, and we want to gain insight into how CCAN team members want to communicate.

Today's objective is to gain valuable knowledge on your role in CCAN, how you've communicated with geographically dispersed and interdisciplinary teams in the past, some struggles you've faced working with teams like this, and how you would like to see the CCAN team communicate as it gets started. Your participation will be instrumental in helping us gain this knowledge.

Thank you for agreeing to participate in this interview today. It will last between 20 and 30 minutes. Before we start the interview, I would like to ask for your permission to record this interview, which will only be used to help with our note taking. Do I have your permission to record today's interview? [Participant's Answer]

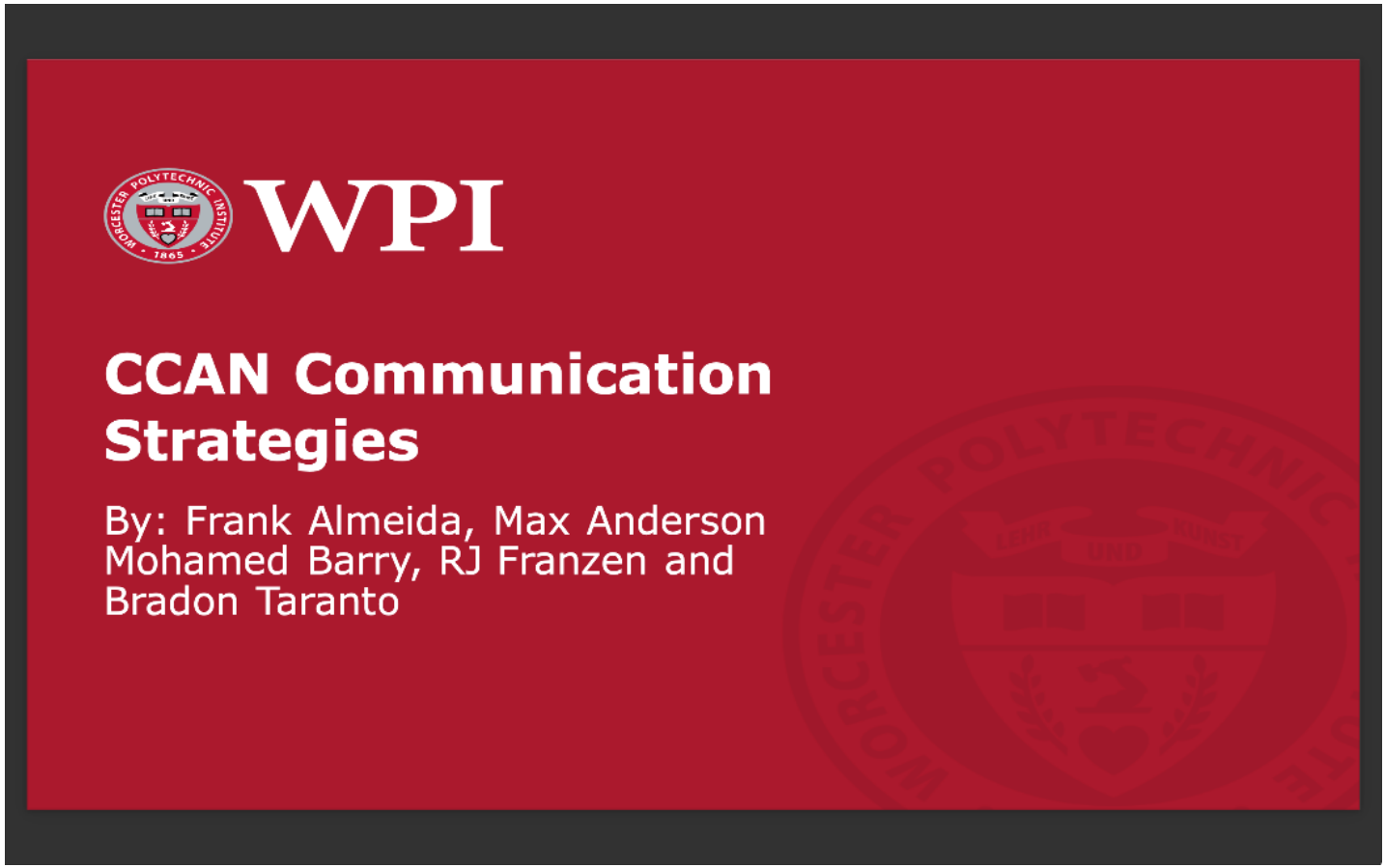
Interview Questions

1. Could you briefly introduce yourself and talk about your role on the CCAN team?
2. How has your team within CCAN been communicating so far?
3. Have you had any experiences working with large geographically dispersed teams like CCAN in the past?
    a. How often did your team meet and who attended these meetings?
        i. How were these meetings set up?
    b. What was the most common communication tool(s) for internal communication?
        i. What was typically communicated or shared on the platform?
        ii. Who used the platform? Were there different platforms for different teams?
        iii. How comfortable were you using this platform?
        iv. What were the advantages and disadvantages of the platform?
    c. Did you have an internal storage platform to share information and collaborate?
        i. How was data kept private?
    d. What was the most common communication tool(s) for external communication?
        i. What was typically communicated or shared on the platform?

ii. Who used the platform? Were there different platforms for different teams?
iii. How comfortable were you using this platform?
iv. What were the advantages and disadvantages of the platform?

e. Did you run into a language barrier?
    i. How did you overcome them?
    ii. Do you have any insight on how the CCAN could overcome language barriers?

Appendix C: CCAN Planning Meeting Communications Strategy Presentation



Introduction

- Research Team of undergraduates from Worcester Polytechnic Institute working on developing an effective communication plan for the CCAN as part of our university's Interactive Qualifying Project
- Working with Pablo Méndez-Lázaro and Tischa Muñoz-Erickson as our sponsors and John-Michael Davis and Alizé Carrère as our advisors
- Frank Almeida – Biomedical Engineering
- Max Anderson – Data Science
- Mohamed Barry – Computer Science
- RJ Franzen – Chemical Engineering
- Brandon Taranto – Civil Engineering

Project Objective

This research aims to develop an effective communication plan that the CCAN entities and outside stakeholders can use to better share information to support resiliency efforts.

"My one advice to you is making [communication] somebody's job …. The PIs and researchers will get way too busy." - NOAA CAP Lead PI

"I mean, this has been a struggle for us for a long time. We do not have anyone on our team who has communications expertise, who has training and experience and how you actually, you know, disseminate." - NOAA Cap Lead PI

Research Methods

Interviewed eight out of eleven NOAA CAP teams

- Focus: Organizational Structure, Internal Communication, External Communication

Interviewed seven CCAN members

- Focus: CCAN Role & Goals, Experience with Interdisciplinary Geographically-Dispersed Teams, Experience with Internal & External Communication

Interview Questions: NOAA CAP

- How is the [NOAA CAP Organization] set up?
- How often does the [NOAA CAP Organization] meet and who attends these meetings?
- What is the most common communication tool(s) for the [NOAA CAP Organization]'s internal communication?
- Does the [NOAA CAP Organization] have an internal storage platform to share information and collaborate?
- Is there anything you'd like to see improved with [NOAA CAP Organization]'s communication structure?
- Has the [NOAA CAP Organization] run into any language barriers? If so, how have you handled them?

Interview Questions: CCAN

- Could you briefly introduce yourself and take about your role on the CCAN team?
- Have you had any experiences working with large geographically dispersed teams like CCAN in the past?

Data Analysis – Grounded Theory

Basic Information

About 15 total people. Program Director (1), Program Manager (1), Core office of researchers (4), executive board of PIs, investigators (10). Mostly flat organization, but if push comes to shove the program director makes decisions. No communications manager, but the program manager might handle it a bit more in the future. Mostly in the University of Arizona, some in New Mexico. Used to have one person who played a lot of communications roles but left the organization.

Internal Communication

Email. Core office uses Slack (free version deletes anything 90+ days old which is problematic, investigating other ideas). Pros and cons to every communication platform – can't find things sometimes in Slack. Stacy says Slack is a good tool for a "communication board" (direct messages) - not good for a file saving platform

In-person meetings every other week with the executive board of PIs and opened it up to other investigators. COVID messed up their routine – used to have quarterly full team meetings.

Use "Box" for file sharing. University has a subscription, seems very familiar to Google Drive users.

External Communication

External communication varies from team to team as well as the audience.

Mailing List – Monthly newsletter using Listserv and send out emails a couple times a month, including their own podcast.

Twitter – lightly use it as an organization, individual members use Twitter more effectively to their advantage. Tweet announcements, podcast updates, etc.

Website – Hasn't been updated in a while, similar things go there as the Mailing List and Twitter. Once translated their website into Spanish but didn't keep it up.

NOAA CAP Data Analysis

External Communication

SCIPP – Social Media (Twitter, Facebook, LinkedIn). Website. Mailing List (MailChimp).

WWA – Social Media (Twitter, Facebook, Instagram). Website. Mailing List (Constant Contact).

GLISA – Website. Mailing List.

Pacific RISA – Social Media (Twitter, Facebook). Website. Mailing List (MailChimp).

NCRC – Independent web pages.

MARISA – Social Media (Twitter). Website. Seasonal Climate Summary.

CLIMAS – Social Media (Twitter). Website. Mailing List (Listserv). Podcast.

CNAP – Website, not updated.

CCAN Data Analysis

Internal and External Communication

Interviewee #1 - Comfortable with Google Drive to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate, regular meetings are necessary to maintain momentum & smaller group meetings are key to get tasks done.

Interviewee #2 - Comfortable with Google Drive to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate, experience with websites / newsletters / social media.

Interviewees #3 & #4 – Comfortable with Microsoft Teams to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate, experience with Phone and WhatsApp.

Interviewee #4 - Comfortable with Google Drive and Microsoft Teams to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate, entire team should be meeting at least once a month & smaller groups can set their own schedule to get tasks done, written meeting minutes are necessary.

Interviewee #5 - Comfortable with Microsoft Teams to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate. Does not really matter what you use if everyone is on the same page.

Interviewee #6 – Comfortable with OneDrive and Google Drive to store/share documents, comfortable with Zoom for online meetings, comfortable with email to communicate.

User Persona

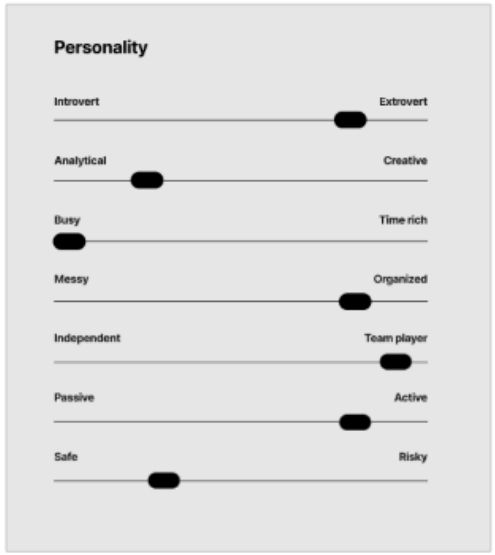
Basic information

NOAA CAP Researcher - Primary Invesitgator

- Academic and a leader of Research
- Is established within a University or other Research Fields
- Has many people they need to share research and findings with

Bio

NOAA CAP researchers often work in many different sections of research and on multiple projects at one time. NOAA CAP researchers often stem across institutional lines and even state lines. Clear communication both internally and externally is essential to make sure that project are done efficiently and shared to communities and stakeholders efficiently.



10

Worcester Polytechnic Institute

User Persona Information

- Needs and expectations
  - Need to talk to stakeholders about their preferred communication platforms and methods
  - Expects to be able to efficiently share information and collaborate on work while maintaining data privacy
- Goals
  - Give communities in differing regions tools and assistance to being resilient against impacts of climate change
  - Be able to effectively communicate findings and tools to communities through external organizations
- Pain Points and Frustrations
  - Differing platforms for communication, information sharing and collaboration across project teams
  - External communication through social media not getting enough engagement
  - Not having a strong support system and funding for many efforts that would make communication easier
    - •*"So, I think the if I had more resources, I would love to employ a communications professional."* - NOAA CAP Lead PI

Interview Outcomes: Effective Communication

- Frequent meetings with project teams (weekly/bi-weekly)
- Large team meetings at a set frequency (monthly, bi-monthly, quarterly) set up by availability software (Doodle Poll, When2Meet)
- Singular collaboration software
- Singular communication software amongst team members
- Annual in-person meeting
- Website kept up to date with current projects, goals, and team members
- Collaborate with stakeholders to see their preference when communicating
- Active social media (Twitter, Instagram, LinkedIn)
- Translators for communicating with CBO's
- Mailing lists
- Webinars & workshops

Interview Outcomes: Ineffective Communication

- Meetings with little substance
- Multiple software being used for communication and collaboration
- Loose and infrequent meetings dates

"It's also important that make sure the meetings are substantive. And we're not just meeting because we said we're having a meeting." - CCAN Member

- Flooding mailboxes
- Not being active on social media
- Infrequent communication with stakeholders/outside groups
- Outdated website

"Inactive social media is even worse than not having it at all." - NOAA CAP Lead PI

Decisions to be Made

- Meeting Frequency (Lead PIs, PIs, External Advisory Boards, etc.)
- Platform for internal communications (Email, WhatsApp, Slack)
- Collaboration Software for Research Work (Microsoft Teams, Google Drive, Box, BaseCamp)
- Outreach methods for external communication (Mailing Lists, Social Media, WhatsApp, Email, Podcasts, Newsletters)
- Mailing list software (Mailchimp, ConstantContact, ListServ)
- Overcoming of language barriers for external communication (Hired translator, Native speaker on team, etc.)

Our Timeline

2–13 Feb.	Analyze feedback from team and develop plan
14 Feb.	Propose plan for team
14–28 Feb.	Take feedback on plan and finalize
1 Mar.	Propose final communication plan

Questions, Discussion, and Feedback

- Meeting Frequency (Lead PIs, PIs, External Advisory Boards, etc.)
- Platform for internal communications (Email, WhatsApp, Slack)
- Collaboration Software for Research Work (Microsoft Teams, Google Drive, Box, BaseCamp)
- Outreach methods for external communication (Mailing Lists, Social Media, WhatsApp, Email, Podcasts, Newsletters)
- Mailing list software (Mailchimp, ConstantContact, ListServ)
- Overcoming of language barriers for external communication (Hired translator, Native speaker on team, etc.)

Survey:

Scan me!

Email: gr-pr22-23ccan@wpi.edu

Our Initial Recommendations

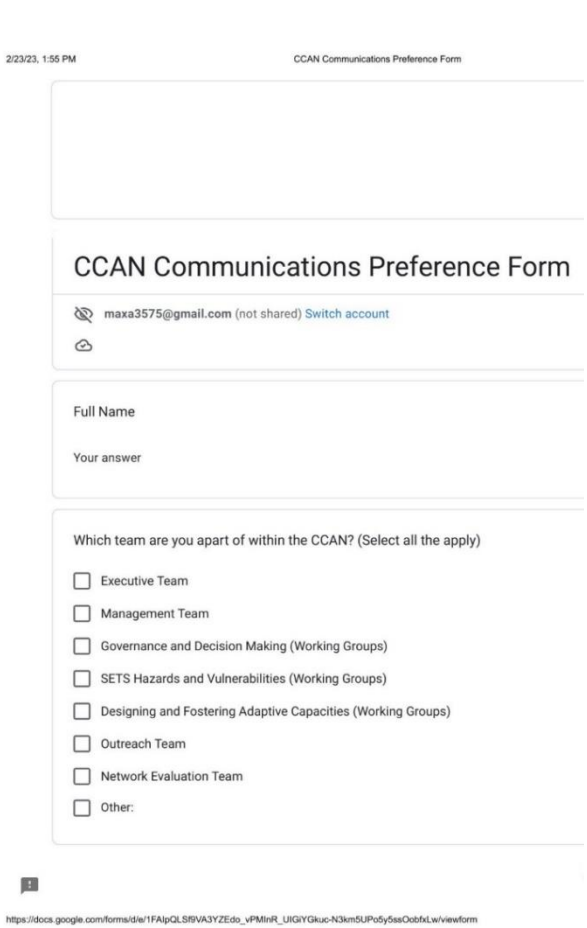
Meetings

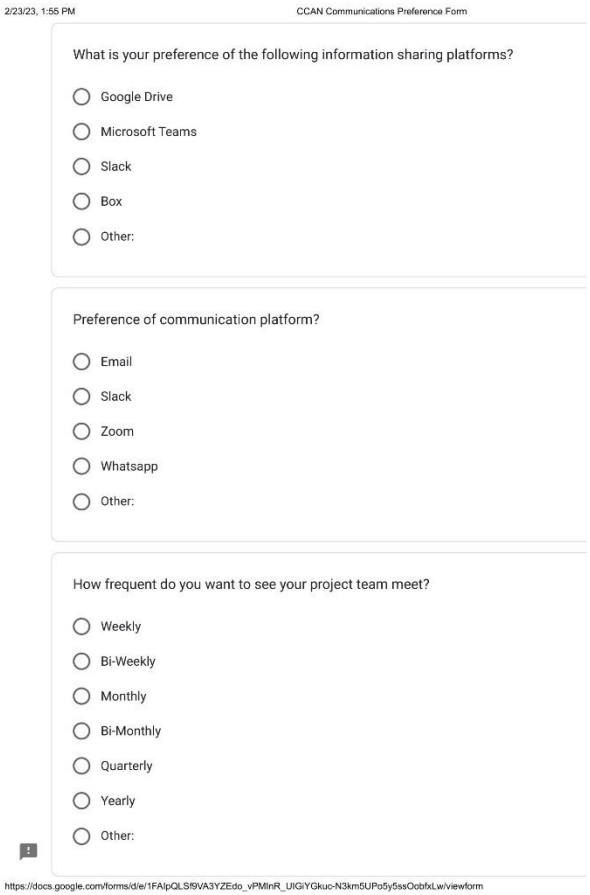
- Meet bi-weekly with internal teams
- Meet quarterly with the entire CCAN over Zoom
- Meet annually with the entire CCAN in-person

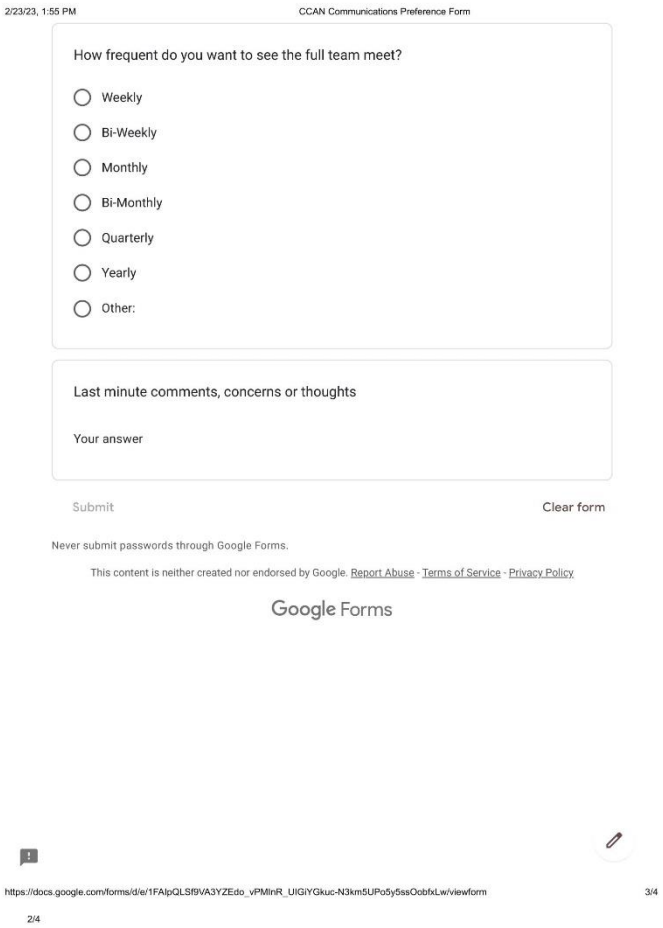
Internal and External Communication

- Email
- WhatsApp – Communicating with teams and with communities
- Microsoft Teams or Google Drive – Dependent on preference and institutional affiliation
- Website
- Mailing List – MailChimp
- Twitter & LinkedIn
- Dedicated staff member focused on communications

Appendix D: CCAN Planning Meeting Communications Preferences Survey







Appendix E: CCAN Communication Plan

CCAN Communication Plan

This communication plan is based on extensive research and best practices in team collaboration and is designed to help your team achieve its goals more efficiently and effectively. The plan covers various topics, including meetings, communication, and task management, and provides actionable recommendations for each.

In a geographically dispersed team, such as the CCAN, regular meetings are of paramount importance. To ensure the efficient coordination of team members, several key considerations must be considered. These include automating meeting times to streamline the coordination process, balancing meeting frequency to avoid wasting time while maintaining momentum and assigning a team lead to coordinate these efforts. By adhering to these best practices, CCAN can ensure that its dispersed team members remain connected and productive, regardless of their physical location.

Meetings

During our research, we found that there are many aspects to have successful and productive meetings. We found that having a set meeting frequency, keeps team members engaged within the team. To achieve a set meeting frequency, we recommend that each team has a team lead to initiate scheduling. When scheduling, we recommend teams to use scheduling software to find meeting times that work. After finding a time that works for everybody, we recommend that the team keeps meetings at this time at a set frequency. Team members should try their best to make it, however if they cannot, team meetings should be recorded and sent out to the team after. Regarding meeting frequency, here is what our team found to be effective during our research:

- CCAN – Bi-Monthly Zoom Calls
- Sub-groups/ – Weekly or Bi-Weekly meetings to share progress. Each team can decide what the best frequency is on their own.

How to set up meetings:
Send when2meet link to email alias or WhatsApp group.

How to schedule meetings:

1. Log into zoom through a zoom account, preferably through an institution.
2. Click the Schedule button.
3. Type in the name of your meeting, what time you want the meeting to be and how long you want the meeting to be.
4. Click send through outlook calendar option.
5. Click Save.
6. If you have outlook downloaded on your computer, zoom should create an email draft with the link in it that you can send out.

Internal Communication Software

When conducting our research, our team looked into the communication preferences of both NOAA CAP Teams and the CCAN. For the CCAN, we found that a combination of WhatsApp and Email will work best for communicating within the team. We also found that Google Drive will work best for collaboration within the team. Our team also set up a Excel Sheet with all of the current sub groups of the CCAN. For every new sub group or task force that arises, we provided instructions for how to add new teams to the sheet. For every new subgroup, it will also be recommended to make a:

Email:

- Email should be used when trying to talk to a singular person. When responding to mass emails, be sure to only reply to the sender and not reply all to avoid flooding mailboxes.

WhatsApp:

- Keep conversations within teams work related. Should be used to ask quick questions over text. Try not to over send invaluable information in chat. Only send project work materials or meeting set-ups in chat.

Google Drive:

- Always add collaboration documents to google drive by adding folders for your individual subgroup. Make sure to adjust restrictions when sharing a document onto the drive. The google drive is organized to be clearer and easier to navigate.

How to create email lists:

1. Open Outlook app on a Windows or PC. Will not work for Mac.
2. Next to the New Email Button, Click the drop-down arrow. When the options drop down, Click Group.
3. Then put in the name of the group, the name the alias is going to be under and a brief description.
4. Then add any colleagues or other groups to the alias.

How to create WhatsApp group:

1. Log into WhatsApp using your phone number.
2. Click the New Chat button in the top right.
3. Click New Group.
4. Add colleagues who need to be added to the group.

How to Navigate Google Drive:

1. Administrative Information
    - Biosketches
    - Current and Pending Work Support
    - IRB
    - Letter of Intent
    - Team Member Information
2. Meetings & Meeting Minutes
    - CCAN Planning Meeting
    - All Hands-on Deck Meetings (Monthly Meetings)
3. NOAA CAP/RISA Proposal
    - NOAA CAP/RISA Proposal Guidelines
    - Previous Drafts
    - Proposal Progress Updates
    - UPR Panel Feedback & Responses
4. Resources
5. Teams
    - 1: Executive Team
    - 2: Management Team
    - 3A: Governance and Decision-Making WG
    - 3B: SETS Hazards and Vulnerabilities WG
    - 3C: Designing and Fostering Adaptive Capacities WG
    - 4: Outreach Team (Visualization and Communication)
    - 5: Network Evaluation Team
    - 6 Scientists and Practitioners External Advisory Committee
    - Students & Research Assistants

How to set up restrictions:

1. Find the file or folder in Google Drive, Google Docs, Google Sheets, or Google Slides.
2. Open or select the file or folder.
3. Click Share or Share > Get link.
4. Under General Access, click the drop-down arrow.
5. Select Restricted.
6. Click Done

New Teams Arising:

1. Open CCAN Groups Master excel sheet in Google Drive.
2. Click the arrow at the bottom of the screen to create a new tab.
3. Rename this tab to what your team's name is by double clicking the tab.
4. Put name, institutional affiliation, and email in the columns and bold each heading.
5. Fill out the sheet with your new subgroup's data.

Appendix F: CCAN Internal Communication Infographics

CCAN COMMUNICATION WORKFLOW

THE PURPOSE OF THIS WORKFLOW IS TO IMPROVE CCAN'S KNOWLEDGE MANAGEMENT AND INFORMATION DISPERSION AS WELL AS CUT DOWN ON MESSAGING TRAFFIC AND IMPROVE VISIBILITY. THE INFORMATION LISTED BELOW COVERS MEETING FREQUENCIES, TECHNOLOGIES, AND COMMUNICATION STRATEGIES CCAN MEMBERS CAN USE TO IMPROVE INFORMATION SHARING.

Meeting Frequency

Overall Team

Bi-Monthly Zoom Calls

Working Groups

Weekly/Bi-Weekly Meetings
One dedicated lead

Meetings should be at a set time

External Technologies

Website

News Stories & Feature Items

Social Media

Twitter/LinkedIn
Interact with other NOAA CAP social media

Mailing List

Use MailChimp Technology
Don't spam inboxes

Internal Technologies

Email

One-to-one messaging
Email to Group Alias

WhatsApp

Keep messages concise and purposeful

Google Drive

Follow consistent naming conventions

Recommendations

Communications Manager

Hire a communications expert or use a graduate assistant
Promotes external outreach and internal organization

Communications Plan

Written plan made by students

Caribbean Climate Adaptation Network

Appendix G: CCAN External Communication Infographic