NETWORK ANALYSIS OF CLIMATE CHANGE & DISASTER RESILIENCE ACTORS WORKING IN BAGERHAT DISTRICT, BANGLADESH

March 2020

PROGRAM ON **RESILIENT COMMUNITIES**

HARVARD HUMANITARIAN INITIATIVE

ROOT **CHANGE**

The **Harvard Humanitarian Initiative (HHI)** is a university-wide initiative with a mission to advance the science and practice of humanitarian response worldwide through research and education. HHI serves as the humanitarian arm of Harvard University and brings an interdisciplinary approach to building the evidence base of humanitarian studies and professionalizing the field of humanitarian aid. Through its research programs and educational offerings, HHI is an influential forum for humanitarian innovation, effectiveness, and leadership.

HHI's **Program on Resilient Communities** uses evidence-based approaches to interpret how communities mitigate the impact of disasters. The program's starting point is the central role local communities play in both disaster preparedness and response. Communities are the front line and locus for interactions with local civil society organizations, the private sector, national disaster management agencies, and the international humanitarian community.

Root Change aims to bring people together to question assumptions, think deeply, test ideas, and lead the way to a world built on social justice principles. Root Change designs products, technologies, and interactive experiences that help people, organizations, and communities build better futures for themselves.

ABOUT THE AUTHORS

This report was written by HHI and Root Change.

At HHI, Phuong Pham, Sarah Ferguson, Vincenzo Bollettino, and Patrick Vinck designed and implemented the study, data analysis, and writing of the report.

At Root Change, Rachel Dickinson, Alexis Smart, and Evan Bloom conducted the analysis and wrote the report.

ACKNOWLEDGMENTS

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ACRONYMS

CBO – Community-based Organization

DEPP – Disasters and Emergency Preparedness Program

DFID – Department for International Development

DRR – Disaster Risk Reduction

E-I Index – External to Internal Index

HHI – Harvard Humanitarian Initiative

INGO – International Non-governmental Organization

IOM – International Organization for Migration

JJS – Jagrata Juba Shangha

NGO – Non-governmental Organization

NPA – Net Promoter Analysis

SNA – Social Network Analysis

UN – United Nations

STUDY OVERVIEW

Coordination among actors during an emergency is crucial for effective, efficient action (1,2). The existence of pre-disaster relationships between actors can strengthen the speed with which coordination occurs in a disaster setting, making relationship-building before a disaster an important element of preparedness (1,2). As such, understanding the relationships between stakeholders working to advance disaster resilience and response is a crucial first step to support institutional strengthening and capacity building (3).

The Harvard Humanitarian Initiative (HHI), Concern Worldwide, and Jagrata Juba Shangha (JJS) are jointly implementing programs to enhance climate change adaptation and disaster resilience among coastal communities in Bagerhat District, Bangladesh. This district is located in Bangladesh's low-elevation coastal zones, which are especially vulnerable to natural disasters and have already begun to see the effects of climate change (4). Bagerhat has high levels of food and water insecurity and poverty, and is highly vulnerable to natural disasters and climate change impacts (5). The district has been heavily impacted by recent cyclones, and is experiencing sea level rise and saltwater intrusion (5).

This network analysis was undertaken to support strengthening coordination and collaboration among actors working on climate change adaptation and disaster resilience in Bagerhat. As a first step toward understanding coordination and collaboration among these actors, HHI conducted a network analysis. This network analysis research had two goals:

1) To understand the relationships among actors supporting climate change adaptation and disaster resilience work among coastal communities in Bagerhat district, Bangladesh; and
2) To develop a representation of the disaster risk and resilience system in Bagerhat through a depiction of the structure and characteristics of the relationships among the actors that make up the system.

This report details the findings of this network analysis study. The study design is modeled after a summative phase external evaluation that HHI conducted in 2016-2017 on the START Network's Disasters and Emergency Preparedness Program (DEPP) (6). The network analysis techniques applied in this evaluation have been adapted from the DEPP study to analyze the disaster resilience network in coastal Bangladesh. HHI partnered with Root Change to conduct the analysis represented in this report. The report presents the network analysis and methods used, as well as findings and recommendations for translating how these results can inform programs to strengthen disaster and climate change resilience in Bagerhat district, Bangladesh.

SUMMARY OF KEY FINDINGS AND RECOMMENDATIONS

The following is a summary of findings from the network analysis, as well as additional questions that these findings raise and recommendations for strengthening the climate adaptation and disaster resilience network in Bagerhat district, Bangladesh.

LOCALIZATION

- Overall, local actors (both district and national) were found to play a prominent role in the network. District and national actors held influential positions in the key actor analysis. Furthermore, international actors had high cross-collaboration with local actors and were well connected to local actors.
- While international actors only made up 22% of the network, when they were removed, we saw a loss of 51% of relationships, and the creation of 13 local actor isolates.
- Collaboration could be increased between local actors to support greater resilience when international actors withdraw their support. Multi-stakeholder platforms, such as social labs or collective impact strategies, that bring together diverse local actors to work towards a common agenda on issues related to climate change and disaster resilience may foster this collaboration. These platforms help to emphasize mutual accountability and co-creation between local actors and groups and can help to support local system self-reliance.

NETWORK OF PEERS AND COLLEAGUES

- The actors working on climate adaptation and disaster resilience in Bagerhat district represent a network of peers and colleagues, made up primarily of district and national level organizations. The majority of local actors have more than a decade of experience working with each other, they interact frequently, and have fairly high levels of trust.
- Formal partnerships and mutual interests define the majority of relationships. This is evident both in how participating organizations have described their relationships and in the network structure.

LIMITED MUTUALITY

- Reciprocal, or bi-directional, ties remain quite low, representing only 7.5% of relationships in the full network, and only 2.4% of relationships between local actors. With actors' long history of engagement and formal partnerships, we would expect to see a higher rate of reciprocity as a sign of mutual collaboration.
- Further research is needed to determine why collaboration is predominately unidirectional and if there are opportunities for local actors to co-collaborate and jointly develop or test solutions.

LIMITED ENGAGEMENT WITH ACADEMIA, CBOS, MEDIA, AND THE PRIVATE SECTOR

- There is low presence and engagement with academic institutions, community-based organizations (CBOs), the media, and the private sector, representing untapped potential resources and knowledge to improve climate change

and disaster resilience in Bagerhat district.

- In particular, engagement with and between CBOs is an area that could be strengthened. Half of the isolates in the network (50%) were CBOs, and this group had no relationships with one another.

LIMITED COLLABORATION AMONG GOVERNMENT

- Government was the main actor type identified in this system, accounting for the highest percentage of actors at 30%. Government was in 730 total relationships in the network (55.6% of all relationships) and also had the highest cross-collaboration with other types of actors. However, government actors were found to have very little collaboration with each other—out of 24 government actors, only 10 relationships were found between them. Therefore, government actors are very present in the network, but are not collaborating much with one another.

- Given the focus area of this network on climate change adaptation and disaster resilience, we might expect there to be greater collaboration and exchange of information and learning between government departments. This may be an area that warrants further investigation to understand the relationships between government agencies and how collaboration could be strengthened.

DOMINANCE OF FEW KEY ACTORS

- Across the multiple collaboration areas, four key actors were consistently found to be the top collaboration hubs in the network, having the most relationships: Mid-Sized INGO A, Mid-Sized Local NGO B, Large International Organization C, and Mid-Sized Local NGO D.

- Their position of influence makes them good candidates to act as brokers and to help connect others in the system. Further research is needed to determine if they are playing brokering roles. Their central position in the network also makes them potential bottlenecks for the flow of information and ideas within the network.

- These actors could be engaged to discuss their role in the system and the findings of this work and to determine if there are actions these actors are taking or could take to elevate other local actors who are providing expertise, resources, and support in the district. These key actors can also help to connect others the system, such as academic institutions, CBOs, media, and the private sector, to increase collaboration with these actors throughout the network.

OBJECTIVE

UNDERSTANDING NETWORKS AND WHY THEY MATTER

The expansion of national and international humanitarian sectors has resulted in increasingly complex inter-organizational partnerships and collaborations. Donors also increasingly pool resources to support large consortiums. The nature and effectiveness of the emerging networks resulting from these changes remain, however, under studied.

From a programmatic perspective, networks likely enable mobilization of resources across actors, enhancing adaptive capability during crisis as well as the mobilization of outside resources, for example through joint fundraising efforts. Effective networks can also result in more effective implementation through sectoral or geographic specialization of members collaborating toward a common objective (e.g., joint projects). Looser connections that do not involve direct collaborations are arguably essential to the coordination of activities, the spread of ideas and innovations, and the building of individual and organizational social capital. Together, these networks of actors and their relations

define the 'humanitarian community' or 'ecosystem', but the features of such an ecosystem are rarely assessed or measured.

NETWORKS IN COASTAL COMMUNITIES OF BANGLADESH

While many low- and middle-income countries have a thriving community of international non-governmental organizations (INGOs), Bangladesh is unique in its long history of domestic and local non-governmental organizations (NGOs) working in disaster relief, livelihoods, and development (7–9). Following a series of deadly and destructive natural disasters in the 1990s, the government of Bangladesh, international donors, and international and domestic NGOs invested in disaster risk reduction and preparedness. These efforts led to reduced loss of life in future cyclones and floods (10). However, significant challenges remain. While many government, INGOs, and local NGOs mobilized to provide disaster relief following Cyclone Sidr in 2007 and Cyclone Aila in 2009, studies have shown that lack of coordination between actors hindered efficient delivery of services, and mapping local organizations to

promote capacity building and coordination and to strengthen disaster management and response was recommended (11–13).

This study focused specifically on actors in the disaster resilience and climate change adaptation spaces that work in Bagerhat district in Bangladesh. This district is highly vulnerable in terms of food and water insecurity, poverty, and health, and is also vulnerable to disasters and climate change impacts (5). The district was heavily impacted by Cyclone Sidr, and is experiencing sea level rise and saltwater intrusion – World Bank estimates from 2014 project that freshwater zones in Bagerhat district will be reduced by 71-93 percent by 2050 (5).

CHARACTERISTICS OF HUMANITARIAN ECOSYSTEMS

To assess the network of actors working on climate change adaptation and disaster resilience in Bagerhat district, we have taken into account key characteristics and potential roadblocks that can affect collaboration within humanitarian systems, building off the approach we used in the DEPP evaluation.

Below we describe the factors that influenced our system analysis and our recommendations.

LOCALIZATION

There is growing attention among donors and humanitarian practitioners to the importance of localization. *Localization* refers to a shift of power, where stakeholders such as donors, United Nations (UN) agencies and INGOs are putting local actors, such as CBOs, civil society, government, and local NGOs, in the driver seat and supporting them to play a more central role in leading humanitarian efforts. Groupe URD and Trocaire's 2017 research on how localization efforts build community resilience and sustainability provides a succinct definition of localization, seen in the text box on the right.

Many humanitarian response initiatives are working to improve local collaboration between a range of stakeholders and strengthen local capacity to plan, implement, and finance efforts. An example of this is seen with the START Network and DEPP, which acted as a global capacity building program and aimed to strengthen the networks and collaboration among local actors working in humanitarian assistance. In assessing the impact of the DEPP network across four country contexts, HHI worked with Root Change to design an analysis approach to

examine dimensions of localization. We have applied similar techniques to the analysis of network actors in Bagerhat district in order to assess:

1. The degree to which district and national local actors are collaborating with each other;
2. Whether local actors are in positions of influence; and
3. The role that international actors play in Bagerhat and effects on local system when international actors are removed.

Below we present suggestions for how to strengthen this system and improve localization of humanitarian efforts.

BEHAVIORAL ROADBLOCKS

Many of the international development and humanitarian response networks we have studied previously show predictable patterns. These are based again on how international aid programs, funders, and organizations engage in a local system. The arrival of foreign assistance can bring much needed resources and support to a country context, but at the same time it can be disruptive to the local ecosystem. In assessing the Bagerhat network, we looked for examples of two common roadblocks to effective collaboration that we

commonly find in international development networks.

Preferential Attachment: Development systems are complex and adaptive, as new organizations enter and exit a system frequently. A common misconception is that new entrants will naturally choose to associate with a range of local-peer institutions on common development challenges. In reality, new actors are much more likely to associate with organizations with the *most links and connections (and of course opportunities for*

funding). *Preferential attachment* to centralized actors reinforces the hegemony of a few key actors, with negative consequences for sustainability. Not surprisingly, when international agencies set up operations, they quickly become the target of preferential attachment by local actors, where local actors go primarily to these international agencies.

Preferential attachment can lead to positive effects, such as local partners implementing aid programs, but often donor attention on a few local partners can make them "usual suspects." This reinforcement of "inner circle" status can create preferential attachment towards these few local actors as well. As a result, networks can become dependent on a few *dominant* actors, who have few incentives to facilitate connections and embrace new brokering roles that might potentially diminish their own influence. We have looked for

presence of preferential attachment and dominant actors in the full Bagerhat network and across collaboration areas in our analysis.

Insularity: Another common feature of systems is homophily – the tendency of individuals and organizations to affiliate with others like themselves. Organizations tend to restrict their relationships to friends, colleagues, or peers who often work in the same sector, have a similar organization type, or have the same beliefs, attitudes, and practices. This creates a "small world" effect where clusters of collaboration are composed of organizations with common characteristics.

This insularity can complicate efforts to spread new knowledge and ideas. Government actors, NGOs, and donors are also susceptible to the small-world syndrome. We have observed how central actors with influence increasingly limit

ties to an "inner circle," further isolating themselves from new connections and alternative viewpoints. In our analysis we have looked for signs of insularity especially among organization types such as CBOs, government, INGOs, and local NGOs. We also look for other drivers of homophily, including the age of an organization and history of collaboration.

METHODOLOGY

DESIGN

In order to assess the humanitarian network operating in the coastal communities of Bagerhat district, HHI undertook a field study that included a detailed network mapping of all actors using a structured questionnaire.

Data collection took place from June to August 2019 and was implemented by trained interviewers who contacted organizations to conduct face-to-face interviews. Annex A provides the detailed study protocol.

INSTRUMENT

The instrument used for the network was adapted from a similar instrument developed by HHI's Phuong Pham for the purpose of humanitarian network mapping in the context of disaster emergency preparedness programming. The instrument includes four sections, which collect organizations' information and attributes, response and resilience activities, financing, and collaborations. See Table 1, "Description of Selected Measures" for the key measures assessed.

SAMPLE

Before data collection, interviewers identified 57 organizations to be approached. This initial sample was based on a list of NGOs and other humanitarian and climate-change-related actors registered with the district government. Each organization provided names of collaborating organizations, which were subsequently approached for interviews. Once no new organizations were identified, the process reached saturation, that is all relevant organizations were captured.

A total of 80 organizations were identified and 64 were interviewed. Among the 16 that were not interviewed, 1 declined to participate, and 2 did not respond to requests for participation. Six were named as collaborating organizations by survey respondents, but were deemed ineligible to take the survey (did not currently have any climate adaptation or disaster resilience programs in Bagerhat district); however, these organizations were kept in the sample for the purposes of assessing their reported collaborations with others in the network. For another six organizations, the research team was unable to locate an appropriate contact to participate. The remaining two organizations were not specific entities, but were generic organization names (e.g., Local Government) kept in the sample for the purpose of analysis. These generic organizations were identified by survey respondents as a collaborating organization, in cases where the respondent declined to name a specific department or contact.

ANALYSIS

Once the data were collected using KoBoToolbox, they were aggregated into a single file for analysis. A quantitative analysis was undertaken using questions about traits of the organization answering the survey, as well as questions about the nature of their collaboration with other organizations.

This analysis focuses on selected indicators, including:

- The degree of separation
- The relationship types
- The strength of relationship
- The organization attributes

Most analysis was carried out using Python coding language, including packages such as NetworkX and DataFrames, to run social network analysis algorithms and summary statistics respectively. We used ORA, a tool developed by CASOS at Carnegie Mellon for network analysis, to create the network images. In addition, the statistical software package R was used for statistical significance tests. Excel pivot tables provided additional breakdowns of the data using multiple variables and was used to create the pie charts found throughout this report. The outputs of all of the tools can be found in the annexes of this report, organized in the same fashion as the findings section.

DEGREES OF SEPARATION

Actors were eligible to participate in the survey if they worked in Bagerhat district and conducted any climate change adaptation or disaster resilience work. The initial list of respondents was based on a list of humanitarian and climate-change-related actors registered with the district government. JJS facilitated introductions between these actors and HHI's enumerators.

The actors that were on the initial list were asked with whom on the list they had connections. They also were asked to name additional actors who were not on this list but

work in climate change adaptation or disaster resilience work in the district. Additional actors named are considered to be 1st degree actors. They are one degree of separation away from the survey informant. The 1st degree actors identified were then invited to also take the network survey. The actors they identified are 2nd degree actors, as they are two degrees of separation from the initial survey informant. Through this process of nomination and follow-up, HHI believes to have reached almost every actor working in climate change adaptation or disaster resilience in Bagerhat district.

RELATIONSHIP TYPES

As part of the network survey, participants identified the organization(s) with which they had collaborated over the last six months. They picked from a list of 38 collaboration areas, representing a menu of topics in which humanitarian actors are likely to engage.

Collaboration areas are the functional or thematic areas in which organizations work together. Participants could also name their own areas of collaboration. Participants identified 12 additional collaboration areas, bringing the total to 50. This report concentrates analysis on the full network and the top four most frequently referenced collaboration areas: Coordination, Advocacy,

Community Capacity Building, and Climate Change Adaptation. For a complete list of collaboration areas, see Annex C.

Figure 1: Example of Degrees of Separation

In this example, Local Government Actor A took the first phase survey, and named NGO B as a collaborating organization. NGO B then took the survey in the second phase and named University C. University C is 2 degrees of separation away from Local Government Actor A.

Local Government
Actor A

↓

NGO B
1st degree actor

↓

University C
2nd degree actor
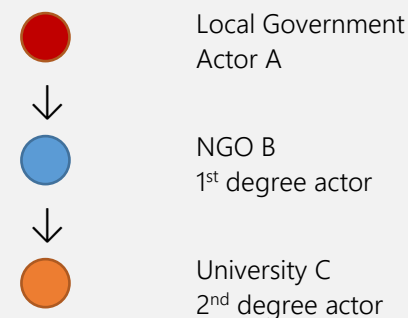
In addition, participants were asked to describe how formal they defined the relationship and if the relationship was based on mutual interest or a funding requirement. Table 1 provides an overview of the

information that was collected on relationship type.

STRENGTH OF RELATIONSHIP

Survey participants were also asked to describe attributes related to the strength of the relationship. The first of these attributes describes how frequently they collaborate with the actors they identified. Frequency of communication or interaction is a common proxy for quality of relationship. The following frequency scale was used:

- Rarely (1-2 times in the last 6 months)
- Occasionally (3-4 times in the last 6 months)
- Often (more than 6 times in the last 6 months

When an actor indicates frequent collaboration, we hypothesize that there is high trust and perceived value in continued engagement.

In addition to frequency, respondents were asked about how long they had collaborated with an actor based on year increments, and the likelihood they would recommend the organization to another actor, which is a common proxy for trust in a relationship. See Table 1 for definitions of the attributes collected on relationship strength.

ORGANIZATION ATTRIBUTES

For the actors surveyed, we captured a range of attributes. See Table 1 for details on the actor attributes collected.

RESULTS

Results of the analysis are reported using three types of statistics:

1. *Attributes summaries*
   Summary counts and percentages of organization and relationship attributes allow us to get a better sense of who is in the network and what types of relationships are present. For example, we can answer questions such as: How many INGOs are in the network vs CBOs? How many relationships were reported for each collaboration area? How frequently are actors collaborating? In the findings section, we have separated these by *organizational attributes*, or information about the survey respondent, and *relationship attributes*, or information collected about the nature of a given relationship between two actors.

2. *Network Statistics*
   Using social network analysis, we can learn about a full system and its sub-systems. For the full network and each sub-

network, we prepared a visualization and calculated social network analysis statistics. Network statistics include identifying key actors that form the basis of this network analysis – *collaboration hubs, brokers,* and *influencers.* Each of these actor types play different but equally valued roles within the network. The aggregate impact these three actor types have strongly affects the viability of the system. Figure 2 defines these three actor types.

Collaboration systems are dynamic and often involve diverse sets of actors who learn, adapt, self-organize and co-evolve over time. Culture, values, beliefs, and one's peers all work to influence relationships and interactions. Seemingly small independent decisions – grant money distributions, choice of program partners, the selection of an international versus a local NGO as an implementing partner – can each have macro-level impacts on the system. Therefore, roles are continuously changing, as they are based on the collaborations between and among all actors in the network.

Figure 2: Types of Actors
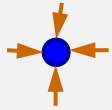
Collaboration Hubs are sources and distributors of subject matter expertise. As intense gatherers and spreaders of information, Collaboration Hubs are often the first to pick up on new trends. The SNA metric total degree centrality is used to calculate these scores.
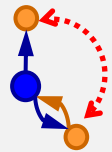
Brokers introduce people and institutions across an array of social, cultural, professional and economic circles. They often have exclusive ties to unique actors and smaller sub-groups, as well as direct ties to central core agencies, such as funders and international agencies. The SNA metric betweenness centrality is used to calculate these scores.
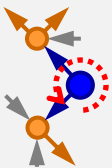
Influencers are connected to other well-connected actors, and therefore spread information quickly through the system. Influencers are often "in the know" and can help to get the message out when rapid communication is needed. The SNA metric eigenvector centrality is used to calculate these scores.

3. *Collaboration Patterns*
    Attributes allow us to dive deeper into specific groups of actors, or specific types of collaboration. The analysis is separated by whether it is based on relationship attributes, organizational attributes, or

both. Most collaboration pattern analysis in this report relies on a Social Network Analysis (SNA) metric called E-I Index, which stands for external-internal index.

By first defining a group of interest, whether it be NGOs, CBOs, local actors, district actors, etc., this metric uses relationship counts to see whether actors within that group are collaborating with actors in their same group or actors in other groups. This is of particular interest when looking for insularity in a network. For more information on this measure see Annex C. We ran a correlation on scaled attributes such as likelihood to recommend another actor, or how long actors have been collaborating. We also ran chi-square tests for significance for categorical attributes.

LIMITATIONS

While the study authors worked to avoid bias in organization selection by using a list of humanitarian and climate-change-related actors registered with the district government, it is possible that not all eligible respondents working in Bagerhat district were identified. In addition, this study was conducted with logistical support from JJS and Concern

Worldwide, two NGOs (one local, one international) working in Bagerhat district. JJS and Concern Worldwide supported the study team in outreach to prospective respondents, which could have contributed to organizations' bias in naming these two organizations as collaborators.

Table 1. Description of Selected Measures

Relationship Type	Collaboration Area	Organizations listed the other organizations with which they collaborate and selected the collaboration areas that described their connection to each actor they nominated. Collaboration areas were chosen from a list or were written in; examples include advocacy, community planning, funding, climate change adaptation, etc. For a full list of collaboration areas identified, see Annex C.
	Collaboration Type	Organizations selected if their relationship with the actor is (1) a formal contractual relationship, (2) mainly information sharing, (3) an informal partnership, or (4) created during a project (e.g., an NGO helped organize a CBO as part of a project, and the NGO continues to collaborate with the CBO).
	Collaboration Reason	Organizations selected if their reason for collaborating with the actor is based on (1) mutual interest or (2) a funding requirement.
Relationship Strength	Frequency of Interaction	Organizations selected the frequency with which they engaged with the actor in the past 6 months, with choices (1) often, (2) occasionally, or (3) rarely.
	Length of Collaboration	Organizations selected incremental choices, such as less than 1 year, 1-5 years, 5-10 years, 10-15 years, and more than 15 years.
	Likelihood to Recommend Organization	Organizations stated how likely their organization would be to recommend the actor for climate change or disaster resilience work, based on a 1-10 Likert scale, with 1 being "not likely at all to recommend" and 10 being "very likely to recommend."
Organization	Organization Type	Respondents selected from 9 options: National NGO (has projects throughout the country), Local NGO (has projects in a specific locality or region within country), Community-Based Organization/People's Organization, International NGO, International Organization (UN, IOM, World Bank, etc.), Government (national, district, sub-district, union, municipality, ward), Academic Institution (University or College), Private Sector, or Media.
	Organization Size	Respondents selected from choices of the number of employees at their organization. We then combined these choices into the following categories: small (less than 100 employees), medium (100-1000 employees), or large (more than 1000 employees).
	Organization Focus	Respondents selected from the following categories: preparedness, risk reduction/resilience, response, adaptation, and/or development. This variable was "choose all that apply."
	Local or International	Whether an actor is local (based in Bangladesh) or international (based in another country).
	District, National, or International	Further breakdown of the above by splitting choices into district (works only within Bagerhat District), national (works within Bangladesh), or international.

Network	Number of Organizations	While there were 80 total organizations surveyed, not all of them will have relationships. This measure indicates the number of organizations who have at least one relationship in the network.
	Number of Relationships	The survey allowed and encouraged respondents to indicate all collaboration areas in which they worked with another actor. This caused redundancy in the number of relationships between actors. Total number of relationships is the number of relationships in the network, counting different collaboration areas separately. Number of unique relationships only includes the number of relationships from one organization to another, and does not count redundancy due to collaboration areas. The latter does preserve directionality of relationships, so a relationship from actor A to actor B is counted separately from a relationship from actor B to actor A.
	Average Number of Collaboration Areas per Relationship	This calculation takes the number of total relationships and divides by the number of unique relationships. In other words, in how many collaboration areas the average two actors work together.
	Average Number of Relationships	This looks at how many total relationships each actor has and divides by the number of actors in the map. This is a measure of how many connections each actor has.
	Average Number of Actors Each Actor is Connected to	This looks at how many other actors each actor is connected to. First, we create a network that does not have redundancy of collaboration areas or relationship directions. Then it looks at how many relationships each actor has and divides by the number of actors in the map. This is another measure of how many others each actor knows.
	Density	This Social Network Analysis (SNA) metric uses the number of actors in the network to determine the total number of possible relationships. It then takes the number of actual relationships and divides by the total number of possible relationships. This calculation does take into account relationship direction, but not redundancy of collaboration areas.
	Reciprocity	This metric divides the number of relationships that are reciprocal, or bidirectional between two actors, by the number of actual relationships in the network to determine the percent of relationships that are reciprocal. This calculation does take into account relationship direction, but not redundancy of collaboration areas.
	Average Reach	This calculation uses the NetworkX algorithm local_reaching_centrality, which calculates the percentage of actors in the network that can be reached by a single actor, using limitless degrees of separation. The algorithm provides a score for each individual actor, so we then calculate an average based on the individual scores and total number of actors in the network.

FINDINGS

NETWORK OVERVIEW

The study identified a total of 80 actors working to support climate change adaptation and disaster resilience in Bagerhat District, Bangladesh. Of these organizations, eight did not have connections to any other organizations. The other 72 organizations reported 1312 total relationships with one another.

Figure 3 shows a visualization of the full network. In this network, you can see a core group of actors working actively together and exchanging information, ideas, and support on climate change adaptation and disaster resilience. The network image in Annex B zooms in on this core group of actors. There are also some actors working on the periphery or working in isolation. Actors in green represent district-level actors, actors in blue are national-level actors, and actors in red are international organizations. Squares represent large-sized organizations (more than 1000 employees), triangles are medium organizations (100-1000 employees), and circles are small organizations (less than 100 employees). We have sized actors by total-degree centrality, which highlights which actors in the system are *collaboration hubs*, or are the most well-connected actors in the network. We explore these actors more in the Key Actor section of this report.

The full network, shown in Figure 3, is comprised of 50 collaboration areas. In collecting relationship data for a range of collaboration areas, we were able to account for both the presence of a relationship between one organization to another, as well as the number of different areas or topics these two actors are collaborating around to exchange information, ideas, and support. We found there were 171 unique relationships, meaning a relationship from one organization to another, disregarding redundancy caused by collaboration areas. This means that on average, each organization went to another organization for eight different collaboration areas. For more on the top collaboration areas, see the *Sub-Network Analysis* section.

On average, each organization has about 33 relationships (including redundancy in collaboration areas) and knows about 4 other organizations. These numbers can be skewed by those who have many connections, but the average helps us better understand how well-connected someone in this system is likely to be. The average can also serve as a benchmark for the system, meaning that those who do not have at least 33 relationships and know 4 other organizations might aim to do more networking. For example, 28 actors know at least 4 others in the network (35% of actors), and 23 actors have at least 33 relationships (28.8% of actors). For reference, the median number of relationships per organization is 16, and the median number of other organizations a given organization knows is 2.

We use two measures to assess how well-connected the network is: density and reach. First, the density of the full network is 0.027. In other words, 2.7% of all possible ties between organizations (if each organization on the map had a tie to every other organization on the

map) have been realized.[1] Second, looking at relationship directionality and flow through the entire network based on degrees of separation, we can see that, on average, each organization's contributions to the network (resources, ideas, or support) have the potential to reach 17.4% of other organizations. This second measure of network connectivity allows us to see not only if relationships exist, but if they form structures that foster information or resource exchange.

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[1] In SNA, a "dense" network is typically 0.3 or higher, but Root Change has never observed a score that high. Most of the networks Root Change has assessed for density have been much larger than this study (a few hundred actors at least). Those networks have had a density of around 0.01. As the number of actors increases, network density typically goes down and vice versa.

Figure 3. Full Network, Climate Change Adaptation and Disaster Resilience in Bagerhat District, Bangladesh

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:

□ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
○ = Small (<100 employees)

Size by Total Degree Centrality (number of relationships)

Line thickness by Frequency of Interaction
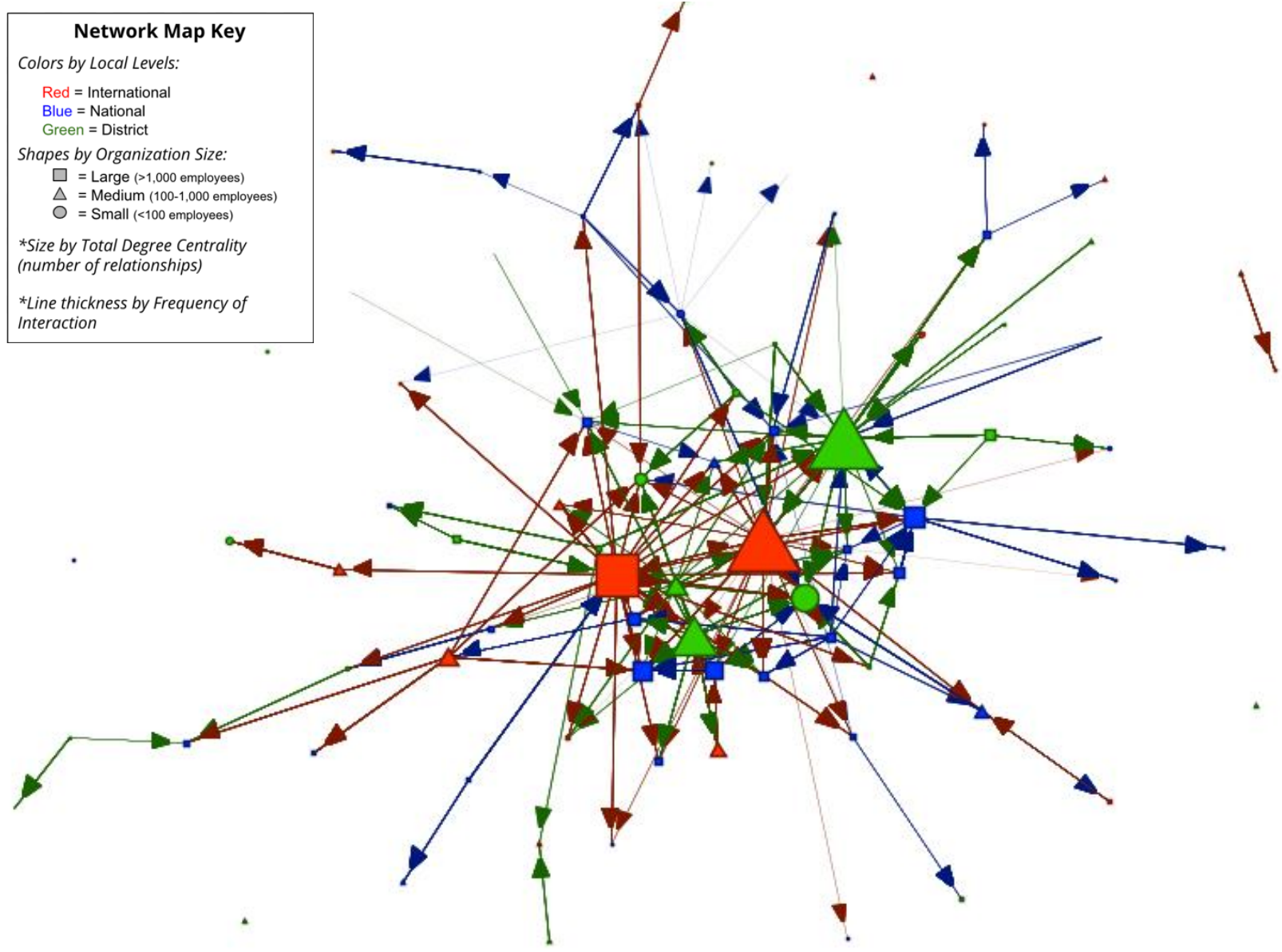
OVERVIEW OF RELATIONSHIPS

SUMMARY OF FINDINGS FOR
COLLABORATION AREAS

In Bagerhat district, 50 total collaboration areas were identified by organizations. Among those, the greatest collaboration was found within three areas: Coordination, Advocacy, and Community Capacity Building, with 113, 89, and 88 relationships respectively. The next top three collaboration areas, which ranged between 79 and 60 relationships, included Climate Change Adaptation, Project Implementation, and Technical Assistance. These six collaboration areas account for 40% of all relationships. Figure 4 shows the number of collaboration areas cited by organizations and the range of total relationships reported in each. Twenty-seven collaboration areas had less than 19 relationships, accounting for over half of collaboration areas. Among those were Climate Mitigation and Disaster Preparedness, two collaboration areas relevant to disaster resilience, which were found to only have 1 relationship each. These were write-in collaboration areas, where the person answering the survey chose to create a new category for them. Before a next round of surveys, it would be good to explore why this respondent felt like those categories were not captured in the other choices, and why other respondents did not also report relationships in these areas. Early Warning System Expertise

Figure 4. Number of Collaboration Areas versus Number of Relationships Identified in Each

Number of Relationships

- 100+-80
- 79-60
- 59-40
- 39-20
- 19-0

Number of Collaboration Areas
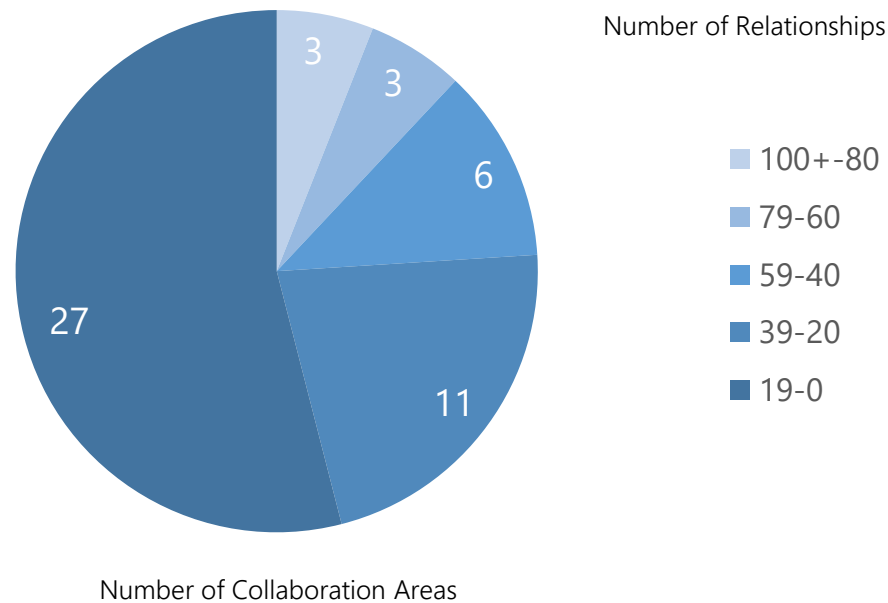
was also found to be on the low end of collaboration, with only 28 relationships.

SUMMARY OF FINDINGS FOR COLLABORATION TYPE AND REASON

In addition to collaboration areas, the network survey asked about collaboration type (formal, informal, or information sharing) and collaboration reason (financially required or mutual interests) to learn more about *why* organizations are collaborating. In terms of collaboration type, collaborations that are informal or informational often do not have explicit financial benefits, which indicate that an actor values the work of the other organization. Formal contracts could also be by choice, but have an additional motivating factor of financial benefits. In terms of

Figure 5. Percentage of Relationships by Collaboration Type

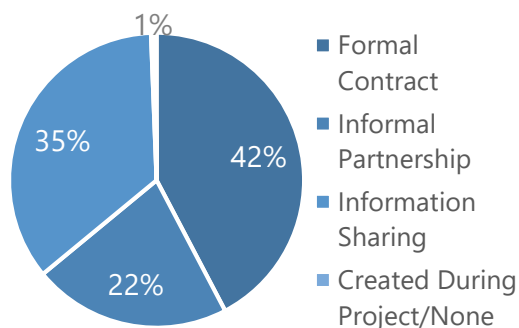collaboration reason, a collaboration based on mutual interests can also indicate that an actor values the work of the other organization, while a collaboration entered into due to funding requirements can indicate that the collaboration is not by choice. For this network, collaboration is fairly evenly split across all three collaboration types, and is most often by choice rather than a requirement imposed by a funder.

When looking at the reason for collaboration, organizations cited that the majority of their relationships were based on mutual interests, accounting for 69.6%, with only 30% relationships based on funding requirements. When looking at the type of collaboration, formal contracts were the most commonly cited relationship type, representing 42.35%, followed by information sharing at 35.4%, and informal partnerships at 21.7% (see Figure 5). This suggests that informal partnerships are not as common among actors, who typically engage in formal partnerships or information sharing.

When looking at the distribution of collaboration reasons across collaboration types, it appears that about half of informal partnerships occur as funding requirements (52.3%) and about half occur as a product of mutual interests (47.7%). 99% of information

sharing relationships were due to mutual interests, rather than funding requirements, and this combination accounts for 35% of all relationships reported in this study. Collaborations which occur due to funding requirements correspond most closely with formal contracts or informal partnerships, and not information sharing. A chi-square test revealed that these patterns are statistically significant ($p<0.001$). This indicates that funding requirements lead to some sort of partnership, whether formal or informal.

*Table 2. Distribution of Collaboration Reason across Collaboration Types*

	Mutual Interests	Funding Requirement
Formal Contract	69.6%	30.4%
Informal Partnership	47.7%	52.3%
Information Sharing	99%	1%

SUMMARY OF FINDINGS FOR RELATIONSHIP STRENGTH

The majority of actors in the disaster resilience system in Bagerhat have more than a decade of experience working with each other, they interact frequently, and have high levels of trust. This is evident both in how they have described their relationships and in the network structure.

The majority of organizations cited their interaction with others as often, or more than 5 times in the last 6 months. This accounted for 75.6% of relationships, which is quite high and suggests that actors have many touch points to meet and engage. This may also be

Figure 6. Percentage of Relationships by Length of Collaboration

- Less than 1 year
- 1-3 years
- 3-5 years
- 5-10 years
- 10-15 years
- More than 15 years
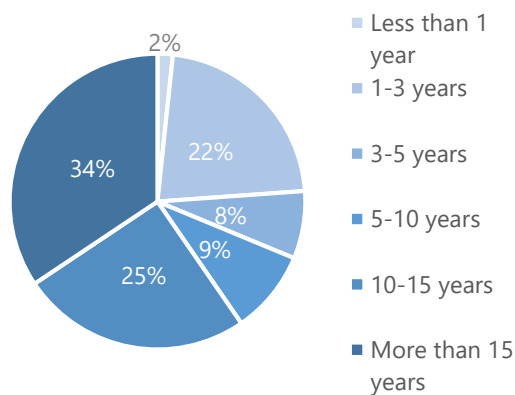
driven by high presence of formal partnerships and mutual interests.

Over half of reported relationships, or 59.6%, are between organizations who have known each other for at least 10 years, with 34.3% of relationships being between those who have known each other for over 15 years. The remaining 40.3% of relationships represent actors who have known each other less than 10 years, with 23.9% being those who have known each other for less than 3 years, or new relationships within the district (see Figure 6). This suggests that the majority of actors have a history of working together, which may be explained by the small size of the geography of this system. High presence of long-term relationships may also be an indicator of preferential attachment of organizations who have history with one another to stay within their own small group.

Trust was also found to be moderate to high among organizations. In the survey, participants were asked how likely they are to recommend their contacts to others on a scale of 1-10, with 10 being extremely likely. This question is commonly used as proxy for trust or strength of relationship. We applied Net Promoter Analysis (NPA) to assess these relationships scores. NPA divides up scores in the following way: organizations that give

scores between 9 and 10 are called "promoters;" they are very pleased with the relationships and would highly recommend those actors. Within the network, 50.6% of relationships received a score between 9 and 10. Organizations that give a score between 8 and 7 are considered to be "passives;" they believe the relationship is okay, but may have a few reservations. Within the network, 29.6% of relationships received a score between 8 and 7. Organizations that give a score of 6 or less are considered to be "detractors;" they have more serious reservations about the relationship, which indicates low levels of trust. Within the network, 19.7% of relationships received a score of 6 or less. Further analysis would be needed to understand the reasons why detractors gave low scores.

When we ran a correlation between variables representing how long actors have been collaborating, how often they have been collaborating, and how likely they are to recommend the other actor, we found that there was a significant (p<0.001) positive correlation (0.347) between frequency of interaction and likelihood to recommend the other actor, and a significant (p<0.001) weak positive correlation (0.126) between frequency of interaction and how long the organization has known the other actor. The was no correlation between how long actors have known someone and likelihood to recommend them (p=0.182).

While interaction, history, and trust appear to be high between the majority of actors in-network, only 7% of relationships were found to be reciprocal, or bidirectional between two organizations. This suggests a small amount of joint-initiatives or joint-collaboration between actors. With a high number of formal relationships within the network, we might expect to see higher reciprocity. It may be that within these formal partnerships there is more of a one-way flow of information exchange as opposed to two-way exchange, or that actors display more "seeking" behavior, seeking information or support rather than co-creating and co-collaborating.

See Annex C for full tables of relationship attributes in the network as well as results from the correlation test.

OVERVIEW OF ACTORS

There are 62 local actors and 18 international actors in the network. Of the 62 local actors, 30 work at the district level and 32 work at the national level. In reviewing the types of actors working in Bagerhat District, the largest group was Government, with 24 actors (30%), followed by National NGOs at 15% of actors, and International NGOs at 14%. Figure 7

provides a breakdown of the actor types. Local NGOs are particularly interesting, as they have 589 total relationships, or 44.9% of all relationships in the network (the second highest of any actor type), but only account for 9 actors in the network, or 11.3% of all actors. It is important to note that one of the local NGOs helped to launch the survey process and identify all actors working in climate change adaptation and disaster resilience in Bagerhat. This actor brings many relationships to the system and therefore skews the numbers or local NGOs.

Figure 7. Percentage of Organization Types Found in Network

- Government (national, district, sub-district, union, municipality, ward)
- National NGO (has projects throughout the country)
- International NGO

- International Organization (UN, IOM, World Bank, etc.)
- Local NGO (has projects in a specific locality or region within country)
- Community-based Organization / People's Organization
- Private Sector

- Academic Institution (University or College)
- Media
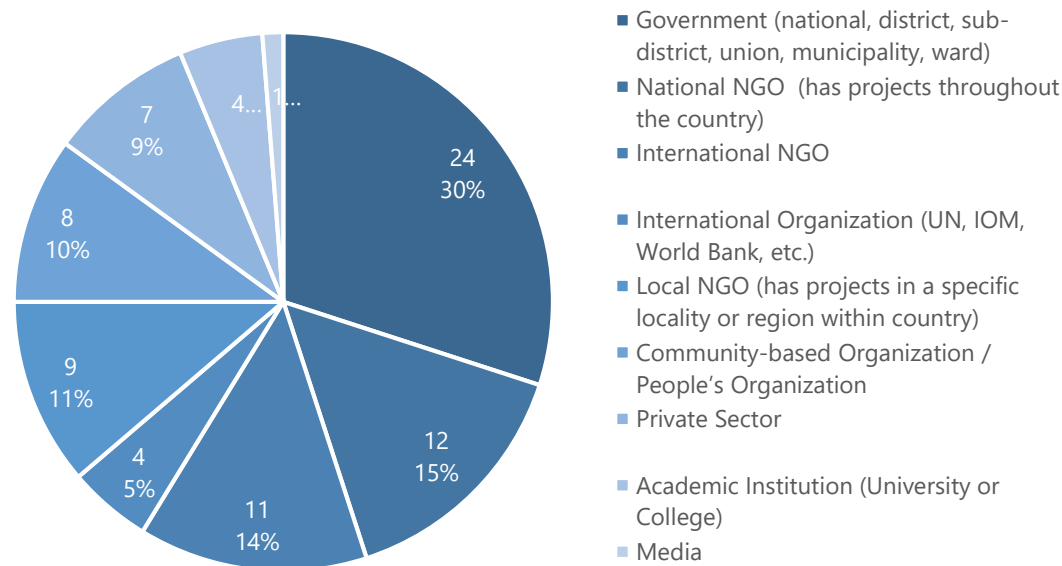
Academia, CBOs, media, and the private sector were the smallest number of actor types found engaging on climate change adaptation and disaster resilience in the system. Only one actor interviewed identified as a media organization. However, media outlets were not explicitly approached for participation in the survey, because, while they are important for advocacy and information sharing around climate change and disasters, they are largely not involved in program implementation for resilience and adaptation.

When comparing the geographic focus of actors, we found that 30 were district actors (37.5%), 32 national actors (40%), and 18 international actors (22.5%). This shows that within the district a majority of actors working on climate change and disaster relief are local, making up 77.5% of all actors, with international actors accounting for 22.5% of organizations working on these issues.

There were twice as many large organizations found in the network, 41 or 51.3%, compared to 20 medium and 19 small organizations. As discussed in the Network Overview section above, the top collaborators in the network tended to be medium or large organizations. This makes sense, as more people in an organization means more potential for collaboration and networking. Medium actors

were the most surprising, though, as they were a small group of 20 actors (25% of the sample), but had 849 total collaborations, which is comparable to that of large organizations, which had 934 total collaborations.

In addition to type, geographic focus, and size, the survey also asked about organizations' focus within climate change adaptation and disaster resilience. The smallest focus area is Response with 55 actors (68.8%), and the largest focus areas were Disaster Risk Reduction (DRR)/Resilience and Development, with 62 actors having each focus (77.5%). Because respondents could choose more than one organization focus, there was not much

variance, with around 70% of actors falling into each category (see Figure 8). See Annex D for a full breakdown of organizational attributes in the network.

ISOLATES

There were eight actors who were surveyed but reported no relationships with others working on climate change adaptation and disaster resilience in Bagerhat. These same eight organizations were not identified by others as partners. We refer to these actors as isolates, as they have no connections to the rest of the network.

Six of the eight isolates (75%) were district actors. There was one national actor and one

Figure 8. Number of Actors with Each Organization Focus
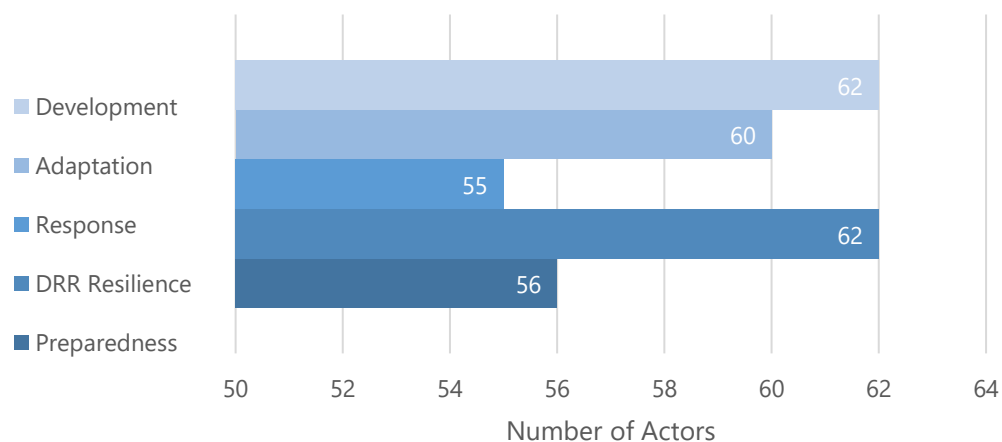
international actor. Half of the isolates were CBOs (50%), two were government (25%), one was in the private sector (12.5%), and one in the media (12.5%). This last isolate was the only actor in the network who was part of the media, whereas there were additional actors in the network for the other organization types. Media as an isolate follows patterns found elsewhere in this analysis around lack of media engagement in this system. For example, there were only 3 total relationships in the Journalism/Media collaboration area, none with the one media actor in the network.

CBOs as isolates also follows patterns found elsewhere in this analysis around limited CBO engagement. CBOs only accounted for 10% of actors. They have no relationships with one another (CBO to CBO engagement), and only have a total of 30 relationships across all eight CBOs, which is less than the network average number of relationships *per actor* (33 relationships).

There were three large organizations (37.5%), three medium organizations (37.5%), and two small organizations (25%) in the isolate group, which goes against earlier assumptions based on the top collaborators of the network that it

is easier for large organizations to be well-connected.

One of the isolates only worked in response, and another only worked in development. The other isolates worked across at least three areas of focus, with one isolate working in all five areas of focus. Perhaps having only one area of focus is limiting, but with most isolates working in at least three areas of focus, this does not seem to be a factor.

Further research is needed to determine why these actors are isolates in the climate change adaptation and disaster resilience network. Geographic focus and organization type seem to be factors, but organization size and focus do not seem to be common trends among these actors.

See Annex D for a list of the eight isolates in the network.

COLLABORATION PATTERNS BETWEEN ACTOR GROUPS

Using organization attributes, we can look at collaboration more closely, answering questions around *who* is collaborating. For example, to what degree does collaboration

exist between local and international actors, and between district and national actors? Is there cross-collaboration happening between different organization types, or actors with the same focus? Cross-collaboration is important to a network to prevent insularity, or homophily, where actors only collaborate with those like themselves. Using attributes around whether actors are local or not also allows us to explore localization, or whether cross-collaboration is occurring among international actors and local actors. Below is a summary of findings across a range of questions.

Are local[2] and international actors collaborating?

In assessing the levels of collaboration between local and international actors, we can begin to see whether localization is emerging in the network. Important to note is that localization does not mean that international actors are only going to local actors, as they also need to coordinate with one another. Instead, we are looking for a healthy balance of relationships, which we do find in Bagerhat district.

[2] Here, local actors include both district organizations and national organizations.

Of the 1312 relationships in the network, 1245 (95.0%) involve at least one local actor. Roughly half of all relationships (46.4%) are between one local and one international actor, and roughly half of all relationships (48.5%) are between two local actors. The remaining relationships account for 67 total relationships that the 17 international actors have with one another. This last figure shows that international actors are collaborating with one another, but mostly collaborating with local actors.

There are three times as many local actors with relationships in the full network than international actors (55 versus only 17), so it is especially important that they are also involved in most of the collaboration happening in the network, which they are.

Further analysis reveals that international and national actors have somewhat more relationships (a total of 327 relationships) than international and district actors (a total of 282 relationships). Additional analysis could reveal whether international actors are hearing a range of voices, meaning they are collaborating with many different local actors, or if international actors are going to the same few local actors at each of these levels.

Are district and national actors collaborating?

Localization also applies at a more micro level, inside a country for example. By analyzing collaboration patterns between national and district actors, we can begin to see if localization is happening at the Bagerhat district level. Overall, there is a healthy balance of collaboration between district and national actors, but national actors are collaborating much more than international actors.

There are about the same number of district actors as national actors in this network (30 and 32 respectively). Of the 48.5% of relationships in the full network that are between two local actors, about half of these (53.8%) are between district and local national actors, about a quarter (23.7%) are between district actors only, and about a quarter (22.5%) are between national actors only. This represents a healthy balance, especially given the even split in the number of district and local national actors in the network.

Is there cross-collaboration between different actor types?

For a resilient network, we expect to see actors exchanging information, ideas, and support across different actor types. In the climate change adaptation and disaster resilience network in Bagerhat, we see a large amount of

cross-collaboration between all actor types (except media, which has no relationships), meaning that actors are collaborating more with those who are a different type of organization than with those who are the same type.

Government is involved in the highest amount of cross-collaborations, with a ratio of 0.973 external to internal relationships. Of the 730 total relationships in the network including government actors, 720 of these were to organizations other than government. While this helps to prevent insularity, the small number of relationships between government actors is worth noting. Government was the largest group in the network, accounting for 30% of all actors, but those 24 government actors only have 10 total relationships with one another. This is an indication that government actors are not collaborating with other government actors on climate change adaptation and disaster resilience, and that some government actors are not exchanging information with other government departments.

The cross-collaboration ratio is also high for international organizations (UN, IOM, World bank, etc.) at 0.967, with 300 of 305 relationships being to other actor types. While this means there are only five relationships

between international organizations, there are only four international organizations in the network, so there should not be many relationships between them. In fact, depending on the structure of those relationships, four relationships could connect all international organizations to one another in a straight line of information flow. Further analysis should be done to see if any of these actors are working in isolation.

Across all nine organization types, actors of the same type are not collaborating much. Local NGOs had the highest number of inter-group relationships, or relationships between local NGOs, with a total of 28 relationships. This is especially notable because there were only 9 local NGOs in the network. CBOs and private sector actors are not collaborating with one another at all.

Is there cross-collaboration between different organization sizes?

For a resilient network, we also expect to see actors exchanging information, ideas, and support across different organization sizes. There is a large amount of cross-collaboration between different organization sizes, with all sizes collaborating more with those who are a different size than the same size. There is also a healthy balance among all three organization sizes of inter-group coordination.

Large organizations have the highest amount of insularity of the three sizes with an external-internal ratio of 0.415, but they are still collaborating much more with small and medium organizations than with large organizations like themselves. Large organizations also represented the largest group of actors according to organization size at 41 actors, or 51.3%, so this is to be expected.

Are organizations collaborating with those who have the same focus?

HHI was also interested in exploring whether organizations' focus along the humanitarian to development continuum affected collaboration patterns.

Organizations could select that they have more than one focus. About 70% of organizations responded that they worked in any given focus area, so the number of relationships that include each focus area is very high given the wide spread of possible actors that can bring each focus to any given collaboration. Because of this, the results of this analysis are skewed and show very high collaboration across organization focus areas.

One interesting finding is that every single relationship that was reported includes an actor focusing on DRR/Resilience, Adaptation, and/or Development. These relationships

could have one actor that does all three, or any combination across both actors who are collaborating. 46 actors (57.5%) have all three of these focus areas, so this is likely also skewing these results, as relationships for those 46 actors are contributing to these findings without even looking at the second actor in the relationship. These results indicate that organizations in this system often work broadly across the humanitarian continuum, rather than specializing in one focus area.

See Annex D for tables indicating each actor group, number of relationships within their own group, number of relationships with those outside of their group, total relationships for that group, and a summary ratio based on the SNA metric E-I index. This annex also includes a table comparing presence of organization focus on DRR/Resilience, Adaptation, and Development.

ADDITIONAL COLLABORATION PATTERNS BETWEEN ACTOR GROUPS

Combining organization *and* relationship attributes, we can examine collaboration to answer questions around *how* those specific actors are collaborating. For example, do different types of organizations collaborate in different ways? This analysis expands on the previous section and dives deeper into collaboration between key groups of actors,

including local and international and the various organization types. The specific questions explored below were established during pre-analysis planning between HHI and Root Change.

How long have district, national, and international actors been collaborating?

We know that there are signs of localization in the network because international and local actors are cross-collaborating, and that international actors have more relationships with national actors than with district actors. We can now look at how long these groups have been collaborating to get a better sense of how long localization has been happening and at which levels.

About a third of relationships between national and international actors (32.4%) have spanned only 1-3 years, but 45% of relationships between these actor groups have existed for at least 10 years. 23% of relationships between international and district actors span 1-3 years, and 62% have been around for over 10 years. This indicates that in recent years, international actors have more connections with national actors than district actors. Further analysis is needed to determine if this is because national actors are becoming more active in the district, because

international actors are prioritizing national level relationships, or for other reasons.

In almost half of relationships between district and national actors (44.4%), the actors have been collaborating for more than 15 years, indicating that localization on the micro level has been occurring for a long time.

When looking within groups, international actors have the youngest relationships with one another, with nearly all relationships (except one) falling into the 1-3 year category. District actors have the oldest relationships with one another, with 90.7% of their relationships with one another being at least 10 years old. In all cases, district actors have been working with one another for at least 3 years. National in-group relationships span the choices, with the majority of relationships (93.7%) being either more than 15 years *or* less than 5 years. Further analysis, including change over time of actors, might reveal whether international actors are coming and going into this system, a phenomenon that is quite possible given international development and humanitarian aid project cycles.

Do different types of organizations collaborate in different ways?

Power dynamics can come from formal contracts between granters and grantees—

INGO formal contracts with local NGOs or CBOs, for example. To assess power dynamics, we therefore looked at collaboration types between different sets of organization types.

Academic institutions, CBOs, and private sector actors only go to others working to support climate change adaptation and disaster resilience for formal contracts. This is surprising for CBOs, who typically have similar missions to INGOs or NGOs working in this sector, but is unsurprising for academic institutions and the private sector, who may only come into the sector to work on research or donate aid money or in-kind support. Further research is needed to determine the nature of these contracts.

International organizations do not go to others for informal partnerships (only about 2% of their collaborations), but engage with others for both information sharing (55.6% of their relationships) and formal contracts (42% of their relationships). National NGOs also go to others most often for information sharing (47.8% of their relationships). This indicates that both international organizations and national NGOs are actively seeking information from others on this topic.

INGOs are the only actor type to have more informal partnerships than any other type of collaboration (37.3% of their relationships).

This might be because they are offering services to local organizations or government. Additional research is needed to determine the nature and topic of these informal partnerships. Both INGOs and government have a spread of relationships across the three collaboration types (formal, informal, and information sharing), indicating that they are involved in this system in many different ways.

See Annex D for a table of collaboration types broken down by type of actor the relationship comes from.

KEY ACTORS

In addition to relationship analyses, we calculated different centrality measures to identify types of influential actors within the network. See Table 3 for a description of the centrality measures used.

In assessing key actors, we explored the degree to which district and national actors were in influential and central positions in the network versus international actors. This would be an indication of local actors serving as information and collaboration hubs, and subject matter expertise, which is a sign that, within certain areas of climate change adaptation and disaster resilience, local actors are leading and providing expertise.

Table 4 lists the top 10 collaboration hubs that were found for the full network. Collaboration hubs are actors who have the greatest number of connections in the system. At the core of the network, we find five organizations that are top collaboration hubs: Mid-Sized INGO A, Mid-Sized Local NGO B, Large International Organization C, Mid-Sized Local NGO D, and Small Local Government Entity E. Three of the five top collaboration hubs are medium in size. Among the local collaboration hubs in the core of the network, all are district-level actors. It is important to note that the local NGO that supported HHI in this study emerged as a collaboration hub. As such, the network may be biased towards actors the local NGO knows and are within their reach. Large National Government Entity F was the top national-level actor found to be an emerging collaboration hub in 6th place.

Table 3. Top Collaboration Hubs in the Full Network

Rank	Name	Local?	Degree
1	Mid-Sized INGO A	I	240
2	Mid-Sized Local NGO B	D	235
3	Large International Organization C	I	201
4	Mid-Sized Local NGO D	D	154
5	Small Local Government Entity E	D	102
6	Large National Government Entity F	N	94
7	Large National Government Entity G	N	88
8	Large National NGO H	N	83
9	Mid-Sized Local NGO I	D	73
10	Mid-Sized International Organization J	I	66

Mid-Sized INGO A has both: a) the highest total relationships (240), and b) connections to the highest number of other actors in the network (31). It is also a key broker (ranked 2nd in the network with a betweenness centrality score of 0.076). This means Mid-Sized INGO A lies on the shortest path between other actors in the network, and is well-positioned to facilitate connections and information exchange between others. A question for Mid-Sized INGO A would be to what degree the organization sees itself as a "broker" in the system and is using its position to help connect district and national actors to coordinate and work together on common issues. While Mid-Sized INGO A is well-positioned to be a broker, more conversation of these results is needed to determine if they are playing this role. If this is not happening, these findings could suggest that this organization could be a bottle-neck to information and idea flow.

The same is true for Mid-Sized Local NGO B and Large International Organization C. Mid-Sized Local NGO B has the second highest number of total relationships (235) and has connections to the third highest number of actors (22). This local organization has the highest broker score (0.094), and is also highly visible in the network image as the large green triangle in Figure 3. Large International

Organization C is a top actor as far as number of relationships (201), number of actors it knows (29), and broker score (0.041). This international organization can be seen in the network image as the large red square.

Small Local Government Entity E and Large National Academic Institution W are the top influencers in the network, with scores of 0.355 and 0.299 respectively. Influencers are those who are connected to those in the network who are very central and have a lot of connections, and therefore have the ability to pass information or ideas to or from powerful actors. Some of these actors' prominence may be explained by their long-standing history in the district. Mid-Sized INGO A, Mid-Sized Local NGO B, and Mid-Sized Local NGO D have relationships within district that are over 15 years old. Large International Organization C appears to be a newer entrant, with relationships only 3 years old. Mid-Sized INGO A and Mid-Sized Local NGO B also share a formal partnership based on mutual interest, which may explain why they share many connections between each other.

We see that local organizations have prominent positions in the network, with Mid-Sized INGO A and Large International Organization C being two central international organizations, and Mid-Sized Local NGO B

being a central district actor. This current network state shows some potential signs of preferential attachment towards these actors and domination in the number of relationships they hold. This raises several questions: What history do these actors have working in the district? To what degree do these actors use their influence and high connectedness to help connect other more isolated or peripheral actors? How are these actors helping to promote information, idea, and resource flows, versus primarily funding or implementing programs? If these actors are playing a brokering and convening role, are helping to connect other local actors with local experts, and are supporting joint initiatives, over time we would expect to see a wider distribution of collaboration hubs among local NGOs, government, CBOs, academia, and others in the district.

See Annex E for tables of the top 25 actors under each key actor measure, as well as further definitions for those measures.

SUB-NETWORK ANALYSIS

Using organization and relationship attributes, we pulled apart the layers of the full network to look at dynamics within specific sub-networks. The sub-network analysis included an analysis of the top four collaboration areas,

where collaboration was the highest among actors. We also conducted a sub-network analysis of collaboration between just local actors, in order again to inform how localized the network is and how the system is impacted when international actors are removed.

COLLABORATION AREA ANALYSIS

The top four collaboration areas found in the network were Coordination, Advocacy, Community Capacity Building, and Climate Change and Adaptation. These represent the areas where district, national, and international actors are collaborating the most to exchange information, ideas, and support.

In each of the four sub-networks, the same five key actors identified in the full network analysis were found to have the highest number of relationships across all four collaboration areas (Mid-Sized INGO A, Mid-Sized Local NGO B, Large International Organization C, Mid-Sized Local NGO D, and Small Local Government Entity E). These actors also appear to have many common contacts and connections with each other, with Coordination being the most interconnected collaboration area. This may be explained, as mentioned above, by these organizations' long-standing history in the system.

For each of these top collaboration area sub-networks we find a more *decentralized* network structure. In decentralized networks, the flow of information can be controlled or managed by a few key central actors. In the case of these areas, the central actors are the same top five collaboration hubs mentioned earlier. The risk over time is that this may lead to bottlenecks and peripheral actors becoming dependent upon those central actors. A more resilient system would ideally move towards a more *distributed* structure, where there is greater cohesion and links between multiple actors in the network, allowing for a more equal flow of information to all actors in the network. Annex G provides an overview of these network structures.

Each the four collaboration areas also have a small number of isolates or islands that appear in each network. An example of this is seen with the Coordination sub-network in Figure 9. See Annex F for visualizations of the top four collaboration areas and a summary of network health, including the top 10 actors in this network broken down by whether they are district, national or international.

COORDINATION NETWORK

This network has 62 actors that reported 113 relationships with one another. On average, each organization in the network has about

3.6 relationships. There are no reciprocal relationships, or bidirectional relationships between two organizations, in this sub-network, so that means each organization knows about 3.6 actors. The network density is 0.03, meaning that around 3% of all possible ties between organizations exist. This is denser than the full network. On average, each organization's resources, ideas, or support has the potential to reach 17.8% of other organizations.

ADVOCACY NETWORK

The second largest collaboration area was the Advocacy network. The top three actors by total number of relationships for the advocacy network were: Mid-Sized Local NGO B, Mid-Sized INGO A, and Mid-Sized Local NGO D. See Annex F for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international. Important to note when looking at the network image is that, in all network images, the actors are sized by number of relationships in the full network. We can easily see that density is lower in this network because there are fewer lines between the actors.

This network has 62 actors that reported 89 relationships with one another. On average, each organization in the network has about 2.9 relationships and knows about 2.8 actors.

The network density is 0.024, meaning that around 2.4% of all possible ties between organizations exist. This network has the same density as the full network. Around 4.5% of relationships are reciprocal, or bidirectional between two organizations. On average, each organization's resources, ideas, or support has the potential to reach 8.4% of other organizations, which is much lower than the other networks we have explored so far.

COMMUNITY CAPACITY BUILDING NETWORK

The third largest collaboration area was the Community Capacity Building network. The top three actors by total number of relationships for the advocacy network were: Large International Organization C, Mid-Sized Local NGO B, and Mid-Sized INGO A. See Annex F for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international. We can easily see the large number of relationships that Large International Organization C has compared to other organizations in the network by looking at the red lines coming from this actor.

This network has 54 actors that reported 88 relationships with one another. On average, each organization in the network has about 3.3 relationships. There are no reciprocal relationships, or bidirectional relationships

between two organizations, in this sub-network, so that means each organization knows about 3.3 actors. The network density is 0.031, meaning that around 3.1% of all possible ties between organizations exist. This network is denser than the advocacy network, even though there are no reciprocal ties. On average, each organization's resources, ideas, or support has the potential to reach 11.7% of other organizations, which is also higher than the advocacy network above.

CLIMATE CHANGE ADAPTATION NETWORK

The final collaboration area we explored was Climate Change Adaptation, due to the focus of this study. This network came in as the fourth largest network when looking at number of relationships. While we no longer have redundancy of relationships (as we are pulling out only one collaboration area), we again are looking at the network of all actors who have relationships in this collaboration area.

This network has 52 actors that reported 76 relationships with one another. On average, each organization in the network has about 2.9 relationships. There is only one reciprocal relationship, or a relationship that is bidirectional between two organizations, in this sub-network. That relationship is between Mid-Sized INGO A and Mid-Sized Local NGO

B. The network density is 0.029, meaning that around 2.9% of all possible ties between organizations exist. This network is slightly denser than the full network. On average, each organization's resources, ideas, or support has the potential to reach 10.4% of other organizations, which is lower than the full network.

The top three actors by total number of relationships for the climate change adaptation network were: Mid-Sized INGO A, Mid-Sized Local NGO B, and Mid-Sized Local NGO D. See Annex F for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international.

LOCAL ACTOR SUB-NETWORK ANALYSIS

To further understand local collaboration within the district and the level of localization, we removed international actors from the full network. This allowed us to visualize a network of only local actors and their connections with each other. When we did this, the local network went from 80 total actors down to 62 actors and from 1312 total relationships to 636 relationships. This means that by removing a total of 18 international actors the network lost 51% of relationships. This is quite high, considering the fact that international actors only account for 22% of the network actors.

The loss of these international actors also made 13 local actors isolates; you can see these actors in Figure 10. This demonstrates a potential weakness in the resilience of this system and local actors' ability to maintain coordination and collaboration if international actors withdraw their support.

The same top three local collaboration hubs, Mid-Sized Local NGO B, Mid-Sized Local NGO D, and Small Local Government Entity E maintained their position as collaboration hubs in the local network. See Annex F for a list of the top 25 actors in this network broken down by whether they work only at the district-level or work nationally.

The top collaboration areas in the local actor sub-network are: Coordination, Advocacy, Climate Change and Adaptation, and Community Capacity Building. These same four were the top collaboration areas in the full network, but Community Capacity Building was third, and Climate Change and Adaptation was fourth. Notable changes appear in the Project Implementation and Technical Assistance collaboration areas, which each lost 70% of relationships by removing international actors. Project Implementation fell from 73 relationships down to 20 relationships, and Technical Assistance moved from 72 relationships down to 22 relationships. This

indicates that, especially for these two areas, international actors are involved in most collaborations. For a full breakdown of the collaboration areas in the local sub-network, see Annex F.

In the local sub-network, there are 82 unique relationships, or relationships from one organization to another disregarding redundancy caused by collaboration areas. The average number of collaboration areas for which each organization goes to another organization is the same for the full network and the local sub-network, at about eight different collaboration areas. Each organization in the network on average has about 26 relationships and knows about 3 other organizations, which is one less organization than in the full network. The network density is 0.035, meaning that around 3.5% of all possible ties between organizations exist, which is a higher density than the full network. On average, each organization's resources, ideas, or support has the potential to reach 12.2% of other organizations, which is down from a reach of 17.8% in the full network.

The number of reciprocal ties went down from 7% to 2.4%, which is significant drop. This indicates that the majority of reciprocal ties are between international and local actors. The

low level of reciprocal ties between local actors could be another indication of a lack of joint-initiatives or co-creation between local actors.

Figure 9. Coordination Sub-Network

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:

▢ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
○ = Small (<100 employees)
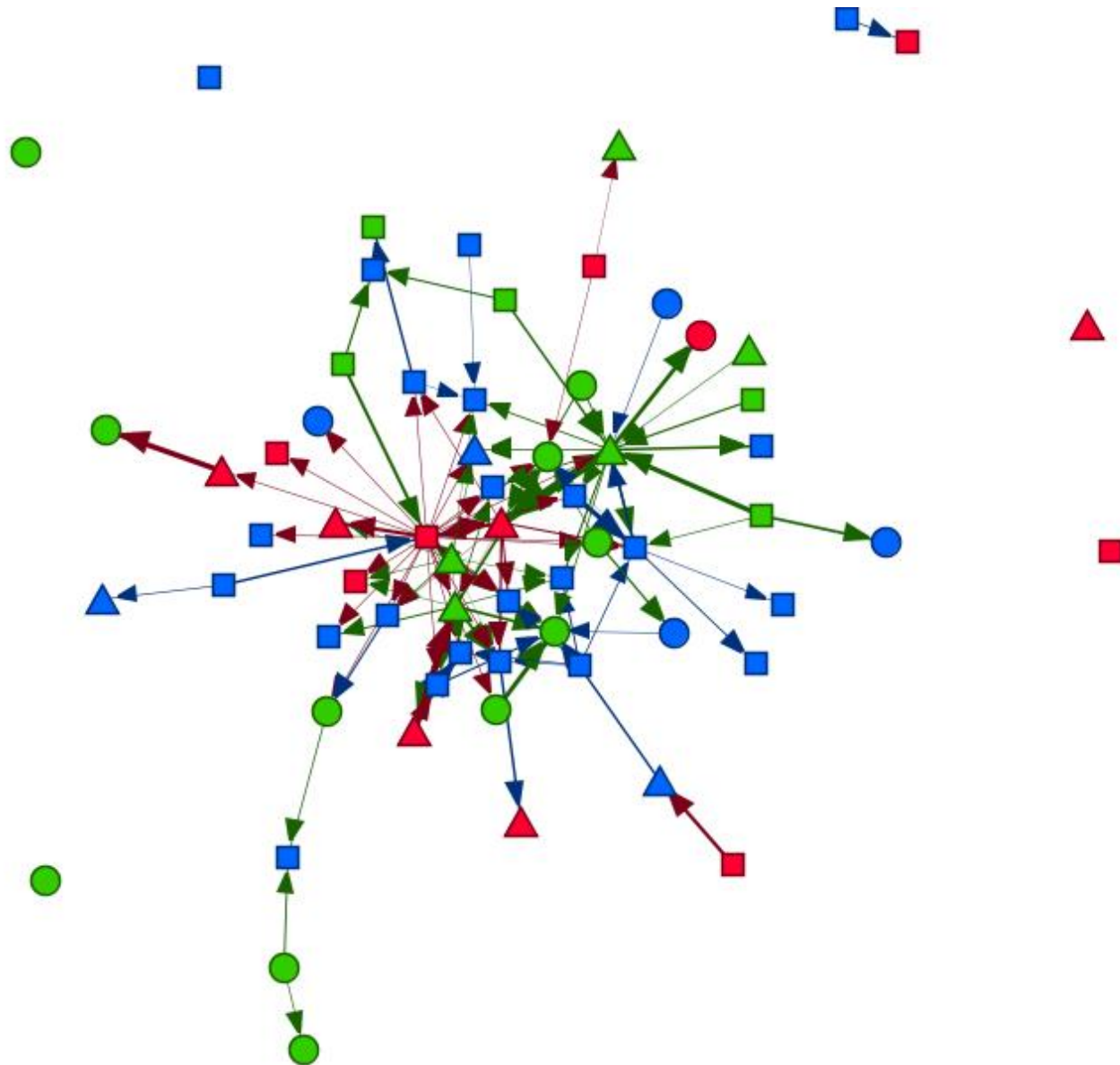
*Line thickness by Frequency of Interaction
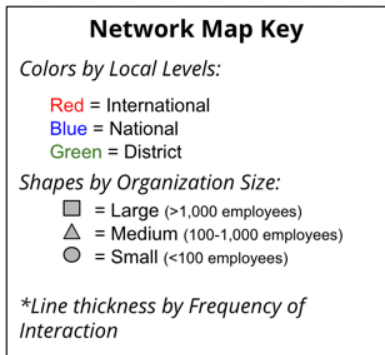
Figure 10. Local Actor Sub-Network, with International Actors Removed

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:

□ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
○ = Small (<100 employees)

Line thickness by Frequency of Interaction
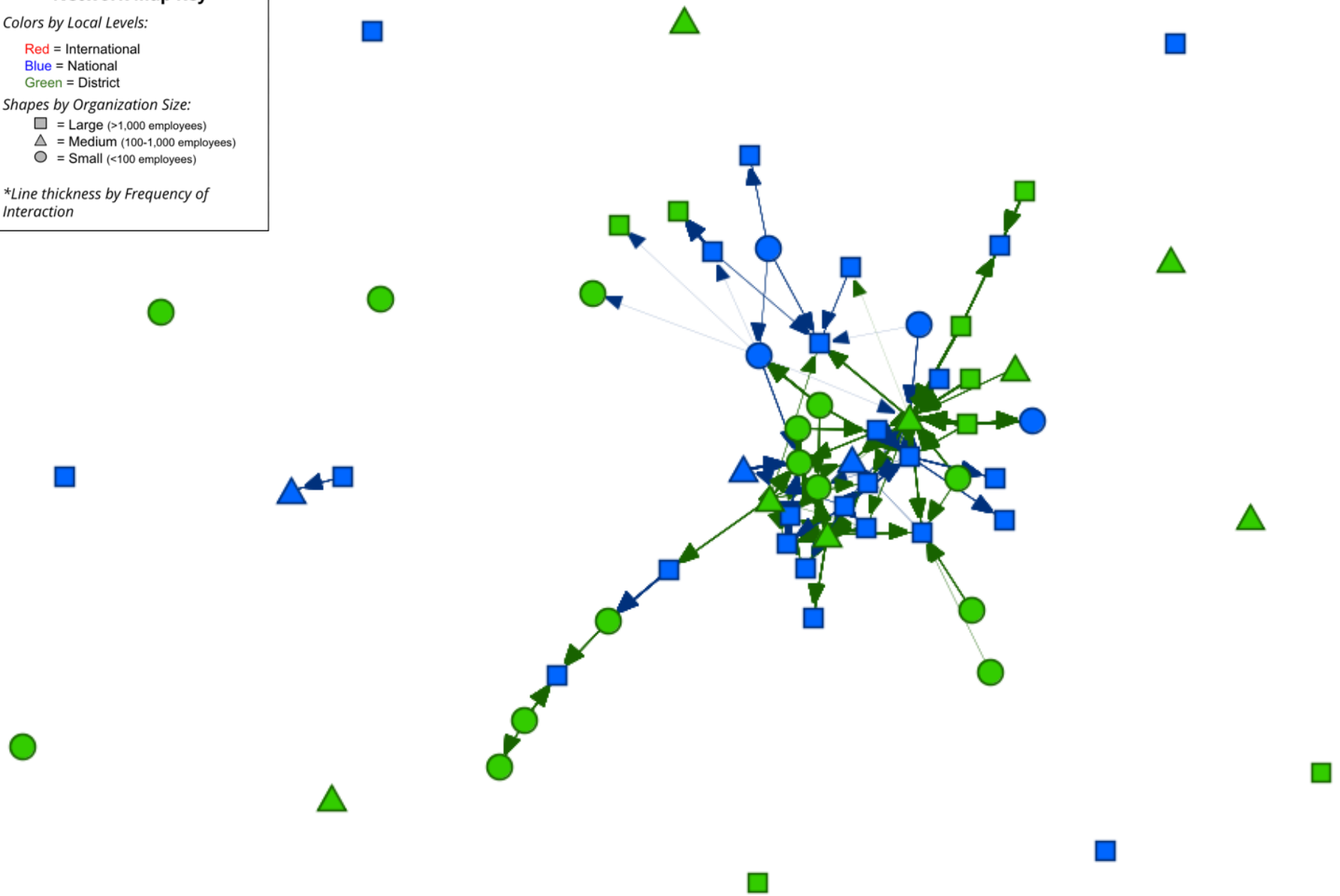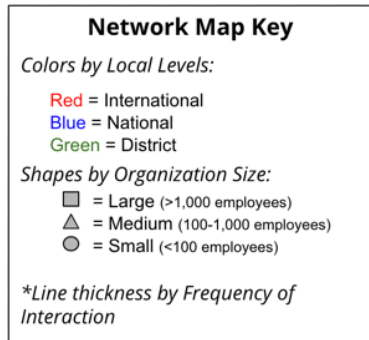
CONCLUSION

In summary, this network analysis reveals a fairly localized, fairly resilient network of climate change adaptation and disaster resilience organizations in Bagerhat district, Bagerhat. This paper presents key findings around localization, collaboaration patterns, engagement within and across sectors, and actor dominance within the network.

Key areas for exploration in efforts to advance resilience of the network include:

- Increasing collaboration between local actors, to support greater resilience when international actors withdraw their support. Multi-stakeholder platforms, such as social labs or collective impact strategies, that bring together diverse local actors to work towards a common agenda on issues related to climate change and disaster resilience may foster this collaboration. These platforms help to emphasize mutual accountability and co-creation between local actors and groups and can help to support local system self-reliance.
- Increasing engagement with academic institutions, CBOs, the media, and the private sector to draw on untapped potential resources and knowledge and further advance climate change and disaster resilience in Bagerhat district.
- Promoting greater exchange of information and learning between government departments working on climate change adaptation and resilience.
- Engaging organizations acting as the top collaboration hubs in the network discuss their role in the system and to determine if there are actions these actors are taking or could take to elevate other local actors who are providing expertise, resources, and support in the district. These key actors can also help to connect others the system, such as academic institutions, CBOs, media, and the private sector, to increase collaboration with these actors throughout the network.

ANNEXES

ANNEX A: PROTOCOL

INTRODUCTION

CONTEXT

Bangladesh is ranked seventh on the 1998–2017 Climate Risk Index of countries most affected by climate change; the country experienced 190 extreme weather events causing over 2.4 million USD in losses and 635.5 deaths annually during this period (1). Located on the Bay of Bengal and in the floodplains of several major rivers, Bangladesh is particularly vulnerable to tropical cyclones and seasonal flooding (2). These events, as well as drought, storm surges, soil salinization, and other climate change-related events, are predicted to increase in frequency and severity due to climate change (2). With a population of 164.67 million and a land mass of only 147.6 square kilometers, the country has one of the highest population densities in the world (3,4). This high population density, combined with high probability of natural disasters and low levels of development, make Bangladesh particularly vulnerable to climate change (5).

The country's low-elevation coastal zones are especially vulnerable to natural disasters, and have already begun to see the effects of climate change (6). These areas account for over 40 percent of the country's landmass and 49 percent of the country's total population (6). In recent years, these areas have been significantly impacted by cyclones, sea level rise, saltwater intrusion, coastal erosion, flooding, and more (5,7,8). Agriculture is a key economic activity; however, food yields in this region are threatened by increasing temperatures, unpredictability of monsoon rains, soil salinization, and limited availability of freshwater for consumption and irrigation (9). These effects have threatened livelihoods and food security and led to significant migration from coastal areas to inland cities (7,10–12). Thus, coastal communities in Bangladesh are of significant humanitarian concern due to their vulnerability to a range of natural disasters as well as more gradual, but very impactful, increasing threats from climate change (2).

POPULATION

While many low- and middle-income countries have a thriving community of international non-governmental organizations (INGOs), Bangladesh is unique in its long history of domestic and local non-governmental organizations (NGOs) working in disaster relief, livelihoods, and development (13–15). Following a series of deadly and destructive natural disasters in the 1990s, the government of Bangladesh, international donors, and international and domestic NGOs invested in disaster risk reduction and preparedness. These efforts led to reduced loss of life in future cyclones and floods (16). However, significant challenges remain. While many government, INGOs, and local NGOs mobilized to provide disaster relief following Cyclone Sidr in 2007 and Cyclone Aila in 2009, studies have shown that lack of coordination between actors hindered efficient delivery of services (17,18).

This research will focus specifically on actors in the disaster resilience and climate change adaptation spaces that work in Bagerhat district in Bangladesh. This district is highly vulnerable in terms of food and water insecurity, poverty, and health, and is also vulnerable to disasters and climate change impacts (19). The district was heavily impacted by Cyclone Sidr, and is experiencing sea level rise and saltwater intrusion – World Bank estimates from 2014 project that freshwater

zones in Bagerhat district will be reduced by 71-93 percent by 2050 (31).

THE VALUE OF A NETWORK ANALYSIS APPROACH

Mapping stakeholders working to advance climate change adaptation and disaster resilience is a crucial first step to support institutional strengthening and capacity building (22). A number of studies of recent emergencies in Bangladesh, including Cyclone Sidr in 2007, Cyclone Aila in 2009, and the ongoing Rohingya refugee crisis, recommend mapping local organizations to promote capacity building and coordination and to strengthen disaster management and response (17,18,23). Due to the number of actors involved in disaster management and response, coordination among actors during an emergency is crucial for an effective, efficient response (24,25). Studies have shown that the existence of pre-disaster relationships between actors can strengthen the speed with which coordination occurs in a disaster setting, making relationship-building before a disaster an important element of preparedness (24,25).

Network analysis techniques seek to illustrate and analyze formal and informal connections between actors to build an understanding of a network structure (24–26). Through this analysis, processes of network governance,

influential actors, social capital, and information flows become apparent (24–26). This information is key to understanding how these networks are able to leverage social capital, exchange ideas, and work effectively and efficiently before, during, and after a disaster (27). It can also be used to support interventions to increase coordination and collaboration between stakeholders to support disaster preparedness and climate change adaptation activities (27).

STUDY PURPOSE AND RELEVANCE OF FINDINGS

The study has two primary aims:

1)   To understand the relationships among actors supporting climate change adaptation and disaster resilience work among coastal communities in Bagerhat district, Bangladesh, and

2)   To develop a representation of the disaster risk and resilience system in Bagerhat through a depiction of the structure and characteristics of the relationships among the actors that make up the system.

The results of the proposed study will be used to inform a research agenda and programs for Harvard Humanitarian Initiative (HHI) and other in-country partners to strengthen

disaster resilience and climate change adaptation in these communities. This study will adapt the Disasters and Emergency Preparedness Programme (DEPP) evaluation's network analysis approach to the context of coastal Bangladesh. The DEPP evaluation, funded by the UK Department for International Development (DFID), conducted an analysis of actors in four DEPP countries to understand network structures in these countries (27).

The findings of this study could be used in a number of ways. For example, developing an understanding of the actors and dynamics within the implementation environment could be used to design strategies to connect local actors in the district to national and international platforms during disasters. This information could also inform the creation of more effective means of collaboration, utilizing and strengthening existing relationships and platforms to more effectively share information, coordinate work, and mobilize resources before, during, and after emergencies.

This research approach is being utilized in both the Philippines and Bangladesh by HHI's Program on Resilient Communities. If found to be effective in informing programs to strengthen coastal community resilience and actor coordination, this protocol could be

rolled out to rapidly assess the actor landscape in other coastal areas in South East Asia or elsewhere in the world to inform program design.

METHODS

DESIGN

The study will utilize a quantitative survey and network analysis of actors working in the disaster resilience and climate change adaptation spaces among coastal communities in Bagerhat district, Bangladesh. As described above, the study will adapt the quantitative survey used by Pham, et al (unpublished) to study connections between humanitarian actors in the Philippines, Kenya, Ethiopia, and Myanmar as part of the DEPP project (27). The survey will include questions about respondent organizations' size, funding for resilience and response activities, and types of resilience and response activities conducted. It will also ask respondents to identify the organizations with which they collaborated in the past six months, and will ask questions regarding the nature and frequency of these collaborations as well as trust in partner organizations.

SAMPLING

As conducted in Pham, et al (unpublished), surveys will be conducted with established

actors in-country (27). The survey is designed to provide results that are representative of the organizations working in Bagerhat District, Bangladesh. The sample population will comprise all organizations (international and local NGOs, government actors, private sector, academic and research institutions, and community-based organizations) doing work related to climate change adaptation and disaster resilience in coastal communities in Bagerhat district. The initial sample will be based on a list of NGOs and other humanitarian and climate-change-related actors registered with the district government. This initial set of actors will be asked to participate in the survey, and any additional actors identified as collaborating organizations through initial round surveys will also be asked to participate using a snowball sampling approach (27).

NGOs will be eligible to participate if they work in Bagerhat district and conduct any climate change adaptation or disaster resilience work. In-country partners estimate that there are approximately 50 organizations that are eligible to participate in this research.

The recruitment process will be as follows:

1.   Introduction by a partner organization (JJS) staff member to colleagues at eligible organizations identified in the Bagerhat District

Government's list of registered organizations. When contact is made, the research team will provide information about the survey and request permission of the agency director for appropriate contact and permission to do the survey interviews.

2.   If no contact information for an organization is known, the research team will reach out to the communications person at eligible organizations and request permission of the agency director for appropriate contact and permission to do the survey interviews.

3.   Referrals to additional organizations identified by respondents during the will be used to identify contacts in additional eligible organizations, and outreach will proceed as in step 1.

DATA COLLECTION

The questionnaires will be programmed in KoBo Toolbox, an electronic data collection software, in both English and Bengali, so that participants will be able to take the survey in the language with which they are most comfortable. The research team will also be able to use the online platform to monitor incoming data for quality and to revise the survey as needed if issues arise. A similar, ongoing survey in the Philippines found that participants were not motivated to complete

the survey when asked by email or phone; as such, the surveys will be administered in person. Two local enumerators with experience conducting quantitative research and who are fluent in Bengali and English will be recruited to administer the survey.

Data will be collected between late June-early August 2019. A member of the HHI research team will train all enumerators and will supervise the piloting of the survey. She will accompany the enumerators for the first few weeks of research, or as long as is needed for the enumerators to feel comfortable using the tool. When the HHI research team, local partner organizations, and enumerators feel that that the enumerators are able to complete remaining data collection without on-the-ground support, the HHI team will supervise data collection remotely.

ANALYSIS AND REPORTING

Analysis of the data will include descriptive statistics and key indicators from the survey, as well as graphical representations of the network. Descriptive statistics will include number of organizations surveyed, average and range of organization sizes, average and range of percent of organization's funding devoted to disaster response and climate change adaptation, etc. Key indicators analyzed will include average number and

range of total and unique links per organization, collaboration areas per link, most common areas of collaboration, types of collaboration (formal or informal; mandated or self-initiated), frequency of collaboration, likelihood of recommendation, etc. (27). As much as possible, results will be stratified by type of NGO (INGO, local NGO; small, medium, large NGO; formal, informal partnership; etc.) to identify whether or not there are different patterns of networking and collaboration between types of organizations or in different types of collaborations.

In addition, network analysis maps will be presented to illustrate network density and key nodes in the network, with different symbols used for type of NGO and number of links. As was used in the DEPP evaluation, the statistical software package R will be used for network statistical significance tests, and the network data will be analyzed using ORA, a tool developed by CASOS at Carnegie Mellon for network analysis (27).

The study's preliminary results will be drafted and participating organizations will be invited to a results validation workshop to review the data, provide feedback on the key trends identified, and collaborate to identify next steps and additional research questions to inform future studies. After this workshop, the

report will be revised as needed and submitted to a peer-reviewed journal.

ETHICS

To ensure protection of survey respondents and local acceptability of the research, the study protocol and questionnaire has been approved by the Harvard T.H. Chan School of Public Health's Institutional Review Board (IRB) as Non-Human Subjects Research. Because the research only collects data regarding organizations, and not individuals, the approval of HHI's full Community Advisory Board (CAB) in Bangladesh will not be sought. However, the protocol has been shared with members of the CAB for their feedback and insights. In order to protect the identify of individual survey respondents, surveys will be de-identified. Respondents will be fully informed of the study purpose and intended use of the data. All respondents will be informed that their participation is voluntary and that they are free to leave at any time and/or skip any question they are uncomfortable answering. All respondents will be asked to provide informed consent before participating in the survey.

Local researchers fluent in Bengali and English will be recruited to administer the survey, and will be trained in the use of Kobo Toolbox, the questionnaire, and research ethics by the study

team before data collection begins. The instruments will be piloted with local partner organizations to ensure that questions are clear and acceptable within the local context, and the team will have regular debriefing and review sessions to ensure quality and to refine the survey as needed if issues arise.

LIMITATIONS

It is important to recognize that the network structure and relationships captured in a network analysis are dynamic (25). Similarly, the activities actors conduct will change rapidly due to funding cycles, changes in community needs, etc. The network described in this paper will change over time as actors enter and exit the space, and as new relationships form and previous relationships fade. While this network analysis is helpful in informing current programs, these results should only be used to understand the landscape of actors at the time the study was conducted. It will be important to conduct follow-up studies to observe changes in the network to inform future programs.

In addition, it is possible that the study will not be able to identify all actors working in the study areas. Some local organizations may not be registered with the district government, and may not be identified by survey respondents.

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ANNEX B: ZOOM IN OF FULL NETWORK IMAGE

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:

◻ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
○ = Small (<100 employees)

Size by Total Degree Centrality (number of relationships)

Line thickness by Frequency of Interaction
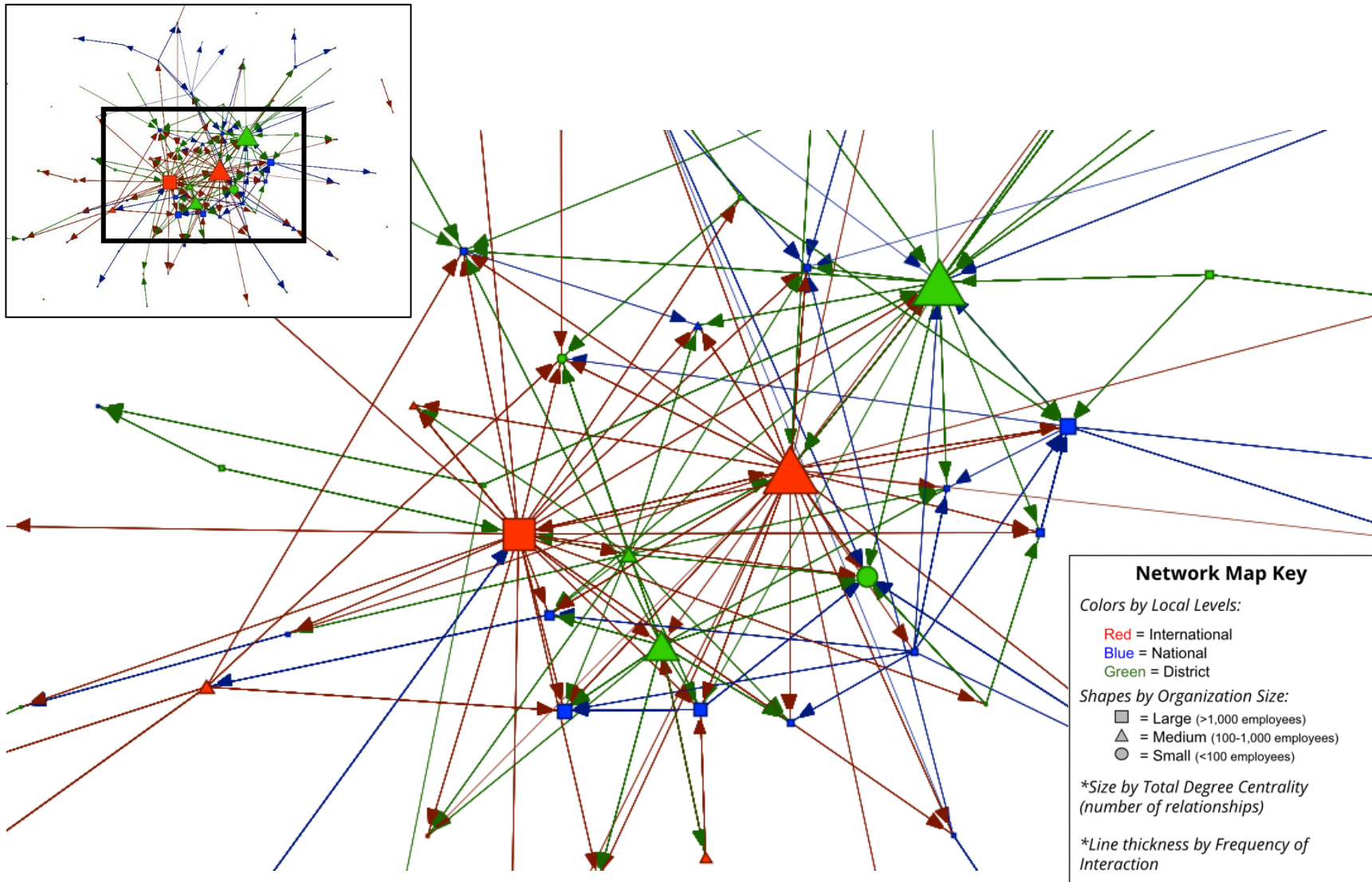
ANNEX C: OVERVIEW OF RELATIONSHIPS

COLLABORATION AREA COUNTS

Collaboration Area	No. of Relationships
Coordination	113
Advocacy	89
Community Capacity Building	88
Climate Change and Adaptation	76
Project Implementation	73
Technical Assistance	72
Funding	59
Facilitation	54
Community Connections	48
Community Planning	48
Research	47
Community-Based Risk Analysis	44
Volunteers and Volunteer staff	39
Water, Sanitation, and Hygiene	37
Agriculture Expertise	34
Project Design	30
Early Warning Systems Expertise	28
Local Expertise	27
Management	26
Leadership	24
Logistics	23
Food Security and Livelihoods Expertise	21
Vulnerable Groups Expertise	21

Proposal Writing	19
Monitoring, Evaluation, and Learning Expertise	17
Policy	15
Health/Public Health Expertise	15
Data Resources (including data sets, collection, and analysis)	15
Education	12
In-Kind Resources (e.g., meeting space)	11
Shelter Expertise	11
Conflict Mitigation Expertise	11
Child Protection Expertise	11
Finance Expertise (e.g., disaster insurance, loans, emergency funds, cash for work, mobile money, other financial tools)	10
Gender-based Violence Expertise	9
Nutrition Expertise	9
Emergency Telecommunications	7
Journalism/Media	3
Technology/web Resources (e.g. server space, web site development, social media)	3
Natural Resource Management	2
Input Support	2
Climate Mitigation	1
Work with Fisheries Community	1
Infrastructure	1
Mangrove Planting	1
Disaster Preparedness Planning	1
Polder Management	1
Migration	1
Wildlife Human Conflict	1
Tidal River Management	1

COLLABORATION TYPE AND REASON COUNTS

COLLABORATION TYPE COUNTS

Collaboration Type	No. of Relationships
Formal Contract	555
Information Sharing	464
Informal Partnership	285
Created During Project	6
None	2

COLLABORATION REASON COUNTS

Collaboration Reason	No. of Relationships
Mutual Interests	913
Funding Requirement	397
None	2

FOR WHAT REASONS ARE DIFFERENT TYPES OF COLLABORATION HAPPENING?

	Created During Project	Formal Contract	Informal Partnership	Information Sharing	None	Grand Total
Funding Requirement		243	149	5		397
Mutual Interests	6	312	136	459		913
None					2	2
Grand Total	6	555	285	464	2	1312

```
Pearson's Chi-squared test for significance between collaboration type and reason (table above):

X-squared = 1615.6, df = 8, p-value < 2.2e-16
```

RELATIONSHIP STRENGTH COUNTS

FREQUENCY COUNTS

Frequency	No. of Relationships
Often *(5 or more times in the past 6 months)*	992
Occasionally *(3-4 times in the past 6 months)*	234
Rarely *(1-2 times in the past 6 months)*	86

HOW LONG COUNTS

How Long	No. of Relationships
More than 15 years	451
10-15 years	331
5-10 years	120
3-5 years	97
1-3 years	291
Less than 1 year	22

LIKELIHOOD TO RECOMMEND COUNTS

Likelihood to Recommend	No. of Relationships
10 (Extremely likely)	414
9	251
8	242
7	146
6	161

5 *(Fairly likely)*	67
4	17
3	9
2	3
1 *(Not at all likely)*	2

CORRELATION OF RELATIONSHIP STRENGTH MEASURES

Pearson's product-moment correlation: Frequency of interaction, How long known the org, Likelihood to recommend

	Frequency	How Long	Likelihood to Recommend
Frequency	1.0000000	0.1263730 p-value = 4.401e-06	0.34714358 p-value < 2.2e-16
How Long	0.1263730 p-value = 4.401e-06	1.0000000	0.03689088 p-value = 0.1817
Likelihood to Recommend	0.34714358 p-value < 2.2e-16	0.03689088 p-value = 0.1817	1.0000000

ANNEX D: OVERVIEW OF ACTORS

LOCAL VERSUS INTERNATIONAL COUNTS

Local Actor	Actors	Percent
Yes	62	77.5%
No	18	22.5%

DISTRICT, NATIONAL AND INTERNATIONAL COUNTS

Local Actor	Actors	Percent
District	30	37.5%
National	32	40.0%
International	18	22.5%

ORGANIZATION TYPE COUNTS

Organization Type	Actors	Percent
Government (national, district, sub-district, union, municipality, ward)	24	30.0%
National NGO (has projects throughout the country)	12	15.0%
International NGO	11	13.8%
Local NGO (has projects in a specific locality or region within country)	9	11.3%
Community-based Organization / People's Organization	8	10.0%
Private Sector	7	8.8%
Academic Institution (University or College)	4	5.0%
International Organization (UN, IOM, World Bank, etc.)	4	5.0%
Media	1	1.3%

ORGANIZATION SIZE COUNTS

Organization Size	Actors	Percent
Large	41	51.3%
Medium	20	25.0%
Small	19	23.80%

ORGANIZATION FOCUS COUNTS

Organization Focus	Actors	Percent
Preparedness	56	70.0%
Resilience	62	77.5%
Response	55	68.8%
Adaptation	60	75.0%
Development	62	77.5%

ISOLATES

Organization Name	Local?	Organization Type	Organization Size
Small Local Media Actor AP	District	Media	Small
Large National Government Entity AQ	National	Government (national, district, sub-district, union, municipality, ward)	Large
Large Local Government Actor AR	District	Government (national, district, sub-district, union, municipality, ward)	Large
Mid-Sized Local CBO AS	District	Community-based Organization / People's Organization	Medium
Small Local CBO AT	District	Community-based Organization / People's Organization	Small
Large Local CBO AU	District	Community-based Organization / People's Organization	Large
Mid-Sized Local CBO AV	District	Community-based Organization / People's Organization	Medium
Mid-Sized International Private Company AW	International	Private Sector	Medium

COLLABORATION PATTERNS BETWEEN AND ACROSS GROUPS OF ACTORS

How to read these tables: Each row represents the possible choices for that attribute (i.e., District versus National). The internal-external column is the total number of relationships in the network that are between actors of that group and actors of any other group (i.e., NGOs and not NGOs). The internal-internal column is the total number of relationships in the network that are between actors of that group (i.e., NGOs to NGOs). The total is the total number of relationships that the group has (i.e., all NGOs in the network).[3]

The E-I index number is a standard SNA calculation that takes the number of external ties, subtracts the number of internal ties and divides by the total number of ties for that group to get a ratio of external to internal ties ranging from -1 to 1, with -1 representing all internal ties, 1 representing all external ties, and 0 representing an even number of external and internal ties.[4]

ARE LOCAL AND INTERNATIONAL ACTORS COLLABORATING?

	internal-external	internal-internal	total	ei index
Local	609	636	1245	-0.022
International	609	67	676	0.802

ARE DISTRICT AND NATIONAL ACTORS COLLABORATING?

	internal-external	internal-internal	total	ei index
District	342	151	493	0.387
National	342	143	485	0.410

---

[3] Note that these calculations ignore tie directionality, and instead focus on which two actors are connected. Therefore, summing tie counts vertically in these tables can add up to more than the total number of ties in the network, especially when looking at attributes that have more than two choices (i.e., organization type, organization size) or where actors could belong to more than one group (i.e., organization focus). Therefore, totals are only provided horizontally. These sums can be used to determine ratio of total network relationships that include this actor type by dividing by the total number of relationships in the network (1312).

[4] https://faculty.ucr.edu/~hanneman/nettext/C8_Embedding.html#EI

IS THERE CROSS-COLLABORATION BETWEEN DIFFERENT ACTOR TYPES?

	internal-external	internal-internal	total	ei index
Local NGO (has projects in a specific locality or region within country)	561	28	589	0.905
Government (national, district, sub-district, union, municipality, ward)	720	10	730	0.973
National NGO (has projects throughout the country)	357	7	364	0.962
International NGO	387	16	403	0.921
Community-based Organization / People's Organization	30	0	30	1.000
Private Sector	63	0	63	1.000
Academic Institution (University or College)	64	5	69	0.855
International Organization (UN, IOM, World Bank, etc.)	300	5	305	0.967
Media	0	0	0	0.000

IS THERE CROSS-COLLABORATION BETWEEN DIFFERENT ORGANIZATION SIZES?

	internal-external	internal-internal	total	ei index
Small	307	57	364	0.687
Large	661	273	934	0.415
Medium	702	147	849	0.654

ARE ORGANIZATIONS COLLABORATING WITH THOSE WHO HAVE THE SAME FOCUS?

	internal-external	internal-internal	total	ei index
Preparedness	350	947	1297	-0.460
DRR Resilience	254	1058	1312	-0.613
Response	336	960	1296	-0.481
Adaptation	359	953	1312	-0.453
Development	231	1081	1312	-0.648

HOW MUCH DO DRR/RESILIENCE, ADAPTATION, AND DEVELOPMENT OVERLAP?

Reading this table: Each cell represents relationship counts. Options for each organization focus were either true, meaning "I do this kind of work," or false, meaning "I do not do this kind of work." Since the table below combines three choices, two choices are represented in the various rows in the left-hand column: DRR and Adaptation. The reader must therefore choose the combination of DRR and adaptation that she wishes to explore before looking across to the Development column. The first row, for example, only combines DRR FALSE with the two choices (FALSE/TRUE) for Development. The second row, however, since it is under DRR, combines all three variables and shows relationship counts for DRR FALSE and Adaptation FALSE plus either Development FALSE or Development TRUE depending if you are looking at the second or third column of the table.

(Number of Actors)	Development FALSE	Development TRUE	Grand Total
DRR FALSE	5	13	18
Adaptation FALSE	2	9	11
Adaptation TRUE	3	4	7
DRR TRUE	13	49	62
Adaptation FALSE	6	3	9
Adaptation TRUE	7	46	53
Grand Total	18	62	80

ADDITIONAL COLLABORATION PATTERNS BETWEEN ACTOR GROUPS

HOW LONG HAVE DISTRICT, NATIONAL AND INTERNATIONAL ACTORS BEEN COLLABORATING?

Each cell represents relationship counts.

	Less than 1 year	1-3 years	3-5 years	5-10 years	10-15 years	more than 15 years	Total
District - District			6	8	59	78	151
District - National	9	28	20	47	86	152	342
District - International		65	33	9	96	79	282
National - National	11	26	17	4	5	80	143
National - International	2	106	21	51	85	62	327

International - International		66		1			67
Total	22	291	97	120	331	451	1312

DO DIFFERENT TYPES OF ORGANIZATIONS COLLABORATE IN DIFFERENT WAYS?

Each cell represents relationship counts. Note this table looks at outgoing relationships (i.e., why are these actors going to others?).

	Created During Project	Formal Contract	Informal Partnership	Information Sharing	None	Grand Total
Academic Institution (University or College)		14				14
Community-based Organization / People's Organization		11				11
Government (national, district, sub-district, union, municipality, ward)		56	40	39	2	137
International NGO		85	93	71		249
International Organization (UN, IOM, World Bank, etc.)		98	5	130		233
Local NGO (has projects in a specific locality or region within country)	6	217	95	136		454
National NGO (has projects throughout the country)		44	52	88		184
Private Sector		30				30
Grand Total	6	555	285	464	2	1312

ANNEX E: KEY ACTORS

For the tables in this annex, the following was used:

I = International Actor (red)

N = National Actor (blue)

D = District Actor (green)

TOP 25 TOTAL DEGREE CENTRALITY

Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Mid-Sized INGO A	I	240
2	Mid-Sized Local NGO B	D	235
3	Large International Organization C	I	201
4	Mid-Sized Local NGO D	D	154
5	Small Local Government Entity E	D	102
6	Large National Government Entity F	N	94
7	Large National Government Entity G	N	88
8	Large National NGO H	N	83
9	Mid-Sized Local NGO I	D	73
10	Mid-Sized International Organization J	I	66
11	Large National Government Entity K	N	59
12	Small Local Government Entity L	D	50
13	Large Local NGO M	D	50
14	Large National NGO N	N	48
15	Mid-Sized INGO O	I	48
16	Large National Government Entity P	N	44

17	Large National Government Entity Q	N	43
18	Large National NGO R	N	42
19	Mid-Sized National NGO S	N	41
20	Large National Government Entity T	N	40
21	Mid-Sized Local NGO U	D	37
22	Mid-Sized International Organization V	I	36
23	Large National Academic Institution W	N	33
24	Mid-Sized National Government Entity X	N	31
25	Large National Academic Institution Y	N	31

TOP 25 UNIQUE DEGREE CENTRALITY

Unique Un-directional Degree Centrality - Know the most actors			
Rank	Name	Local?	Degree
1	Mid-Sized INGO A	I	31
2	Large International Organization C	I	29
3	Mid-Sized Local NGO B	D	22
4	Mid-Sized Local NGO I	D	14
5	Mid-Sized Local NGO D	D	13
6	Large National Government Entity F	N	11
7	Small National NGO Z	N	10
8	Small Local Government Entity E	D	9
9	Large National Government Entity P	N	9
10	Small Local Government Entity L	D	8
11	Large National Government Entity Q	N	8
12	Large National NGO H	N	8
13	Large National NGO R	N	8
14	Large National Government Entity G	N	7
15	Large National Government Entity K	N	7

16	Large National Academic Institution W	N	6
17	Mid-Sized International Organization J	I	6
18	Large National NGO N	N	5
19	Small National NGO AA	N	5
20	Mid-Sized National Government Entity X	N	5
21	Large National NGO AB	N	5
22	Large National Government Entity T	N	5
23	Small Local NGO AC	D	4
24	Large INGO AD	I	4
25	Mid-Sized National NGO S	N	4

TOP 25 BROKERS

Betweenness Centrality - Brokers			
Rank	Name	Local?	Broker Score
1	Mid-Sized Local NGO B	D	0.094
2	Mid-Sized INGO A	I	0.076
3	Large International Organization C	I	0.041
4	Large National Government Entity F	N	0.025
5	Small National NGO Z	N	0.022
6	Large National Government Entity K	N	0.009
7	Large National NGO N	N	0.008
8	Small National NGO AA	N	0.007
9	Mid-Sized International Organization J	I	0.007
10	Large National Academic Institution Y	N	0.006
11	Mid-Sized Local NGO D	D	0.005
12	Large INGO AD	I	0.003
13	Mid-Sized National NGO S	N	0.003
14	Large National NGO AB	N	0.003

15	Large National Government Entity AE	N	0.003
16	Mid-Sized International Organization V	I	0.003
17	Large National NGO AF	N	0.001
18	Large National NGO H	N	0.001
19	Large National Government Entity P	N	0.001
20	Small Local NGO AG	D	0.001
21	Small Local NGO AC	D	0.000
22	Mid-Sized Local NGO I	D	0.000

TOP 25 INFLUENCERS

Eigenvector Centrality - Influencers			
Rank	Name	Local?	Influencer Score
1	Small Local Government Entity E	D	0.355
2	Large National Academic Institution W	N	0.299
3	Small Local Government Entity L	D	0.274
4	Large National Government Entity Q	N	0.269
5	Mid-Sized National Government Entity X	N	0.258
6	Large National Government Entity G	N	0.254
7	Large National Government Entity F	N	0.253
8	Large National Government Entity P	N	0.227
9	Large National Government Entity K	N	0.220
10	Mid-Sized Local NGO B	D	0.218
11	Large National NGO H	N	0.214
12	Large National NGO N	N	0.167
13	Large National NGO AH	N	0.149
14	Large National Academic Institution Y	N	0.135
15	Large National Private Company AI	N	0.135
16	Large National Government Entity T	N	0.133

17	Mid-Sized INGO A	I	0.119
18	Large INGO AJ	I	0.114
19	Large National Government Entity AK	N	0.104
20	Large National Academic Institution AL	N	0.102
21	Large National NGO AB	N	0.097
22	Mid-Sized International Organization J	I	0.088
23	Small INGO AM	I	0.087
24	Mid-Sized Local NGO D	D	0.084
25	Large National NGO AF	N	0.080

ANNEX F: SUB-NETWORKS

For the tables in this annex, the following was used:

I = International Actor (red)

N = National Actor (blue)

D = District Actor (green)

COORDINATION NETWORK

This network has 62 actors that reported 113 relationships with one another. On average, each organization in the network has about 3.6 relationships. There are no reciprocal relationships, or bidirectional relationships between two organizations, in this sub-network, so that means each organization knows about 3.6 actors. The network density is 0.03, meaning that around 3% of all possible ties between organizations exist. This is denser than the full network. On average, each organization's resources, ideas, or support has the potential to reach 17.8% of other organizations.

Collaboration Hubs, Coordination Network

Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Large International Organization C	I	31
2	Mid-Sized Local NGO B	D	18
3	Mid-Sized Local NGO D	D	13
4	Mid-Sized Local NGO I	D	12
5	Large National Government Entity F	N	11
6	Mid-Sized INGO A	I	10
7	Small Local Government Entity E	D	8
8	Large National Government Entity K	N	6
9	Small Local Government Entity L	D	5
10	Large National Government Entity Q	N	5

COORDINATION NETWORK MAP

Network Map Key

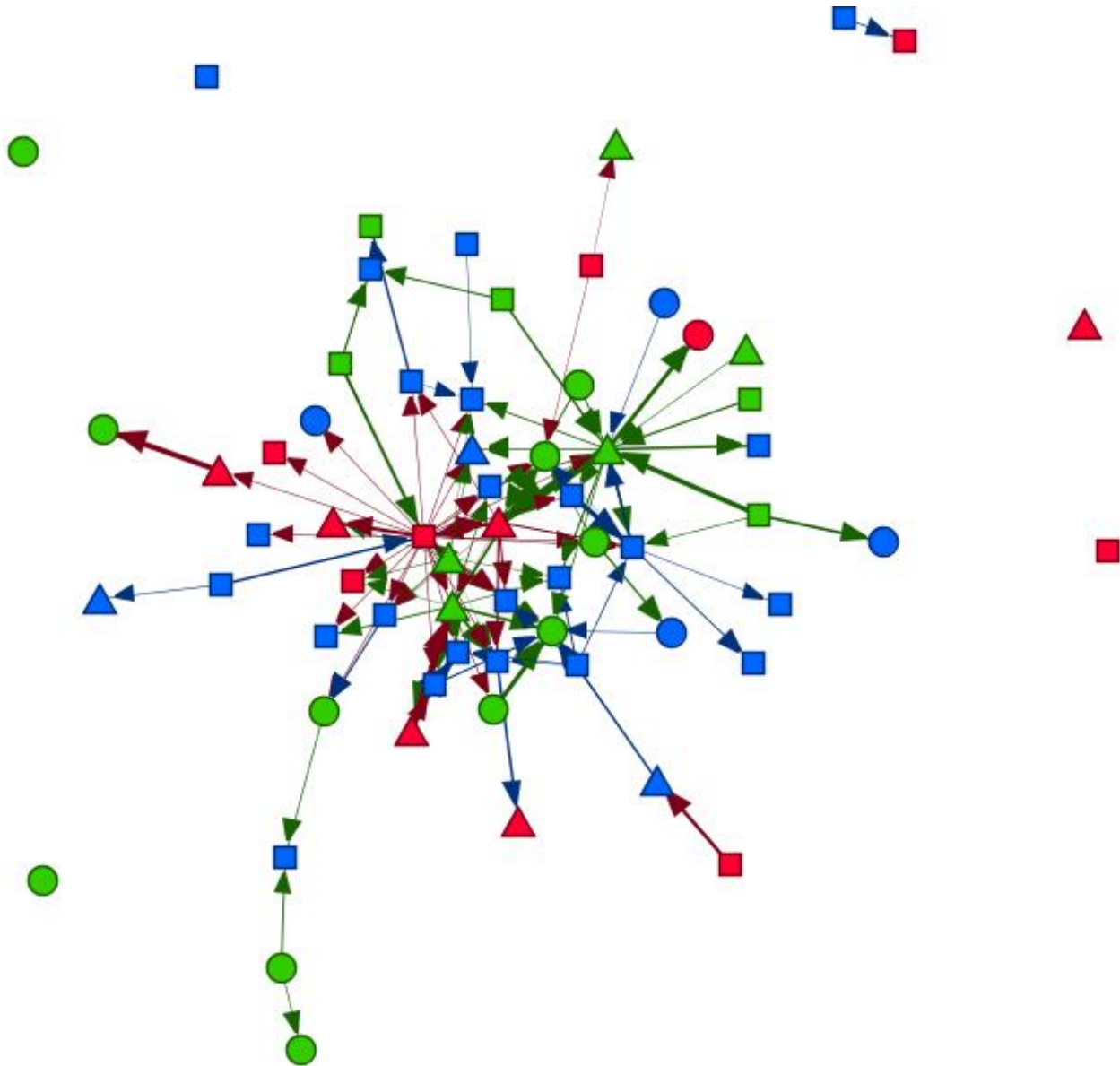*Colors by Local Levels:*

Red = International
Blue = National
Green = District

Shapes by Organization Size:

☐ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
◯ = Small (<100 employees)

Line thickness by Frequency of Interaction

ADVOCACY NETWORK

The second largest collaboration area was the Advocacy network. See the table below for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international. Important to note when looking at the network image is that, in all network images, the actors are sized by number of relationships in the full network. We can easily see that density is lower in this network because there are fewer lines between the actors.

This network has 62 actors that reported 89 relationships with one another. On average, each organization in the network has about 2.9 relationships and knows about 2.8 actors. The network density is 0.024, meaning that around 2.4% of all possible ties between organizations exist. This network has the same density as the full network. Around 4.5% of relationships are reciprocal, or bidirectional between two organizations. On average, each organization's resources, ideas, or support has the potential to reach 8.4% of other organizations, which is much lower than the other networks we have explored so far.

Collaboration Hubs, Advocacy Network

| Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Mid-Sized Local NGO B	D	16
2	Mid-Sized INGO A	I	16
3	Mid-Sized Local NGO D	D	11
4	Large National Government Entity F	N	10
5	Mid-Sized Local NGO I	D	9
6	Small Local Government Entity E	D	7
7	Small Local Government Entity L	D	5
8	Large National Government Entity P	N	5
9	Large National NGO H	N	5
10	Large National Government Entity G	N	5

ADVOCACY NETWORK MAP

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:
▢ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
◯ = Small (<100 employees)

Line thickness by Frequency of Interaction
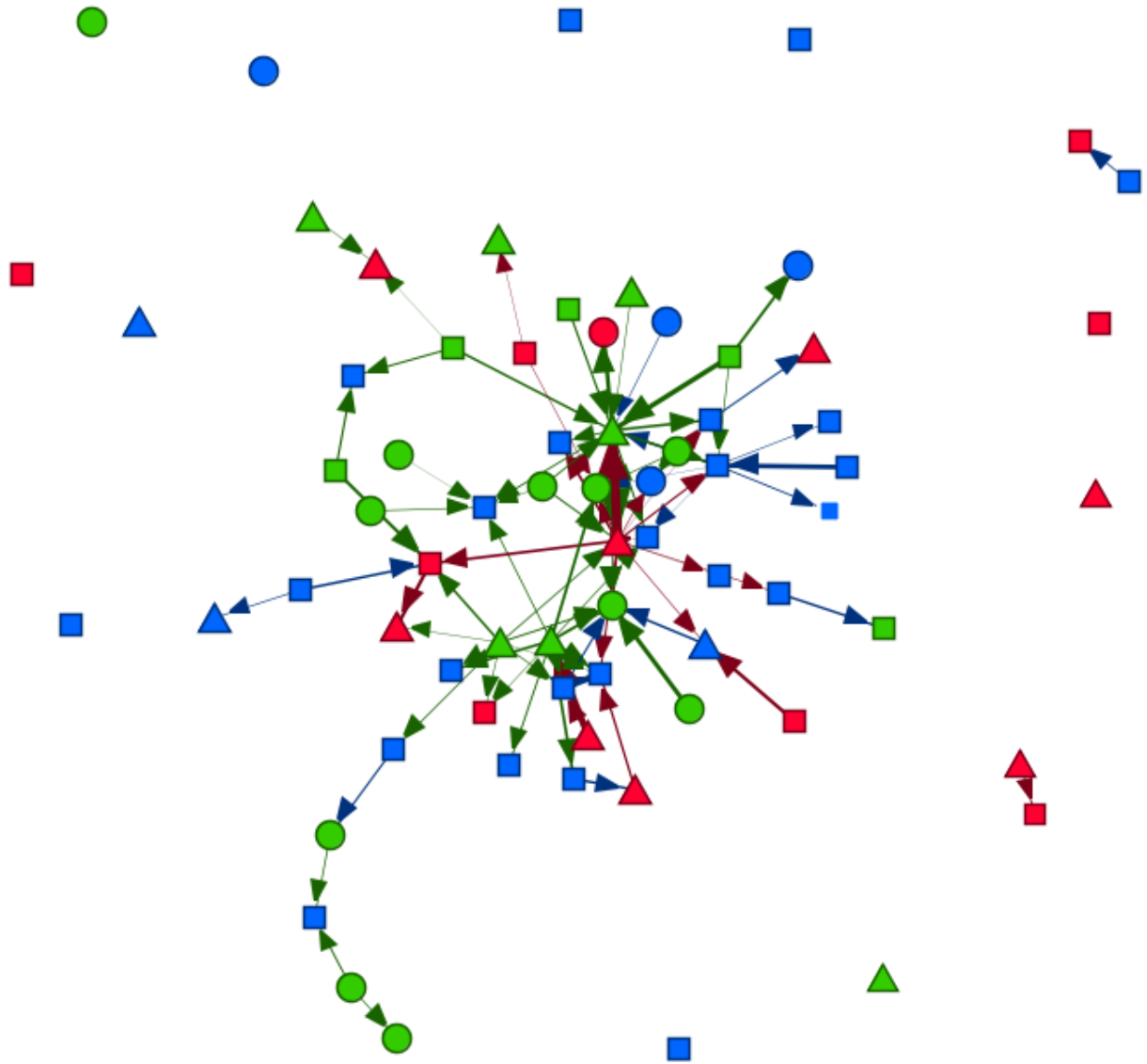
COMMUNITY CAPACITY BUILDING NETWORK

The third largest collaboration area was the Community Capacity Building network. See the table below for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international. Important to note when looking at the network image above is that in all network images the actors are sized by number of relationships in the full network. We can easily see the large number of relationships that Large International Organization C has compared to other organizations in the network by looking at the red lines coming from this actor.

This network has 54 actors that reported 88 relationships with one another. On average, each organization in the network has about 3.3 relationships. There are no reciprocal relationships, or bidirectional relationships between two organizations, in this sub-network, so that means each organization knows about 3.3 actors. The network density is 0.031, meaning that around 3.1% of all possible ties between organizations exist. This network is denser than the advocacy network, even though there are no reciprocal ties. On average, each organization's resources, ideas, or support has the potential to reach 11.7% of other organizations, which is also higher than the advocacy network above.

Collaboration Hubs, Community Capacity Building Network

Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Large International Organization C	I	28
2	Mid-Sized Local NGO B	D	17
3	Mid-Sized INGO A	I	10
4	Large National Government Entity F	N	8
5	Small Local Government Entity E	D	8
6	Mid-Sized Local NGO D	D	7
7	Mid-Sized Local NGO I	D	6
8	Large National Government Entity K	N	5
9	Small National NGO Z	N	4
10	Large National Government Entity G	N	4

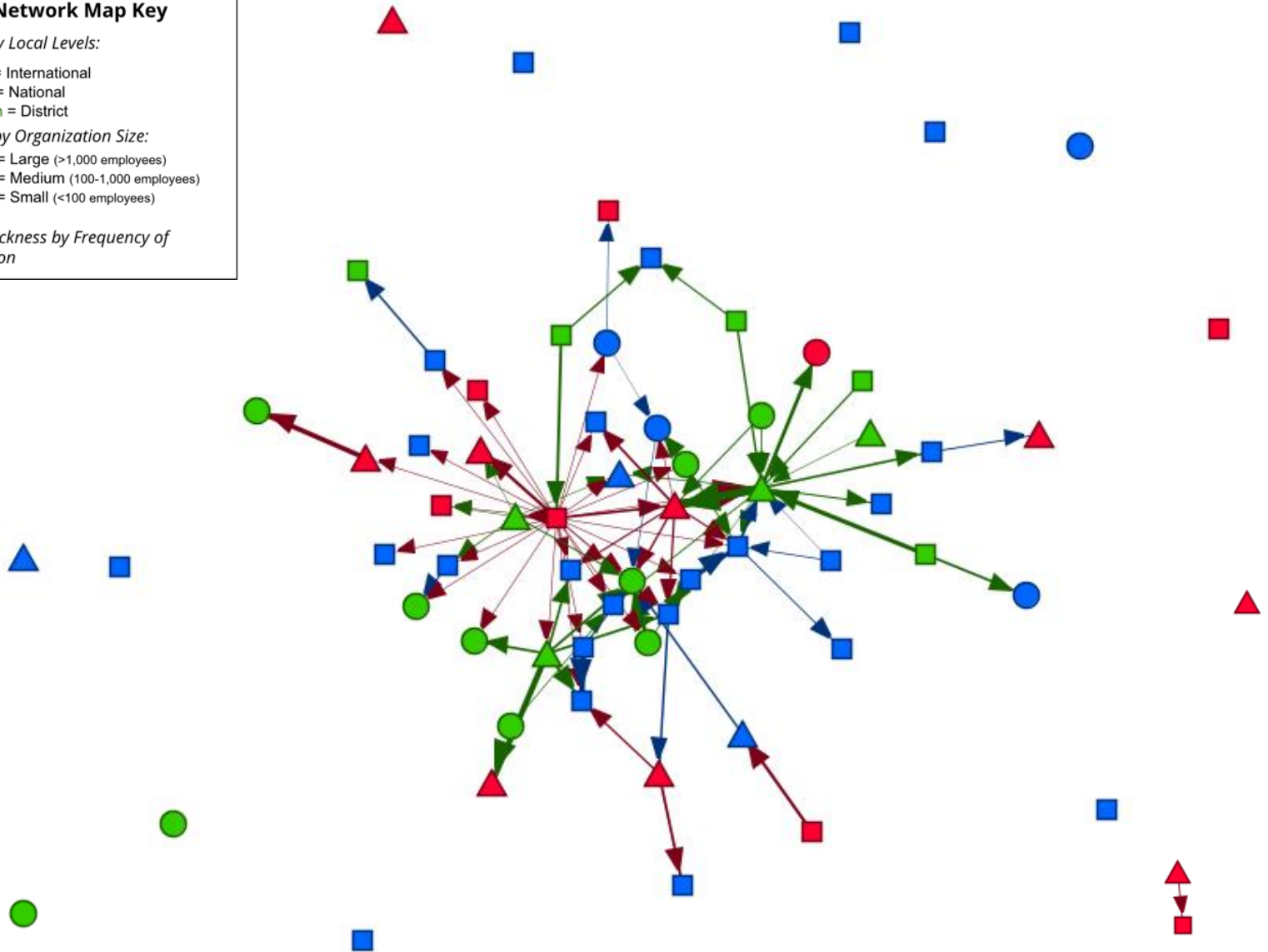# COMMUNITY CAPACITY BUILDING NETWORK MAP

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:
◻ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
◯ = Small (<100 employees)

Line thickness by Frequency of Interaction

CLIMATE CHANGE ADAPTATION NETWORK

The final collaboration area we explored was Climate Change Adaptation, due to the focus of this study. This network came in as the fourth largest network when looking at number of relationships. While we no longer have redundancy of relationships (as we are pulling out only one collaboration area), we again are looking at the network of all actors who have relationships in this collaboration area.

This network has 52 actors that reported 76 relationships with one another. On average, each organization in the network has about 2.9 relationships. There is only one reciprocal relationship, or a relationship that is bidirectional between two organizations, in this sub-network. That relationship is between and INGO and local NGO. The network density is 0.029, meaning that around 2.9% of all possible ties between organizations exist. This network is slightly denser than the full network. On average, each organization's resources, ideas, or support has the potential to reach 10.4% of other organizations, which is lower than the full network.

See the table below for a list of the top 10 actors in this network broken down by whether they are local local, local national, or international. Important to note when looking at the network image above is that, in all network images, the actors are sized by number of relationships in the full network.

Collaboration Hubs, Climate Change Adaptation Network

Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Mid-Sized INGO A	I	18
2	Mid-Sized Local NGO B	D	13
3	Mid-Sized Local NGO D	D	7
4	Small Local Government Entity E	D	6
5	Large National NGO R	N	6
6	Mid-Sized International Organization J	I	6
7	Mid-Sized Local NGO I	D	6
8	Large National Government Entity G	N	5
9	Large National Government Entity K	N	5
10	Large National Government Entity F	N	4

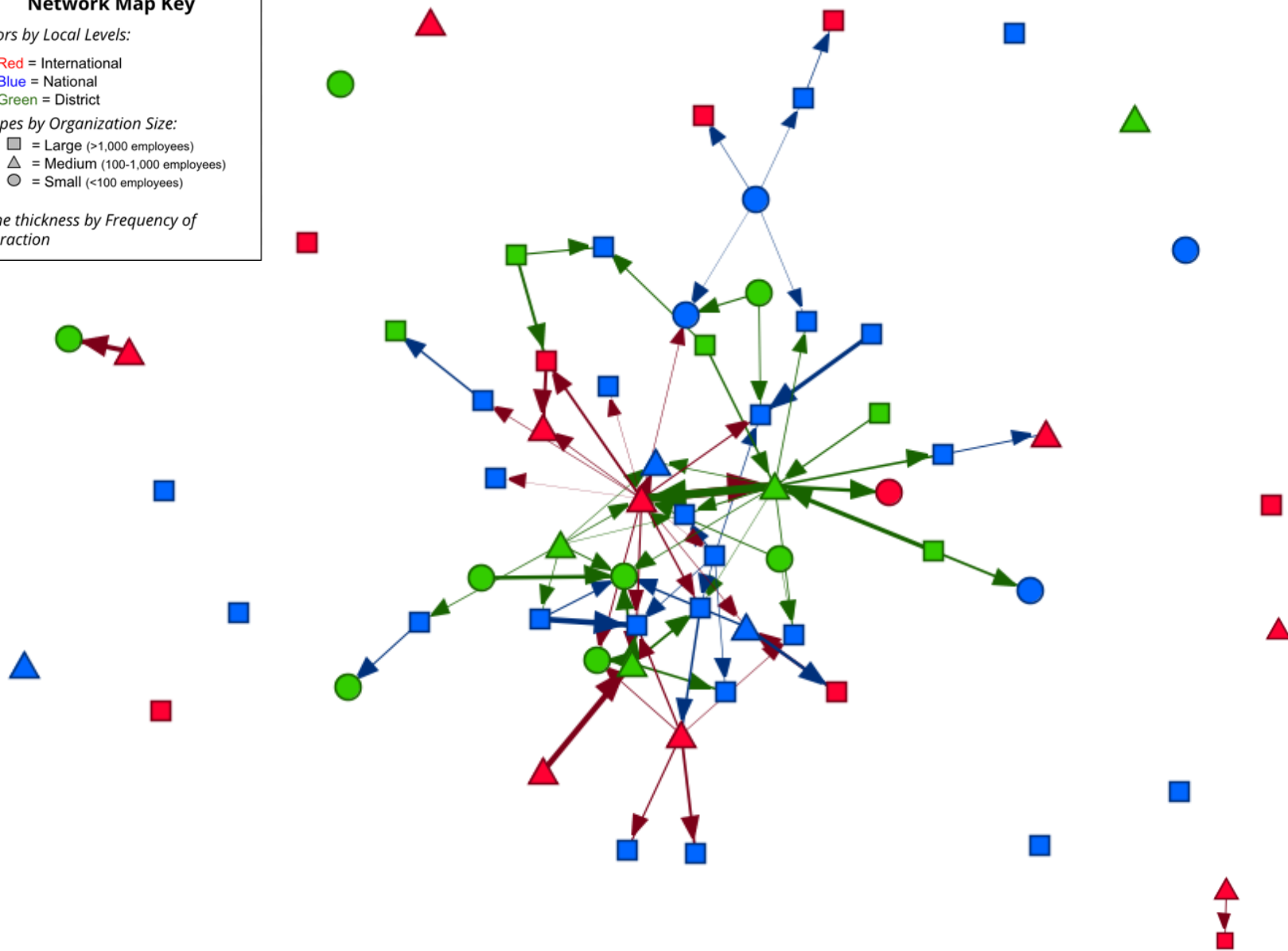# CLIMATE CHANGE ADAPTATION NETWORK MAP

Network Map Key

Colors by Local Levels:

Red = International
Blue = National
Green = District

Shapes by Organization Size:

☐ = Large (>1,000 employees)
△ = Medium (100-1,000 employees)
◯ = Small (<100 employees)

Line thickness by Frequency of Interaction

LOCAL ACTOR NETWORK
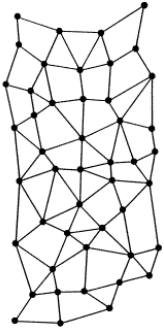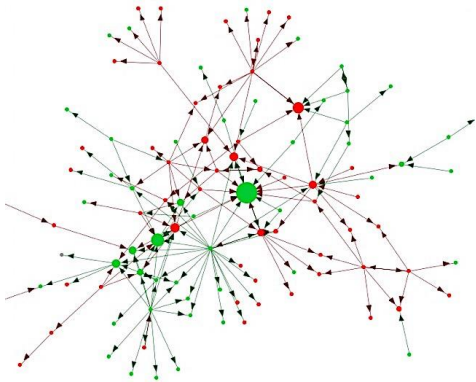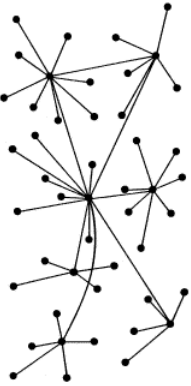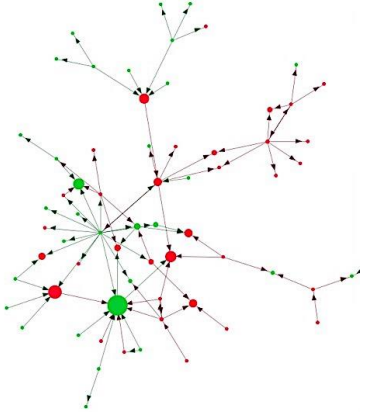
Collaboration Hubs, Local Network

Total Degree Centrality – Collaboration Hubs			
Rank	Name	Local?	Degree
1	Mid-Sized Local NGO B	D	154
2	Mid-Sized Local NGO D	D	106
3	Small Local Government Entity E	D	85
4	Large National Government Entity F	N	79
5	Large National Government Entity G	N	61
6	Large National NGO H	N	59
7	Large Local NGO M	D	50
8	Mid-Sized Local NGO I	D	44
9	Large National NGO R	N	40
10	Large National NGO N	N	38
11	Mid-Sized Local NGO U	D	32
12	Large National Academic Institution W	N	31
13	Large National Government Entity P	N	29
14	Large National Government Entity K	N	28
15	Small Local NGO AC	D	25
16	Small Local Government Entity L	D	25
17	Large National Government Entity T	N	25
18	Small National NGO Z	N	23
19	Large National Government Entity Q	N	23
20	Large Local Government Entity AN	D	23
21	Large National NGO AO	N	21
22	Large National NGO AB	N	17
23	Large National NGO AF	N	17
24	Small Local NGO AG	D	17

Collaboration Area Counts, Local Network

Collaboration Area	No. of Relationships
Coordination	60
Advocacy	52
Climate Change and Adaptation	41
Community Capacity Building	39
Community Connections	32
Facilitation	32
Community Planning	25
Volunteers and Volunteer staff	24
Research	24
Agriculture Expertise	23
Technical Assistance	22
Project Implementation	20
Community-Based Risk Analysis	20
Funding	15
Early Warning Systems Expertise	14
Vulnerable Groups Expertise	14
Water, Sanitation, and Hygiene	14
Local Expertise	14
Leadership	14
Logistics	13
Management	12
Monitoring, Evaluation, and Learning Expertise	12
Project Design	11
Health/Public Health Expertise	10

Education	9
Child Protection Expertise	7
Data Resources (including data sets, collection, and analysis)	7
Policy	7
Food Security and Livelihoods Expertise	6
Conflict Mitigation Expertise	6
In-Kind Resources (e.g., meeting space)	6
Proposal Writing	5
Gender-based Violence Expertise	4
Shelter Expertise	4
Emergency Telecommunications	4
Finance Expertise (e.g., disaster insurance, loans, emergency funds, cash for work, mobile money, other financial tools)	4
Nutrition Expertise	3
Journalism/Media	2
Technology/web Resources (e.g. server space, web site development, social media)	2
Natural Resource Management	1
Wildlife Human Conflict	1
Tidal River Management	1

ANNEX G: NETWORK STRUCTURES

DISTRIBUTED	Model Network	Example Network from DEPP Study
  • *Greater cohesion and links between multiple actors in the network* • *Allows for more equal flow of information to all actors in the network* • *Minimizes bottlenecks and promotes sustainability; information flow is not disrupted if actor leaves network*		 *Advocacy Network, Kenya*
DECENTRALIZED • *Flow of information is controlled/managed by key central actors* • *Can lead to bottlenecks* • *Peripheral actors are dependent upon those that are more central*		 *Conflict Mitigation Experience Network, Kenya*

ISOLATED

- *Network actors disconnected, "islands" of activity*
- *Lack of information flow and coordination between actors working in similar areas*
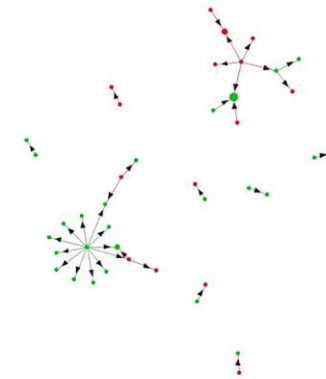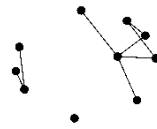
Gender Based Violence Network, Kenya

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