AN ANALYSIS OF THE GLOBAL MOBILIZATION HYPERLINK NETWORK FOR VULNERABLE ISLANDS

By

Laleah Fernandez

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ABSTRACT

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Mobilization is the movement and synchronization of ideas, people or resources for a specific social goal. As a collective phenomenon, mobilization requires communication and social interaction in order to occur and potentially to be effective. Organizations that mobilize on behalf of a cause can be viewed in network terms as nodes connected by hyperlinks. This characterization allows for an examination of how central or influential organizations are to a mobilization network, and which organizations are most essential to the continued existence of a network. This dissertation integrates mobilization theory with theory and methods of social network analysis to provide a case study of an international mobilization network devoted to Small Island Developing States (SIDS).

SIDS are island nations particularly vulnerable to global climate change, and in particular, to rising ocean levels that threaten their water supplies, food sources, community structure, and traditional way of life. Through an analysis of hyperlinks serving as connections among the labyrinth of organizations working with SIDS, this dissertation has two specific goals: first, to better understand the structural dynamics of the global SIDS network, and second to identify the most active and influential groups within the mobilization effort.

To Jhovonne – where I land, you launch.

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Professor Freedman served as a mentor and inspiration long before I had even considered graduate studies. As an undergraduate journalism student at Michigan State University, he helped me find my voice, and created numerous opportunities to publish and broadcast socially-relevant stories. This dissertation is a reflection of his early mentorship and guidance. His role on my dissertation committee provided a sense of completeness, as my experience as a student came full circle.

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Dr. Cole set this journey in motion by inviting me into the department and facilitating assistantship and research opportunities. Dr. Cole helped me realize my own potential and was instrumental in my success as a student and scholar.

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Through my journey from dog groomer to doctorate, my son learned that anything is possible. I would like to thank Jhovonne Fernandez for providing motivation and meaning to my work, and to my life.

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INTRODUCTION

Global Mobilization for Small Island Developing Nations

The rapidity of technological, geopolitical, environmental and demographic change has been a hallmark of the 21st century. The past decade has witnessed unprecedented innovations in ICT development, the power of mobilized public will to effect meaningful change in repressive regimes, the sobering consequences of global climate change, and epochal shifts in human migration and population density. With these and other changes has come recognition that many contemporary social problems are simply too daunting and complex to be solved in piecemeal fashion by a local government, a well-intentioned foundation or any single entity whatsoever, regardless of how capable that entity may be. Instead, the 21st century paradigm for large-scale, planned social change reflects the growing impact of globalization as a factor in social change efforts, the ascendancy of international level non-profits and inter-governmental organizations as indispensable sources of resources and social problem construction, recognition of the role that technology-assisted mobilization can play in building consensus and achieving action, and the power of networks to build coalitions, set agendas and harness the power of collective action.

The overarching goals of this study are to (1) better understand the structural dynamics of global mobilization for vulnerable populations; (2) understand the use and role of hyperlinks as a strategic communication tool in international mobilization efforts, and (3) identify active and influential groups within the international effort to assist isolated populations amid climate change. To accomplish these goals, this research takes a case study approach, examining efforts to assist and protect small island developing nations by analyzing a mobilization hyperlink

network. This study compares structure, influence and role of organization attributes for alliance building and action over time.

Drawing on these elements, the primary focus of this dissertation will be to study (a) hyperlink connectivity through (b) communication network analysis among (c) international agencies to understand (d) consensus and action mobilization on behalf of (e) vulnerable island populations affected by climate change.

This focus thus necessitates a sub-goal of reviewing the literature on network analysis, international organizations, mobilization, and populations rendered vulnerable due to climate change. In the course of these reviews, efforts will be made to integrate concepts and theories across the different bodies of literature, for example, merging literature on international relations and globalization with communication theories such as agenda-setting research (Carpenter, 2011), alliance building and sociological research on mobilization (e.g., Klandermans, 1984). These concepts are subsequently applied to network theories and techniques (e.g., Contractor, Wasserman & Faust, 2006; Knoke, 1993; Monge & Contractor, 2003; Wasserman & Faust, 1994). This interdisciplinary approach has the potential to enhance our understanding of influence and power structures and their role in mobilizing to achieve international consensus and political action.

A second supporting sub-goal will be to study change over time of hyperlink networks among international agencies and to examine how international actors are influenced and consensus crystallized. Mapping and analyzing international advocacy networks can identify influential groups through various measures of network structure and centrality (Carpenter, 2011). This approach can therefore help develop communication theory that relates to

mobilization, networks and international agencies such as inter-governmental organizations and non-governmental transnational organizations (i.e., IGOs and NGOs).

A third sub-goal will be to examine how information enabled by information technology (IT) is implicated in inter-organizational mobilization. This study explores the proposition that this process reflects similar patterns of information flow in real space and can lead to attitude change across connected actors, thereby leading to consensus and mobilization. Hyperlink networks are compared over two points in time in order to build new theory and revisit existing theories of network influence and mobilization.

Because the challenges facing vulnerable islands are so massive and complex, solutions require the involvement of networks of international organizations that share intersecting interests. This project reports an analysis of these global networks. More specifically, hyperlink relationships among international governmental, non-governmental, financial and research institutions are examined through a case study of current efforts to assist small island developing nations.

Chapter 1 provides background and definitions for small island developing states. Types of vulnerability are described, and the plight of Tuvalu is used as an example to illustrates the impacts of climate change at the local level. The chapter concludes with an overview of the international level response to climate change induced vulnerabilities.

Chapter 2 provides a literature review of mobilization theories and hyperlink analysis research. Consensus mobilization and resource mobilization are discussed and compared. Hyperlink research is described as a means for examining mobilization efforts at the international level. Important concepts are explained and research questions are introduced.

Chapter 3 describes the procedure and methodology used to answer research questions. This chapter describes the construction of the observed hyperlink network and the preliminary tests used to identify and characterize the organizations in this network. The hyperlink webcrawl is explained as are the operationalizations used to measure network features and actor position.

Chapter 4 describes the network characteristics for the full network at Time 1, and further explains the procedures used to analyze network properties and characteristics. Network ties, nodes and isolates are explained and described.

Chapter 5 investigates questions about centrality, reciprocity and homphily, with particular emphasis on how the network changes over time.

Chapter 6 summarizes important findings, limitations, and suggestions for future research.

CHAPTER 1

Background: Climate Change and Vulnerable Islands

> For us Pacific peoples, the discussion on climate change is not just a theoretical issue that we talk about when we come to these global meetings! It is there and we see the effects in our daily lives. For us it is a matter of life and death! In many cases we have to decide whether to stay on our islands or leave our homes. Fiu Mataese Elisara, Executive Director, O le Siosiomaga Society, Samoa (2008)

Climate change is an issue with implications for countries throughout the globe, but small island developing states (SIDS) arguably suffer the greatest repercussions. For these nations, rising sea levels compromise islanders' water and food supplies, threaten their economies, destroy their coastlines and public infrastructure and force families to abandon their homes. Extreme weather surges add to these problems and have hastened the necessity for international aid to island populations.

This chapter provides background on the current circumstances for SIDS. To meet this end, SIDS are defined. Types of vulnerabilities are explained, such as slow-onset and sudden-onset natural disasters. Environment-driven displacement and relocation is discussed. The island nation of Tuvalu is highlighted to serve as an exemplar for the types of challenges and local impacts of climate change for SIDS. This chapter concludes with examples of international actions in response to climate change, on behalf of vulnerable island nations.

Vulnerable Islands

In the context of the climate conversation, "*vulnerability"* refers to the degree to which a system is susceptible to, and unable to cope with, adverse impacts of climate change. Determinants of vulnerability include the magnitude, likelihood, distribution, timing, persistence and reversibility of impacts. The potential for adaptation and importance of system at risk are also important considerations for assessing vulnerability.

The term "*vulnerable islands"* refers to a group of 52 geographically dispersed nations classified as SIDS by the United Nations. Among these, ten are considered Least Developed Countries (LDC), including Samoa, which remains in the LDC category due to its vulnerability to natural disaster and the economic setbacks caused by the 2009 tsunami (UN Office of High Commissioner for Human Rights, 2011).[1] One ironic implication of this lack of development is that these islands contribute very little to global warming – less than 1.3 percent of all greenhouse gas emissions – and yet they are the most vulnerable to the potential ravages of global warming (UN-OHRLLS, 2012). For these nations, food availability, water sources, island infrastructure and culture are all inherently tied to the ebb and flow of the oceans. At the same time, many island nations have few financial resources and limited infrastructure.

Vulnerable island nations are often categorized by their three regions: (1) The AIMS (Africa, Indian Ocean, Mediterranean and South China Sea) (2) The Caribbean and (3) The Pacific. Table 1 lists SIDS and regions.

[1] Samoa was scheduled to 'graduate' to Developing Country status in December 2010. However, due to the "unprecedented human and material losses which Samoa suffered as a result of [the tsunami] and the severe disruption this natural disaster caused the socio-economic progress" the UN General Assembly decided on 3 September 2010 to extend Samoa's LCD status until 2014.

Table 1.1

Small Island Developing States (SIDS)

Pacific	**Caribbean**	**Mediterranean & South China Sea (AIMS)**
American Samoa	Anguilla	Guinea-Bissau*
Cook Islands	Antigua and Barbuda	Bahrain
Fiji	Aruba	Cape Verde
French Polynesia	Bahamas	Comoros*
Guam	Barbados	Maldives
Kiribati*	Belize	Mauritius
Marshall Islands	British Virgin Islands	São Tomé and Principe*
Micronesia, Federated States	Cuba	Seychelles
Nauru	Dominica	Singapore
New Caledonia	Dominican Republic	
Niue	Grenada	
Northern Mariana Islands	Guyana	
Palau	Haiti*	
Papua New Guinea	Jamaica*	
Samoa*	Montserrat	
Solomon Islands*	Nether. Antilles	
Timor-Leste*	Puerto Rico	
Tonga	St. Kitts and Nevis	
Tuvalu*	St. Lucia	
Vanuatu*	St. Vincent & the Grenadines	
	Suriname	
	Trinidad & Tobago	
	U.S. Virgin Islands	

*Least Developed Country

SIDS account for about 3 percent of the earth's land surface with a combined population of about 65 million, which is slightly less than one percent of the world's population (United Nations Department of Economic Affairs, 2014). Yet, they are home to 20 percent of world's biodiversity and 20 percent of all plant, bird, and reptile species. Consequently, the species on these islands are at the highest risk of extinction: 95 percent of bird, 90 percent of reptile, 69 percent of mammal, and 68 percent of plant extinctions worldwide have occurred on islands (Convention on Biological Diversity, 2014).

Types of Vulnerability

Vulnerable islands face a unique set of challenges, many attributable to or exacerbated by climate change. The dangers of climate change for island populations can be categorized into two general types: (1) sudden-onset disasters (e.g., cyclones, earthquakes, tsunamis, volcanic eruptions and flooding) and (2) slow-onset natural disasters (e.g., riverine erosion, coral bleaching, rising sea levels leading to soil and water salination).

Sudden-onset disasters have increased significantly since 1950. Some estimates suggest that the number of sudden-onset natural disasters has tripled since the 1970s; and almost 90 percent of the recorded natural disasters today are climate related (Ferris, Cernea & Petz, 2011). As with all island nations, SIDS are vulnerable to raging ocean storms and high waves with the added problem that many SIDS have only limited high ground to which inhabitants can escape in times of flooding.

The severity of hurricane-strength cyclones has grown. At the same time, the total population affected by each natural disaster steadily increases because of population growth, rapid urbanization and environmental degradation of reefs, trees and shorelines which historically buffered islanders from oncoming hurricanes and tsunamis (Pelling & Uitto, 2001). The 2004 Indian Ocean tsunami drew attention to some of the special circumstances of displaced islanders, when more than 15,000 people relocated from their homes in Maldives (Lovgren, 2005). The 2007 Solomon Islands tsunami displaced 24,000 islanders. The Solomon Islands later experienced flash floods, in April of 2014, displacing 10,000 more islanders (New Zealand Red Cross, 2014). Most recently, Pacific Cyclone Ian, of 2014, displaced 2,000 islanders in the Ha'apai island group of Tonga. What make these events unique is the interaction of such 'natural' and irreversible events with processes of human-induced environmental degradation

where a failure to observe principles of good environmental management and sustainable development can be seen to have contributed to the environmental decline that is at the root of displacement (Black, 2001). Most notable is the predicted effect of human-induced climate change, and the impact this may have on sea-level rise and increased flooding of low-lying coastal areas (Myers, 1993)

Displacement can occur because of sudden-onset disasters, such as cyclones or gradual changes such as sea level rise. Slow-onset disasters, such as rising sea levels and shoreline erosion, are equally as destructive as sudden-onset disasters. On average, 26 percent of SIDS' land mass is only 5 meters (approximately 15 feet), or less, above sea level. For two nations, Maldives and Tuvalu, the entire populations live less than 5 meters above sea level (UN-OHRLLS, 2014). As beaches erode, islanders are displaced and populations are forced to move to inland, thereby either increasing population density or triggering population displacements, leaving citizens state-less (Hales, 2002). The average length of coastline in SIDS is slightly more than 1,000 km, though the most common length in these countries is between 100 km and 500 km. Almost 50 percent of all SIDS fit into this category.

The local impact of rising sea levels and extreme weather patterns can be catastrophic for small island populations. Small island nations have little land to spare. Two islands in the British Gilbert strip are already uninhabitable. In Maldives, a one-meter rise in sea level is expected to result in the complete submersion of the nation (United Nations Development Programme, 2008). Palau, an island nation 500 miles southeast of Philippines is struggling to preserve the remaining shorelines of eight principal islands and more than 250 smaller ones. The president of Palau, Johnson Toribiong, describes the eroding shorelines and loss of crops as "a slow-moving tsunami" (Brangham, 2012). The recent prevalence of slow-onset disasters is largely attributed to

and aggravated by human-caused environmental damage and industrial development (Ferris, et al., 2011).

In the Carteret Islands, off the coast of Papua New Guinea, agricultural production has already been devastated by higher king tides, leading to flooded farmland and resettlement of the population to the larger island of Bougainville (Barnett &Webber, 2011). In 2005 the central government of Papua New Guinea agreed that islanders should be moved to the Solomon Islands, located four hours by boat from their homeland in Papua New Guinea. The agreement entailed that ten families would move off the island each year (Biermann, & Boas, 2008). Tsunamis in 2007 in the Solomon Islands then forced further migration of these islanders (Ferris, Cernea & Petz, 2011). In 2008 the government of Papua New Guinea revamped its efforts and organized a voluntary evacuation plan for the entire island lasting until 2020.

Kiribati, Tokelau, Marshall Islands and Tuvalu face a similar risk of becoming completely uninhabitable because of low-lying atolls, which may become submerged by the ocean. For Kiribati and Tuvalu, once sea levels reach a certain point, the whole population will have to resettle in some other country or countries (Ferris et al., 2011). Some island states are in the process of relocating, others are trying to take measures to protect their existing environments, and most are trying to adapt to changes through a combination of relocation and adaptive measures.

Such displacements threaten public health and compromise the livelihood of island populations. Relocation is very difficult, due to a variety of cultural and socio-economic factors. Islanders displaced by natural disasters are particularly vulnerable to threats to security and physical integrity, loss of contact with children and family members, inadequate and insecure shelter, discrimination in aid distribution, psycho-social stress and sexual and gender-based

violence (Office of High Commissioner for Human Rights, 2011). While some islanders leave in anticipation of the effects of climate changes, others wait until there are no other options. Individuals and families assess risk differently and make decisions accordingly. Those inclined to leave earlier tend to be the young, healthy and mobile (Wellington, 2012), thus leaving behind the elderly, physically disabled and immobile (Ferris, Cernea & Petz, 2011). Those with secure land holdings will be less likely to leave, while the lower middle classes tend to leave earlier if they have the means to travel (Webber & Barnett, 2010).

For centuries, the islanders adapted to scarce resources and fierce tropical storms that struck the islands once or twice per decade. In one year, 1997, the Pacific island nation of Tuvalu was struck by three typhoons. Unable to recover from the series of storms, the island of Tepuka Savilivili was left uninhabitable. The remainder of population must now consider relocating or remain exposed to the threat of sudden inundation and drowning.

Tuvalu as an Exemplar of the Plight of SIDS

The story of this island nation illustrates the fragility of the ocean's ecosystem and the interconnectedness of storm surges, rising sea levels, public health, culture, agriculture and a growing climate crisis. Tuvalu, formerly the British Islands of Ellice, is a sovereign nation scattered over 500,000 square miles of equatorial ocean midway between Hawaii and Australia (Allen, 2004). With the shortest coastline (24 km) of all island nations, and the entire population living less than 5 meters above sea level, Tuvalu is considered one of the most vulnerable SIDS (UN-OHRLLS, 2014). It is also one of eleven SIDS which is also a least developed country (LDC).

The lives and livelihoods of Tuvaluans are linked to the Pacific Ocean; rising sea levels and severe storm surges threaten the islanders' way of life and national identities (Ferris, et al.,

2011). Some climatologists predict that the nation will be under water in less than 50 years (Allen, 2004). People of Polynesian descent have inhabited Tuvalu for thousands of years. Over this stretch of time Tuvaluans faced many climatic threats and developed strategies to cope with these threats. Today, however, Tuvalu is faced with an unprecedented threat created by human-induced climate change (Ielemia, 2007). Higher surface water temperatures in the tropics and subtropics lead to the radiation of more energy into the atmosphere, which impacts the storm systems.

The total population is nearly 11,000 (Europa World Book, 2011). Most of the nation's islands have between 400 and 600 inhabitants, though the main island, Funafuti, houses the national government and is home to approximately 1,000 inhabitants. Because Tuvalu is an isolated nation--it takes about three days by boat to travel from Australia to the main island, Funafuti--the prospect of outside emergency relief is daunting and slow. For most of the world, Tuvalu seems to be in the middle of nowhere. The nation spans the International Date Line, designated as 0° longitude, located just south of the equator on the Pacific Tectonic Plate, spanning nearly 560 km (350 miles) between the southern-most and northern-most islands (Europa World Book, 2011). The remoteness of the nation and distance between islands complicates coordination and communication. The nation has limited Internet access, slow and congested bandwidth speeds, and lack of access to computer services and repairs, further isolating residents from other islands and the mainland.

The islands communicate with one another and surrounding areas largely by radio signal, which puts islanders at further risk in crisis situations. For example, during a recent tsunami alert prompted by the 2011 earthquake in Japan, the main island in Tuvalu, Funafuti, was alerted through a radio warning. Islands were then notified by a phone call to the police station on each

island and police officers went door to door in order to notify residents of the tsunami warning (Nguyen Berg, 2011). Some of the outer islands have no feasible mechanism to communicate with the world beyond the island.

Despite the expansive distances between the islands, it is among the smallest nations in the world, in terms of actual land mass. The total land surface of Tuvalu is 26 sq kilometers – little more than 10 square miles. The highest point above sea level is around 4 metres, slightly more than 13 feet. On average, Tuvalu is less than 2 meters (less than seven feet) above sea level (United Nations Framework Convention on Climate Change, 2014).

Tuvalu is a coral nation, dependent on coral for food stock and protection. The coral reefs support a large, but fragile, ecosystem. Corals serve as the glue for a much larger, symbiotic, ecosystem. Reefs surrounding Tuvalu, much like corals throughout the world, are weakening, dying off, and breaking apart, taking with it the diverse resources and food systems which have sustained Tuvaluans for thousands of years.

The bleaching and breaking of the reefs are a result of higher acidity in the Pacific Ocean due to increased CO2 in the atmosphere. The calcium carbonate skeletal structures of reefs dissolve in acidic water and kill the microscopic algae housed by the coral. In the absence of the algae, the corals suffer from malnutrition and lose their bright colors, a process known as bleaching. Eventually, the malnourished coral dies and the reef can no longer support the diversity of marine life (Hoekstra & Molnar, 2010).

Biodiversity is further threatened because the algae are at the base of the aquatic food chain. When the algae die, fish migration patterns change and dependent species such as sea urchins, some crabs, green sea turtles, and herbivorous fish are at risk. Acidic seawater also

weakens the shells of various shell fish and further threatens their survival. Consequently, the nation is now largely dependent on foreign imports for food sources (Lusama, 2011).

A second threat occurs as the earth's temperature rises. Warm water further impacts the growth and migration of marine species within the reef system (Ielemia, 2007). Corals thrive in tropical waters in temperatures between 64 and 86 degrees Fahrenheit. Many coral species are highly vulnerable to heat stress. Following unusually warm water temperatures in the late 1990s, coral surrounding Tuvalu started bleaching, setting in motion mass bleaching which extended across the globe through 1998. Similar trends were observed in 2002 and 2005. As such, Tuvalu lost much of its fish stocks, a principal source of protein, medicines and other important traditional resources (Lusama, 2011). This is a new phenomenon for these islanders. Native languages, such as French Polynisian, do not even have a word to describe the bleaching of coral reefs.

The loss of coral reefs leaves many islands unprotected from the brunt of ocean waves and storms. The buffer is weak and fragile, leaving inhabitants more vulnerable to storm surges. Similarly, beach erosion and salination have compromised mangroves, another natural buffer. The reefs and mangroves once worked as a shield to massive waves tearing through the Pacific, but today the buffer is severely depleted (Mimura et al., 2007).

Storm surges in and near Tuvalu are more frequent and more severe today. In 1972, tropical Cyclone Bede destroyed nearly all the houses on Funafuti, Tuvalu's largest island and the nation's capital. In 1992, Cyclone Nina flooded five more islands. In 1997 Tuvalu was struck by three more typhoons. Coconut trees and other forms of vegetation were swept away. Unable to recover from the series of storms, the island of Tepuka Savilivili was left uninhabitable. Seawater inundation was trapped inland by a poorly designed sea wall, causing

saltwater contamination of the island vegetation, food exports and livestock feed (United Nations Framework Convention on Climate Change, 2006).

Tuvalu has no lakes, no rivers and no streams. The nation continuously faces shortages of fresh water, which is essential for human life and and crops such as breadfruit tree, pulaka and coconut. Freshwater bays are inundated with salinated sea water and further compromised by introduction of wastewater, due to poor sanitation infrastructures. Seawater contaminates the septic systems and causes sewage contamination of the groundwater lens. The sanitation infrastructure is not equipped to handle floods; flooding contaminates scarce freshwater sources putting the entire population at risk of disease and death (Arnell, 2004). Floods also wash over the roads and croplands, compounding the food and freshwater scarcities.

Not only are the islands getting smaller due to shoreline erosion, but because the atolls are made of limestone, they are porous and allow sea water to rise through the ground. Pulaka, was once the island's main agricultural food source, constituting the bulk of the islanders' traditional diet. Once salt water seeps into the pulaka pits the roots rot. Islanders have begun to line the pits with cement in an effort to protect the crop (Ielemia, 2007). Nevertheless, pulaka is no longer able to sustain the island population. The bleaching of the coral, the devastation of mangrove, the salination of the water supply have left islanders dependent on non-traditional imported foods. This poses an additional risk to public health since imports are processed, often high in sugar, fat and carbohydrates, causing a rise in health conditions like diabetes and hypertension previously little known in Tuvalu (Lusama, 2011).

Moreover, the lack of freshwater puts the entire population at risk of dehydration, starvation due to loss of crops, and economic losses. In 2011 Tuvalu experienced a six-month drought, compelling a state of emergency. Preschools were closed and the hospital accepted only

critical patients. Residents were asked to stay home during the day because the loss of shade trees left people directly exposed to the scorching tropical sun, with no means of rehydrating. Scarce resources following the 2011 drought created a division among islanders resulting in social tensions between residents of the main island, Funafuti, and outer-islanders who migrated to Tuvalu's capital in search of drinking water (Connell & Lea, 2002).

International Response

Tuvalu threatened in 2002 to sue the United States and Australia for excessive carbon dioxide emissions. Addressing the United Nations in 2002, Tuvalu's Former Prime Minister, Saufatu Sapo, called on the international community to help correct the devastation caused by global warming, describing it as "a slow and insidious form of terrorism against us" (Allen, 2004). Tuvalu is not alone in such calls for action. Most vulnerable islands are low-lying, share similar physical and structural challenges to their development. The factors that make most island nations vulnerable are the same characteristics which inherently restrict island populations from mobilizing on their own behalf.

More recently, Anote Tong, President of the Republic of Kiribati stressed the urgency and necessity of international action on behalf of vulnerable island nations. Tong explains that island nations need to be brought to the forefront of global action not only because of their vulnerabilities, but also because these islands foreshadow a global outcome. In his opening address at the 2010, Cancun Climate Talks, Tong warned:

> Pacific Island countries are internationally regarded as a barometer for the early impacts of climate change warning to the international community and a precursor for what could

> ultimately be the fate of humanity if further action is delayed (Opening Ceremony of the High Level Segment of the COP 16, Cancun, 8 December 2010).

The President of the Pacific Island of Nauru, Marcus Stephen, made a plea for the United Nations Security Council to recognize that climate change is as great a threat to international peace and security as nuclear proliferation or global terrorism:

> Negotiations to reduce emissions should remain the primary forum for reaching an international agreement. We are not asking for blue helmets to intervene; we are simply asking the international community to plan for the biggest environmental and humanitarian challenge of our time (Marcus Stephen, president of Nauru, 2011)

Island nations are disadvantaged because of limited resources, remoteness, susceptibility to natural disasters, and disproportionate vulnerability to global developments (United Nations Department of Economic Affairs, 2014). Among all SIDS, the average Gross Domestic Product (GDP) is $13.7 billion (United Nations Department of Economic Affairs, 2014). However there are large disparities among the islands' GDP. Eighty-one percent of SIDS have GDPs lower than $13.7 billion, while 54 percent have GDPs less than $1 billion (United Nations Department of Economic Affairs, 2014). SIDS also have to contend with a lack of economies of scale, given their geographic remoteness and small size. This translates into a dependency on imports, and limited export base.

While most of these nations have very limited GDP, their economies are often dependent on tourism, which, in turn, is dependent on stable infrastructure, food supplies and water sources. Antigua and Barbuda, the UK Virgin Islands, Anguilla, Seychelles and Vanuatu all depend on tourism for more than 50 percent of their GDP (World Travel & Tourism Council, 2013).

Aruba's travel and tourism industry made a total direct contribution of 26.5 percent of their GDP, an estimated 86 percent with indirect contribution from tourism (World Travel & Tourism Council, 2013)[2]. Yet essential resources have been compromised, if not destroyed, on most of these islands by rising sea levels and extreme weather surges. They incur especially high costs for transportation, communication, public administration and infrastructure (United Nations Framework Convention on Climate Change, 2006).

Island nations such as Tuvalu are dependent on foreign aid and consequently at the mercy of international efforts to help improve their physical infrastructure and develop plans for displaced residents in the event of a major storm or the loss of land as shorelines erode and communities flood. Vulnerable island developing states are seeking help from developed countries to: (1) help curb climate change; (2) provide funding to build protective infrastructures ;(3) assist in emergency relief efforts exasperated by severe weather and lack of fresh water; and (4) absorb climate change refugees. All of these activities require massive efforts to mobilize resources and people through global networks.

While the international community discussed and debated threats to vulnerable islands, islanders have been dealing with the effects of climate change through community-level, ad-hoc, sustainability and adaptation efforts. Coastal erosion has been met with community-built structures such as sand dune fences and trees planted along the coast by community members to buffer incoming waves and strengthen coasts through root systems. In Jamaica, islanders placed concrete blocks on the top of their houses to prevent the zinc roofs from being blown away during hurricanes. On the tiny island of Timor, farmers have tried to address sustainability issues

[2] Total contribution: GDP generated directly by the travel & tourism industry plus its indirect and induced impacts. Indirect contribution: Capital investment, government collective spending and supply chain effects Induced contribution: the broader contribution to GDP and employment of spending by those who are directly or indirectly employed by travel & tourism

by developing their own varieties of major staple crops to adapt to erratic rainfall and cyclones and to ensure food security. More recent efforts, those organized and financed by international and transnational agencies, have focused on collaborative efforts to refine measurement, improve adaption, develop risk management strategies and create regional policy to protect vulnerable populations (Mimura, et. al., 2007).

International efforts to support local adaption include: engineering solutions such as sea barriers or walls, hurricane resistant buildings and provision of water storage; legislative solutions such as revised building codes, land zoning around coasts and rivers and updating water policy; and technological solutions such as using more resilient crops (ProAct Network, 2008). Generally these initiatives move from local to regional. Once regional-level pilot projects are vetted, international agencies partner with the regional groups.

Most of the early efforts involved funding from the World Bank and the Global Environment Facility (GEF) to pilot projects intended to develop frameworks and strategies that would apply to SIDS. Projects included partnerships among: the (1) World Bank (2) GEF (3) United Nations Development Programme (UNDP) (4) International Bank for Reconstruction and Development (IBRD) (5) United Nations Education, Scientific and Cultural Organization (UNESCO) (6) United Nations Environmental Program (UNEP) (7) Catastrophic Risk Insurance Facility (CRIF) (8) United Insurance Company of Barbados (9) Caribbean Community Secretariat (CARICOM) and (10) United Nations Refugee Agency (UNHCR).

The specific projects included: (a) Piloting Climate Change Adaptation to Protect Human Health; (b) Caribbean Hazard Mitigation Capacity Building Programme, piloted in Dominica, St. Lucia, St. Vincent and the Grenadines to help Caribbean countries create national hazard vulnerability reduction policies; (c) Pacific Islands Adaptation to Climate Change Project to

develop long-term adaptation measures to increase resilience of multiple development sectors among ten different Pacific islands focused on water resources management, food production and food security, coastal zone and infrastructure (Sprep.org, 2013); (d) Mainstreaming Adaptation to Climate Change in the Caribbean region (MACC) and the Kiribati Adaptation Programme to develop and demonstrate the diagnosis of climate-related problems and cost-effective adaptation measures (World Bank, 2006) (e) Catastrophic Risk Insurance Facility parametric insurance coverage against natural disaster risk (Hay, 2012). (f) United Insurance Company of Barbados financial incentives for homeowners who put preventative measures in place (Hay, 2012). (g) Programme of Action for the Sustainable Development of Small Island Developing States to develop measures to define appropriate actions for SIDS.

The UNHCR, in June 2011, presented a set of Guiding Principles for dealing with those displaced by the effects of climate change. Among the principles outlined by the organization, the UNHCR committed to addressing the special needs of landlocked developing countries and SIDS through the Programme of Action for the Sustainable Development of Small Island Developing States (Park, 2011).

All of these efforts described above have required collaboration and coordination among NGOs, multilateral financial institutions and bilateral development assistance agencies. Through hyperlink analysis, this study examines network relationships among such organizations dedicated to help SIDS contend with the increasing problem of global climate change.

CHAPTER 2

Literature Review: Mobilization and Social Network Theory

Recognizing the changing landscape of the contemporary information age, an era of especially robust communication advancements and wide-spread adoption of information communication technology, scholars have identified new forms of consensus development, and evidence of resource exchange by studying the role of hyperlinks in social networks (e.g., Garrido & Halavais, 2003; Lusher & Ackland, 2010; Kropczynski & Nah, 201; Rogers & Marres, 2000; Shumate, 2012; Shumate & Dewitt, 2008; Shumate & Lipp, 2008).

The following literature review first describes the emergence of mobilization theories and changing paradigms of mobilization theory over time. Concepts and theories relating to globalization are described thereby providing context for a discussion of mobilization theory in the 21st Century information society. Studies of hyperlink network analysis are reviewed as a mechanism to examine mobilization in the context of globalization. Throughout this review of literature, network features and relations are conceptualized for the current study. This literature aims to first, provide background and context for the study on mobilizing groups. Second, define and conceptualize the meaningfulness for mobilizing groups at the international level.

Mobilization

The term mobilization has gained popularity among scholars as well as the popular press as a catch-all phrase to describe massive, coordinated actions such as Tea Party campaigns, the Arab Spring, and the Iranian "All for Freedom" effort. The widespread use of the term "mobilization" in political rhetoric and media news coverage demonstrates public interest in the

process and outcomes of mobilization. However, the concept of mobilization is often assumed rather than explicit (Salmon, Fernandez & Post, 2010).

Broadly defined, mobilization is the movement and synchronization of ideas, people or resources for an explicit social goal (Salmon, Fernandez & Post, 2010). The process involves the construction and dissemination of social movement frames (Benford & Snow, 2000) diffused among movement adherents and potential adherents (Snow, 2004). Coordinated action occurs after consensus among networked actors is reached. That is to say, action mobilization is the process by which an organization calls on a pre-existing network of members to participate (Klandermans, 1984).

Opportunity

Mobilization theory stems from sociological work such as Peter Eisinger's (1973) effort to explain race riots in the 1960s. Eisinger (1973) proposed that political restraints, particularly oppressive political conditions, would trigger groups to organize in order to air grievances. Charles Tilly, another early theorist, examined mobilization and technological change across a vast range of social contexts (e.g., Tilly, 1978; Tilly, 1995). His work focused on large-scale social change and its relationship to contentious politics. Tilly's (1978) assessment of collective action posits that successful mobilization is a function of both political opportunity and social structure.

According to Tilly (1978), opportunities are "the extents to which other actors, including governments, are vulnerable to new claims which would, if successful, enhance the contender's realization of its interests" (p. 133). This proposition holds that local government may or may not be an ally in mobilization efforts, particularly if change efforts are perceived as threatening by the local power structures (Salmon, Fernandez & Post, 2010). Overall, the early body of

mobilization research found that opportunity occurs when a strain in the socio-political system necessitates action, in societies that allow for groups to mobilize (see Eisinger, 1973; Tilly, 1978; Smith, 1996).

Tilly is credited with introducing a range of concepts to better understand mobilizing groups, large-scale social change and collective action. His work also demonstrated a clear concern for methodological practices for studying mobilization. In hindsight, Tilly argued for methodological approaches well-suited for the information era. He argued that assumptions of state and nation-level autonomy ignore the interwoven, inter-dependent nature of social and political mobilization[3]. Much of his methodology identified social relation—a repeated interaction between two or more persons – as a key factor for mobilization (Tilly 1995). Rather than broad generalizations based on particular case studies, Tilly advocates that researchers should identify the smaller social mechanisms that in combination structure larger social phenomena. In some ways, this early articulation of mobilization laid the conceptual, theoretical and operational groundwork for the study of mobilization using network analysis techniques, and more specifically, multi-level approaches for examining how the parts of a network connect to create patterns we can now identify as network characteristics and structure.

There are two main bodies of literature on mobilization that are particularly germane to the present study: resource mobilization and consensus and action mobilization. These two bodies of literature are defined and contrasted in the following sections.

Resource Mobilization

In 1977, McCarthy and Zald (1977) examined the role and distribution of resources in social movements, coining the term "resource mobilization." McCarthy and Zald (1977) argue

[3] More specifically, Tilly warned against "Big Case Comparison" method.

that ties among organizations represent information flows among organizations to stimulate mobilization. Connections are the mechanism that allow information and resources to reach different group segments and funnel the necessary resources for social action (Kropczynski & Nah, 2011). This process is often explained in terms of theories of dependence (Galaskiewicz, 1989) and exchange. For example, Galaskiewicz (1989) argues that people and organizations that are more central in community resource-exchange networks are seen as more influential in community affairs and more likely to achieve their desired outcomes (Galaskiewicz, 1989).

This body of work suggests that links between organizations in a network can involve strategic decisions in order to reach a specific social goal. The underlying assumption of these exchanges is that organizations have different levels of resources and have opportunity and motivation to exchange (Monge & Contractor, 2003). From this perspective, network power is a function of the pattern of ties throughout the network in which information and resources are exchanged.

Knoke (1990) argues that dependence drives power within a network. He makes an important distinction about resource-dependent organizations and level of operation. More specifically, Knokes asserts that (1) principal actors are organizations rather than individuals and (2) A major problem for these organizations is the reduction of dependency, thus, structural autonomy within a network allows an organization to pursue its own goals with fewer restraints (Knoke, 1990). Organizations having more common interests and short communication links can better coordinate action to achieve collective action.

This balance between autonomy and inter-agency agendas, however, creates what some scholars refer to as the NGO paradox. The general argument is that international mobilization requires partnerships and alliances among different types of organizations, at different levels of

operation. That is to say, inter-governmental agencies and non-governmental agencies seek out partnerships as a movement grows international. The paradox lies within the mismatch between achieving a public good and satisfying the demands and expectations at the agency or organizational level.

Public goods are the outcomes of collective action, and are the results of critical mass (Marwell & Oliver, 1993). Public goods are considered non-excludable, so the use of one group or individual does not compromise or limit the use or access to another group or individual (Olson, 1965). Some examples include clean air and water quality, roads and parks (Marwell & Oliver, 1993), labor unions (Olson, 1965) and election reforms (Knoke, 1990).

The paradox for many mobilizing groups is in the necessity to reach certain inter-agency goals as well as achievement of the public good. For example, international NGOs oversee and distribute billions of dollars each year (Keane, 2003), and essential funding for projects and salaries is often tied to governmental agencies and private interest groups. As such, decisions are often dictated or influenced, sometimes unintentionally, by incentives tied to the specific interests of funders or central agencies within the international network (Cooley & Ron, 2002). This means that organizations can be restricted or immobilized due to the competition for resources among smaller or dependent agencies organizing for action, sometimes at the expense of the marginalized populations that international NGOs aim to protect (Sklair, 2001). This research will look at achievement toward the public good as indicated by the extent connectivity among inter-organizational partnerships, demonstrated through hyperlinked relations.

Consensus and Action Mobilization

A second major body of literature on mobilization that relates to network structure focuses on consensus and action mobilization. The opportunity to mobilize can explain the

emergence of a mobilization effort; however, opportunity to act collectively explains only the first steps toward mobilization. Addressing the gap between mobilization opportunity and the process of coordinating large-scale coordinated action, Klandermans sought to explain how social issues attract and maintain membership with his theory of consensus mobilization (1984). The theory refers to the ways in which new attitudes, beliefs, and frames of interpretation are activated and spread. More specifically, Klandermans (1984) defines consensus mobilization as the diffusion of generalized beliefs specific to a purposeful effort of a social-movement organization. The spread of consensus, which includes the act of recruitment and the process of building alliances toward a shared social goal, will ultimately determine the mobilization potential of a movement (Klandermans, 1984; Klandermans & Oegema, 1987).

From the consensus mobilization perspective, the nature of the term "resources" takes on a different meaningfulness, when compared to resource mobilization. More specifically, the movement and acceptance of information is most essential for mobilizing success. As such, network power is conceptually different for consensus mobilization. Power is a function of agreement. Contemporary theories of mobilization use the term "expressive actions" (see Pilny & Shumate, 2012, p. 262) to describe the mechanism, by which potential adherents reach a point of agreement, shared identity and shared identity necessary for mobilization (Melucci, 1988).

Applying this idea to the 21st Century information society, scholars such as Shumate and Lipp (2008) Ackland and O'Neil (2011) Park and Thelwell (2003) suggest that hyperlinks play a unique role in the process of consensus-building toward collective action. Across these studies, hyperlinks are conceptualized as online expressive action and studied as part of the representational and positional flow of information (Shumate & Lipp, 2008). The nature of representational communication comes down affiliations and connections across agencies. From

this framework, hyperlinks are a public announcement of affiliation, from one group to another. Thus hyperlinks have been found to communicate trust (Palmer et al., 2000), credibility (Park et al., 2002), and inter-organization endorsements (O'Neil & Ackland, 2006).

Empirical research suggests that social movement actors use hyperlinks to express shared interests and consequently a collective identity (Ackland & O'Neil, 2011; Pilney & Shumate, 2013). Unlike other forms of information exchange, hyperlinks from organizations suggest a public affiliation with connected actors, thus, hyperlinks can inform mobilization theories by examining the representational and positional flow of information diffused throughout the network (Shumate & Lipp, 2008). Pilney and Shumate (2013) extend this idea even further finding that hyperlinks are representative of common social aims, financial ties, membership ties, collaborative ties, and media visibility (2013).

The structure of a network, as illustrated by ties across members of the network, plays an important role in the diffusion of information for social mobilization. Since the patterns of relationships bring members into contact with the attitudes and behaviors of other network members, these relationships can explain why groups develop certain attitudes (Pollock, Whitbred & Contractor, 2000). Monge and Contractor (2003) observe that exposure through information links among actors, in a shared network, increases the likelihood that members will develop beliefs, assumptions, and attitudes that are similar to those of others in their network, particularly those with direct communication ties (p. 174; see also Wheeler & Mitchelson, 1989).

Johnston and Lio (1998) argue that the rise of transnational mobilization efforts can be explained by the global diffusion of the Western democratic model. The spread of democratic ideals is facilitated by international non-governmental organizations (NGOs), and global market capitalism diffusing from West to East. In essence Johnston and Lio expand Tilly's concept of

opportunity from local to global, noting these characteristics "… give rise to similar movements when patterned across different nation states" (p. 458).

The study of diffusion and collective action has been motivated by an interest in globalization and the increasing interdependencies among actors and events in disparate locations (della Porta, Kriesi, & Rucht, 1999). Globalization can be understood as the thickening of the networks of interdependence spanning international boundaries (Brown, Khagram, Moore, & Frumkin, 2000). Studies of globalization often attempt to explain the emergence of globalization (Bartley, 2007), the changing role of nation states (Sassen, 2002), the impact on economies and foreign relations and future trends (e.g. Held & McGrew, 2007; Meyer, 2007, Leisink, 1999). However, studying the process of a growing interdependence on a global scale is quite complex. By definition, global processes and institutions simultaneously transcend national states and inhabit national territories (Sassen, 2007, p. 3).

Castells et al. (2007) describes globalization as the emergence of a "networked society" created by hypertext websites and other new media (Castells, Fernandez-Ardevol, Qiu, & Sey, 2007). Warkentin (2002) asserts that websites facilitate and represent other forms of inter-organizational communication networks "In creating an online persona, NGOs engage in framing activities . . . by shaping the ways that issues are conceptualized and understood'' (pp. 36–37). The internet is a self-organized virtual network composed of content and hyperlinks. Castells (2004) notes that the internet enables values such as diversity, decentralisation and grassroots democracy which align well with ideological and organizational needs among social mobilization groups (Castells, 2004).

Mobilization through Hyperlinks

Advanced technology drives both the speed and volume of cross-border resource and information transactions. These international exchanges cover a wide range of goods and services, capital flows, and information. The hyperlink network structure consists of a group of websites that are connected by the hyperlinks. The series of hyperlinks allow web surfers to travel from one website to another. The structure is not bound by the singular path followed by a web surfer; it is typically represented by a map of all possible connecting websites (Kropczynski & Nah, 2011). Park and Thelwall (2003) contend that a hyperlink network can be described as a specific type of computer-mediated communication network, in which website authors are interconnected by hyperlinks.

Hyperlinks have been used to measure mobilization potential as it relates to resource mobilization, consensus mobilization, and even in more applied contexts to determine web authority. For resource mobilization hyperlinks can demonstrate authority and illustrate patterns of alliance building (Rogers & Marres, 2000). From this perspective, resources can be thought of as accessibility to web traffic, increased visibility and public credibility. Pilney and Shumate (2013) found that hyperlinks illustrate patterns of resource sharing, concluding that hyperlinks are an extension of offline collective action behavior.

When hyperlinks are conceptualized as representational communication, hyperlinks can be used to study consensus mobilization illustrated through online expressive action. A hyperlink between actors may exist with no information transmitted between the link, however, the link represents an acknowledgement of the other and a public symbol inferring affiliation (Pilney & Shumate, 2013).

From a practical and applied perspective, hyperlinks have been found to increase issue visibility. The organization that can control visibility of other organizations through an embedded position within the network, is powerful. Depending on the level of agreement among organizations within the network, centrally embedded actors can either boost visibility of the network goals or constrain such visibility (Pilney & Shumate, 2013). Merging concepts of mobilization with hyperlink research, Shumate describes the concept of connective public goods, this is the arrangement of inter-organizational hyperlinks that bring attention to network goals (Shumate and Dewitt, 2008; Shumate and Lipp, 2008).

While hyperlink networks cannot proxy the exchange of real-world resources (Ackland & O'Neil, 2011) the study of hyperlinked websites provides opportunity for social scientist to better understand the process of global mobilization efforts. Previous hyperlink research has looked at the various uses and functionality of hyperlinks for purposes such as increased visibility (Pilney & Shumate, 2013) trust (Palmer, Bailey, & Faraj, 2000) authority (Rogers, 2002), credibility (Borah, 2014), alliance building (Rogers & Marres, 2000), and endorsements (O'Neil & Ackland, 2006). Hyperlinks can represent collective identity in terms of shared goals, shared funding sources, membership ties, collaborative ties, and media visibility (Pilney & Shumate, 2013).

Network Structure

Network structure can reveal a great deal about the way a system functions based on the properties of the network as a whole (Burt, 1980). Networks can be hierarchal or polycentric. A polycentric structure represents a decentralized management model for mobilization. A polycentric network is characterized by multiple clusters of exchange connected by a few sparse connections (Baldassarri & Diani, 2007). Networks with structural features leading to control of

resource flows generate power inequality (Willer, 1999). Typically, scholars identify hierarchal structures as most vulnerable to these types of inequalities (Moody & White, 2003).

RQ1: What structural properties best describe the international mobilization hyperlink network for SIDS?

Knoke (1990) argues that an international network of NGOs often behaves much like a political economy. That is to say hierarchies emerge as a result of competition for scarce resources among actors. Empirical studies suggests that international mobilizing networks tend to be hierarchal in which relatively few actors dominate the flow of information or resources (Lake & Wong, 2009), and pathways between peripheral nodes are dependent on these actors (Carpenter, 2011). These include a few large, well-connected organizations that shape norm adoption and consequently the international human rights agenda (Brewington, Davis & Murdie, 2009; Lake & Wong, 2009).

Network Power

Because the challenges facing vulnerable islands are so massive and complex, solutions require the involvement of networks of international agencies that share intersecting interests. The network approach emphasizes that power is inherently relational. Individuals do not have power in the abstract, they have power because they can dominate others: ego's power is alter's dependence (Hannman & Riddle, 2005). Because power is a consequence of patterns of relations, the amount of power in social structures can vary. Power relations have been described as the right and obligations of actors to issue or obey rules (Keck & Sikkink, 1998). In power relations one actor or agency is often imposing rules, norms or guidelines onto another.

Previous research looking at the structure of international mobilization networks suggests that network power can be identified by locating the organizations that set the agenda for the

network as whole. Keck and Sikkink (1998) posit that international NGOs set the agenda and standards for mobilization, which at times can be at odds with the agenda and standards of the mobilizing groups at the community level. This body of research also reports a disproportionate level of influence among a handful of central actors within the international NGO network (Carpenter, 2011; Brewington, Davis, & Murdie, 2009; Hafner-Burton, 2009; Keck & Sikkink, 1998; Moore, 2003). Several sociological studies assert that international agencies have the ability to set the global agenda; these same agencies represent an essential entry point for any emerging social issue to reach the global political sphere (Bob, 2009; Carpenter, 2011; Nelson, 2009). As such, influence exerted among a few, central actors in the global network can be explained by examining the communication ties, and diffusion of information, controlled by certain organization or network members (Carpenter, 2011).

Carpenter (2011) notes that analysis of structural position among actors is necessary to understand the wider networks of meaning and power dynamics within the international mobilization network. Position, he argues, illustrates which actors hold the power to set the network agenda. Often this achieved by specific actors who will set the standards for inclusion or entry (Bob, 2009; Castells, 2010). Scholars such as Bob (2009) and Keck and Sikkink (1998) similarly assert that position within the global network explains why transnational NGOs are growing especially powerful amid the process of globalization and why some specific actors are especially influential.

RQ2: Which organizations are most central within the international mobilization hyperlink network for SIDS?

Hyperlinks are considered a public acknowledgement of inter-organizational agreements, and resources are conceptualized as information access via hyperlink relations. Influential actors

are identified through tests designed to determine web authority (i.e, directed degree centrality) information control (i.e., betweeness centrality) and access to diverse resources (i.e., closeness and eigenvector centrality).

Degree centrality is used to determine index power, an important feature for hyperlink networks. This is a fairly straightforward assessment of network power based on the extent of in-degree hyperlinks, which boost visibility of highly central organization.

From the perspective of consensus mobilization theory, influence is conceptualized as the ability to control information, to recruit others and/or constrain movement. Betweeness centrality is used to identify gate-keepers within a network. As such, betweeness centrality provides the opportunity to determine if NGOs, or other types of organizations, serve as gate-keepers in the observed network.

Eigenvector centrality can be conceptualized as positional power within the network based on access to other central organizations. Since resource mobilization is contingent upon the ability to mobilize through the process of exchange and dependence, it is a well-suited measure for influence from the resource mobilization perspective. This study identifies key players based on eigenvector power, in order to measure influence through the resource mobilization model.

Reciprocity

Rogers and Marres (2000) define hyperlinks as inscriptions of communicative and strategic choices on the part of site producers. More specifically, these authors argue that the degree to which linking is reciprocal is one way to assess whether organizations acknowledge each other. In the case of hyperlinks, reciprocal links can enhance the recognition of each member of the dyad in search result and lead publics from one website back to a website which

recognized the organization (Shumate & Lipp, 2008). Beyond the structural necessity for interconnectivity, hyperlinks seemingly play a purposeful role in the pattern of ties for online networks. Hyperlinks serve a function, enhance credibility, visibility and search scores among linked organizations. Rogers and Marres (2000) observed that hyperlinks serve as a form of acknowledgement across nodes linked to one another. Reciprocating ties enhances the other organization's position, favoring collective visibility over individual prestige. Supporting this interpretation of the role of function of reciprocated hyperlinks, Shumate and Dewitt (2008) found that NGOs are aware of which organizations hyperlink to them and are more likely than by chance to reciprocate. This suggests that reciprocity serves as an indication of agreement, a precondition for unified action. Such reciprocity further supports the larger argument that to hyperlink is a strategic communication choice (Jackson, 1997; see Shumate & Dewitt, 2008).

However, Shumate (2012) argues that there is a cost involved in reciprocity, in a competitive environment reciprocated tie boosts the prestige of the other organization. Increases in reciprocated ties across the mobilization effort could therefore suggest that the network is advancing toward the public good since public goods are non-excludable (Olson, 1971).

RQ3: To what extent are hyperlinks reciprocated in the international mobilization hyperlink network for SIDS?

Networks of like-minded international organizations are facilitators of collective action. As Baldassarri and Diani, (2003) note, a long-term movement cannot occur without inter-organizational networks of collective action. Transnational non-governmental organizations (NGOs), governments, and international donor agencies generally work together in partnerships with the goals of improving the delivery of social services and catalyzing transformative social change (Krasner, 1983). The patterns of collaboration resulting from these partnerships represent

a form of networked governance (Rhodes, 1996). Networks work as the social system that facilitates or prevents the formation of alliances and partnerships to move a mobilization effort forward.

Homophily

Homophily can explain strategic alliances among organizations with shared qualities; theories of homophily posit a greater tendency for a tie from organizations that both share a common attribute and a lower tendency for a tie from organizations that not share a common attribute. In the situation where uncertainty exists organizations use alliances to reduce uncertainty that could threaten performance or survival (Shumate, et al., 2005). These purposeful connections serve a number of purposes.

Similar organizations are more likely to have similar or compatible operating systems and practices. This compatibility helps partner organizations cooperate more effectively with each other. Since organizations differ based upon their experiences, organizations that have similar experiences during certain life stages may be similarly influenced by those experiences (Shumate, et al., 2005). This common background often leads to a preference for alliances among members of a similar organizational cohort. Previous research has demonstrated that factors such as, organizational type (Atouba & Shumate, 2010), level and proximity (Barnett & Choi, 2011) can all contribute to an understanding of homophily in social networks.

Type of Organization

The primary difference between IGOs and NGOs is that IGOs are established by international agreement among nations and NGOs are not (Jordan & Feld, 2001). IGOs are established by international agreement among nations, whereas NGOs are often founded by registering the organization in a single nation (Jordan & Feld, 2001).

Although IGOs and NGOs are increasingly cooperating with one another to achieve common goals (Keck & Sikkink, 1998; Krasner, 1983), these organizations are established in different ways and have different operating structures. For example, IGO decision making is governed by the organization itself, or the nation states belonging to the organization, while NGOs generally operate with a board of directors and are subject to the influence of individual or organizational members, volunteers, and/or granting agencies (Jordan & Feld, 2001). These differences may influence the pattern of relationships in the development network (Atouba & Shumate, 2010). This research explores whether similar types (inter-governmental, non-governmental, financial and research) of groups tend to hyperlink.

Atouba and Shumate (2010) suggest that networking is regarded as a strategic inter-organizational response to globalization which produces a complex business-like environment inhabited by more sophisticated consumers than in the past. International NGOs, international financing organizations, governments, and international donor agencies generally work together in partnerships with the goals of improving the delivery of social services and mobilizing toward social change (Atouba & Shumate, 2010). Keck and Sikkink (1993) argue that collections of NGOs leverage IGOs to access resources, ideas, strategies and political actors. International scholars have argued that IGOs leverage NGOs in order to access community-level groups and civic movements (Steffek, Kissling, & Nanz, 2008). The current study looks for evidence of partnerships through hyperlinks across different types of organizations for evidence of advancement toward the public good.

Proximity

Organizations may choose to create link with other local organizations to reduce costs (Rosenkopf & Almeida, 2003). Groups located in the same geographic area often have access to

similar environmental resources, speak the same language and understand a shared culture. All these factors create similar or compatible operating systems and practices thereby increasing the potential efficiency of collaboration. On the other hand, global regions can create imbalances between partners, meaning one group may be not be able to dedicate the same level of resources to the collaboration. For example, Shumate, Fulk and Monge (2005) examined formal alliances between organizations, finding that common region predicted alliances between HIV/AIDS International NGOs. However, Shumate and Dewitt (2008) did not find support that common region predicted alliances in a hyperlink network.

While internet technologies may have led to the transcendence of the regional divides across international agencies (Castells, Yazawa, & Kiselyova, 1995; Kreimer, 2001; Lane & Dominguez, 2003; Mercer, 2006) in some respects, regional divisions continue to persist. Shumate and Dewitt (2008) found a North/South divide continues to exists within the hyperlink network among non-profit agencies. Shumate and Dewitt (2008) say that this divide can be explained by differences in strategy (see also, Ahmad, 2006; Dubash & Oppenheimer, 1992). These findings suggest that savvy agencies leverage ties to insert themselves into central or influential positions within the network. The current study explores whether groups with a global orientation tend to hyperlink to other global organizations, if regionally-specific organizations hyperlink to other organizations in the shared region.

Previous research suggest that proximity plays a role in the coordination among mobilizing groups because organizational populations in the same geographic area will have access to similar geography-related environmental resources; these resources might include costs, labor pool, and political opportunity structures. Barnett and Choi (2011) mapped the structure of the international hyperlink network as a global communication system (see also

Barnett, 2001) finding little direct communication across the regional boundaries. Locality, or geographic similarity, has been studied in other contexts such as collaboration and innovation development, finding geographically localized knowledge flows (e.g., Rogers & Larsen 1984; Saxenian, 1990; von Hippel, 1988). Overall, these studies suggest that geographic proximity reduces the cost and increases the frequency of personal contacts that build social relations between organizations. Rosenkopf and Almeida (2003) note that distant contexts may offer ideas and insights about alliances and the mobility. These studies have broad implications in terms of power differentiation, more specifically domination of Northern NGOs, in the global discourse of social issues and the dissemination of resources. Imbalances between regions could suggest dependency on Northern NGOs. For this study, proximity is conceptualized as groups with projects in the same region.

SIDS are broken down into three geographic regions: the Caribbean; the Pacific; and Africa, Indian Ocean, Mediterranean and South China Sea (AIMS) (United Nations Department of Economic and Social Affairs, 2014). This study looks at patterns of hyperlink relations within and across groups with regionally-specific projects in Caribbean, the Pacific and AIMS.

Level

Partnering with organizations of similar status, particularly among high-status organizations, serves a signalling function to sources of external resources, facilitating access to those resources (Podolny, 1994). That is, if high-status organizations collaborate, that partnership sends cues to other groups about the quality of output, prompting investment from groups such as government agencies or financial institutions. Additionally, status similarity makes it more likely that both parties will exhibit increased levels of fairness and commitment in sharing both

the costs and benefits of an alliance. Organizations with unequal status, are generally unable dedicate the same level of resources to an alliance (Chung, et al., 2000, p. 4).

Studies among this body of research suggest that several predictable patterns of connections demonstrate strategic alliances among international agencies. Podolny (1994) asserts that high-status organizations create alliances to attract external resources. That is, if high-status organizations collaborate, that partnership sends cues to other groups about the quality of output, prompting investment from groups such as government agencies or financial institutions, thereby strengthening the network. Additionally, status similarity makes it more likely that both parties will share the costs and benefits of an alliance. On the other hand, organizations with unequal status, are generally unable dedicate the same level of resources to an alliance (Chung, et al., 2000, p. 4).

Organization may choose to link with organizations with a similar status because it improves the likelihood of shared contributions, and can attract external resources (Podolny, 1994). That is, if high-status organizations collaborate, that partnership sends cues to other groups about the quality of output, prompting investment from groups such as government agencies or financial institutions. Additionally, status similarity makes it more likely that both parties will exhibit increased levels of fairness and commitment in sharing both the costs and benefits of an alliance. Organizations with unequal status, are generally unable dedicate the same level of resources to an alliance (Chung, et al., 2000, p. 4). For this research, status is examined by looking at the tendency for hyperlinks among groups within the same level. For the purposes of these tests, level is conceptualized by organizational reach, at the country, regional or international level.

Examinations of global collective action emphasize the relevance of international partnerships and transnational human rights and non-profit agencies within the larger global sphere (Keck & Sikkink, 1998; Moore, 2003). This study explores patterns of hyperlink relations within and between groups based on organization attributes. More specifically, this research looks at whether groups tend to hyperlink with groups at the same level of operation (country, regional, global), regional project focus, and type of organization.

RQ4: Does the international mobilization hyperlink network for SIDS demonstrate tendencies toward homophily based on organization type, level or regional focus?

A hyperlink is a structural unit that connects two web pages. The structure of a typical web graph consists of web pages as nodes, and hyperlinks as edges connecting between two related pages. Ackland, O'Neil, Bimber, Gibson, and Ward (2006) stress those hyperlinks "help to establish the structure and boundaries of political communication on the web" (p. 4).

Network structures can be seen as displaying high levels or low levels of power or cohesion as a result of variations in the patterns of ties among actors. Network structure can tell us a great deal about the way a system functions based on the properties of the network as a whole (Burt, 1980). Networks can be hierarchal or polycentric. A polycentric structure represents a decentralized management model for mobilization. A polycentric network is characterized by multiple clusters of exchange connected by a few sparse connections (Baldassarri & Diani, 2007). Networks with structural features leading to control of resource flows generate power inequality (Willer,1999). Typically, scholars identify hierarchal structures as most vulnerable to these types of inequalities (Moody & White, 2003).

For this study, network features are examined through tests designed to spot hierarchies. The degree of inequality or concentration of power is indexed and analyzed for evidence of

hierarchies. More specifically, the distribution of nodes is examined. The observed network is then tested for core-periphery structure, and subgroups. Those subgroups are counted and compared to determine if inequalities emerge. Action hierarchy is conceptualized as the overall network degree centralization. This is a feature in which one or few nodes are highly connected to sets of actors that are not connected to one another (i.e, k-instar centrality). Star parameters are useful substitutes for network centralization measures, which have been more commonly reported in communication research (Shumate, 2012).

Building from Granovetter's articulation of the strength of weak ties, network clusterability refers to a condition that could facilitate mobilization. Grannovetter (1983) gave the example of an Italian community of the west end in Boston in 1962, which was unable to fight the "urban renewal" process which ultimately destroyed it. He asserts that that a lack of weak ties could explain constraints to mobilization. When groups were divided into kinship and lifelong friendship, cliques were relatively closed and clique members were unable to connect across cliques. In other words, no bridge existed. Granovetter instead asserts that more weak ties are more capable of acting in concert. Strong ties breed local cohesion and macro fragmentation (Granovetter, 1983). The current study looks at structural properties in the form of subgraphs and cohesion across groups to determine the potential to mobilize based on the number and connectivity of cliques and components within the network.

The presence or absence of a directional link, of bi-directional links, and of missing links has been discussed in terms of the everyday "politics of association" illustrated on the web (Rogers & Marres, 2000). For example linked sites give the impression of consensus on a topic, a sense of critical mass support, and the impression of a broad support base connecting previously disparate groups and their audiences; linked groups create a sense of "critical mass"

that may be lacking in the real world (Marwell, et al., 1988). On the other hand, the absence of a link may be thought of as an act of boycotting, or an attempt to de-couple an organization from an issue space, reducing its presence and its rank (Park, Barnett, & Chung, 2011; Park & Thelwall, 2003). In this way, the self-organized structure of a hyperlinked network takes on a new meaningfulness.

Previous studies have found collaboration among international organizations changes over time based on variation, selection, and retention of strategic choices about their communication linkages (Shumate, Fulk, & Monge, 2005). These types of changes have substantial impact on the functioning of the entire community as well as the organizations themselves (e.g., Powell, White, Koput, & Owen-Smith, 2005). Florini and Simmons (2000) note that network research can help us better understand power relationships, issue adoption, and effectiveness among international mobilizing groups. Looking at the centrality of specified organizations at two points of time can indicate if those organizations are becoming more or less influential over time.

RQ5: How do structural features of the international mobilization hyperlink network change over time?

This research looks for variation at the network and node levels to access whether and to what extent the network changed over time. Florini and Simmons (2000) note that network research can help us better understand power relationships, issue adoption, and effectiveness among international mobilizing groups. Looking at the centrality of specified organizations at two points of time can indicate if those organizations are becoming more or less influential over time. The network explicated in this study is examined for multiple types of influence (i.e., degree centrality, betweeness centrality, and eigenvector). Variation is defined as changes in

routines, competencies, resources, forms, or most importantly for this research, network ties (Campbell, 1965). As such, rate of variation indicates the amount of change that occurs in a given time period (Shumate, 2012).

Conclusion

The process of mobilization begins with alliance building, leading to the establishment of a more coordinated and sustained movement over time (Ghimire, 2005). While the stages of mobilization are interrelated, the theoretical underpinnings of each stage are best described by different communication theories. This type of multiplicity is typical of network organizational forms because information networks are not vertically organized. They are dynamic, and flexible. For mobilization efforts, the inter-related, layered, and multi-theoretical character of a network is exaggerated as the network moves from local to global. Fortunately, network analysis techniques accommodate the dynamic nature of communication and information networks (see Contractor, Wasserman & Faust, 2006; Monge & Contractor, 2003).

Scholars continue to ponder, explain and predict how and why certain network patterns emerge. Atouba and Shumate explain that networks are strategic inter-organizational responses to globalization (2010). Pilny and Shumate echo this assertion, arguing that many international collective action networks exist to produce tangible public goods (Pilny & Shumate, 2013). It is widely understood that networking is a strategy, at the individual, local and global levels. Globalization scholars posit that this strategic networking is especially prevalent because of the growing interdependence across nation states, and rise of global social issues.

Network analysis techniques are used as a framework for exploring the research questions presented above. These concepts are operationalized in terms of structural features of hyperlink patterns among organizations in the observed network for SIDS. Network analysis can

also identify communication-related roles of actors (e.g., stars, gatekeepers, and isolates). These two functions can help predict outcomes for action mobilization by identifying influential actors. Thus, helping to explain why groups develop certain attitudes (Pollock, Whitbred & Contractor, 2000). This approach is applied directly to theories of diffusion, dependency and exchange, thereby informing broader theoretical frameworks of mobilization and globalization.

Beyond the research questions outlined throughout this chapter, this research seeks to answer general questions about changes in network properties and actor position within the international network as illustrated by patterns of hyperlinks. To meet this end, hyperlink network analysis is one way to improve scholarly understanding of the structural network and dynamics of global mobilization for vulnerable populations.

CHAPTER 3

Methodology: Network Concepts and Operationalizations

The social network approach is grounded in the notion that the patterning of social ties in which actors are embedded has important consequences for those actors (Freeman, 2004, p. 2). Network analysis is used to study power relationships, issue adoption, and effectiveness among mobilizing international agencies (Florini & Simmons, 2000). Network analysts assume that social units are interdependent. Organizational interdependence may take multiple forms, and networks can display a wide range of structures (Powell, 1990). Baldassarri and Diani (2007) argue that in order to advance our understanding of the potential for mobilization it is necessary to first look at the overall properties of interdependent, inter-organizational networks (Baldassarri & Diani, 2007).

Following the logic outlined in Baldassari and Diani's exploration of civic mobilization networks, this study does not present a classical hypothesis-testing analysis, but simultaneously explores and describes the main features of the network, while testing some working hypotheses along the way (see Baldassarri & Diani, 2007).

Procedure

This is a study of the international mobilization network for SIDS. As discussed in previous chapters, this network represents hyperlinks among agencies working on projects that are directed at helping SIDS adapt to climate change. Nodes represent organizations and ties are directed hyperlinks. A variety of procedures-- including the calculation of density, reciprocity, three measures of centrality, Bonacich's eigenvector analysis, and cluster analysis--are performed. These calculations inform all the research questions, to varying degrees. The

following chapter describes the process of data collection, data cleaning, constructing the network and a set of measures that will be used to answer research questions. These measures are compared at two points in time to look for emergent structure and node-level position changes within the international mobilization hyperlink network for SIDS.

Data Collection

Data were collected using SocSciBot webcrawler. SocSciBot crawled a list of websites to produce the network, illustrating which websites were connected and the pattern of connection. Next, the network is analyzed using Pajek and UCINET and visualized using Netdraw. The process for this research required the following steps:

(Step 1) determine the nodes for inclusion in the network and network construction (i.e., the universe of analysis);

(Step 2) web crawl indicating hyperlink relations between each possible binary relation (i.e., data collection);

(Step 3) clean the data to produce the specified network in preparation for analysis;

(Step 4) generate socio-graphs to examine structure and descriptive statistics (i.e., network visualization and descriptive analysis);

(Step 4) analyze network using UCINET and Pajek.

Constructing the Network

The first step of this study, the construction of the network, focuses on the process of identifying which agencies represent SIDS in the international effort to address and adapt to climate change. Rather than pulling a sample to study the overall population, the goal of this research is to gather the relations of the entire population. As such, specification for inclusion in the network is essential to analysis. This study does not aim to generalize findings. Instead, it assesses and monitors a particular network to inform future research and contribute to broader body of hyperlink research, through a case study approach.

This research starts with a directory of agencies in order to identify international organizations working on projects specifically for SIDS. Organizations are first identified using the *Directory of Development Organizations (11th edition, 2011),* a directory of 70,000 development organizations working toward Millennium Development Goals by 2015. This directory is organized by region and state. That is to say, each region and each nation state have a directory within the larger directory. Each country lists development organizations with projects in that country. Each of the 52 vulnerable island nations are included in the directory, with a list of development agencies and some general information about the nature of each organization. From this directory, a list of "seed" organizations was identified. All of these organizations met the following criteria (1) organization is designated as "international" in the directory and (2) organization is listed in one or more of the 52 nation-level directories as having an ongoing project. The directory provides websites for each organization listed. Thus, international agencies, listed in any of the 52 vulnerable island nation subdirectories, were added to a list of "seed" websites for a preliminary webcrawl. In total, 68 organizations met the criteria for this

research. See Table 1.1 (Chapter 1) for designated SIDS at the time of data collection (March, 2013).

Preliminary Webcrawl

A hyperlink is a structural unit that connects two web pages. The hyperlink contains the URL of the destination page. In a preliminary phase of this study, additional organizations were identified using a specialist information science webcrawler called SocSciBot. The webcrawler collects hyperlinks from each website, as well as the frequency of outgoing links and use of social media platforms. The first webcrawl was used to identify organizations that may not be listed in the directory, but are directly connected to two or more of the seed organizations. A second preliminary webcrawl collected the hyperlink network among organizations directly connected with the *Small Island Developing Nations Network* -- a digital network specific to SIDS.[4]

To summarize, creating the international mobilization network for SIDS for the this research involved a three-step approach. First, Inter-governmental organizations (IGOs), international non-governmental organizations (NGOs) and international funding organizations (FOs) involved in region-specific projects for small-island developing nations are identified to develop a core network of international and transnational agencies. Second, government agencies, online communities and community-level groups directly connected with the core agencies are identified, and added to the network. Third, groups connected with a specific international initiative to help small-island developing nations (i.e., the Small Island Developing Nations Network) are identified and included. The resulting network included 243 groups.

[4] The resulting network includes 243 groups, representing the core 68, 110 transnational funding and government agencies, and 75 groups affiliated with SIDS digital initiative. After cleaning data by removing redundant organizations, and inactive and unrelated links, the new network consists of 197 groups.

Data Cleaning

One of the functions of the SoSciBot crawl allows for standardization among home page file names. This process treats different versions of a website home page as the same for the analysis, thereby reducing redundancy. All remaining self-loops, (i.e., inner-agency hyperlinks) were removed using Pajek. The remaining websites were checked to make sure each match the criteria for inclusion. This means organizations that were not connected to at least two organizations, OR organizations that do not have a specific project aimed at assisting one or more small island developing nation were not included in the network for analysis. Anomalies (such as events, conferences or meetings) were identified and removed from the data set[5]. After cleaning data by removing redundant organizations and unrelated links, 197 network nodes remain.

Once the relations are mapped, network ties are indexed and analyzed for network properties, and through this process central and influential nodes are identified. First, actors and attributes are explained. Second, dyadic relations and subgroup patterns are measured and explained. Centralization and centrality are then described for the network as a whole and among nodes. All of these measures are used to determine structural properties of the network.

Hyperlink Network Graphs

Graphs serve as the basis for analyzing structural properties of a network. More specifically, graph theory (e.g., Haray, 1969) serves as a framework for describing various characteristics of a network such as density and centralization. In the matrix form, sites are listed and ties are dichotomized as either (1) a tie exists, or (0) a tie does not exist. Rows and columns represent nodes (websites), while entries in the cells are hyperlinks between the nodes from the rows to the columns. In the table below, the matrix indicates a hyperlink from the organization *Adapting to*

[5] Inactive links at the time of data cleaning March, 2014

Climate Change (acclimate-oi.net) to the *Indian Ocean Commission* (*coi-ioc.org*), and a directed link from the *Asian Development Bank* (*adb.org*) to the *Asian Development Institute (adbi.org)*.

Operationalization: The information in a directed graph is recorded as a square 1-mode adjacency matrix (not necessarily symmetric) where X(i,j) = 1 if i is connected to j and X(i,j) = 0 otherwise(Borgatti, Everett & Freeman, 2002).

Table 3.1

First Four Nodes of the International SIDS Network

	Adapting to Climate Change	Indian Ocean Commission	Asian Development Bank	Asian Development Institute
Adapting to Climate Change	0	1	0	0
Indian Ocean Commission	0	0	0	0
Asian Development Bank	0	0	0	1
Asian Development Institute	0	0	0	0

Multiple lines deleted (n=1) and loops removed.

Matrices are also used to represent derived connections between pairs of nodes, such as the distance between nodes (Borgatti et al., 2013, p. 19). Table 3.2 is an example of the distance matrix among the first five nodes in the main component of the hyperlink network. The distance network is an example of a valued network. The cell entries now represent the distance between pairs of nodes. This is an example of a symmetric matrix. Both the hyperlink adjacency matrix and distance matrix are one-mode, square matrices. The rows and columns in both matrices are network nodes.

Table 3.2

Distance Matrix among First Five Nodes Hyperlink in the Main Component

	Asian Development Bank	Asian Development Institute	African Development Bank	Asian International Economists Network	Asia-Pacific Economic Cooperation
Asian Development Bank	0	1	1	1	1
Asian Development Institute	1	0	2	2	2
African Development Bank	1	2	0	2	2
Asian International Economists Network	1	2	2	0	2
Asia-Pacific Economic Cooperation	1	2	2	2	0

Multiple lines deleted (n=1) and loops removed.

Some network techniques will shrink the network. For example some measures of centrality require connectivity across all nodes. Tests focusing on components, clusters or subgraphs within the network also require shrinking the network (e.g., focusing on connected nodes within the network) or similar transformations. In some cases the research question is intended to examine blocs or components of the network within the network, rather than the network in its entirety. In some cases it is simply more meaningful to examine nodes that are active or central to network. In all such cases isolates are dropped for analysis. Thus, descriptive characteristics of network structure will often include two analyses: (1) 197 node network with the isolates included and (2) 153 node network with inactive links and isolates dropped from the network.

Network Properties

A number of metrics are used to calculate network properties and actor position. These are computed at five levels (Wasserman & Faust, 1994). (1) The actor-level is the level of participants represented by the nodes, in this case, organizations or agencies mobilizing on behalf of vulnerable islands. (2) The dyad level refers to pairs of organizations, and their hyperlinked relationship. (3) Triad level examines three nodes at a time. (4) Subgroups are a way to examine which organizations belong to what groups within the network. (5) The global level refers to the network as whole. Each level of analysis helps answer Research Question 1: *What structural properties best describe the international mobilization hyperlink network for SIDS?*

Actor-Level

At the actor-level, nodes are tested for various types of centrality in order to answer Research Question 2: *Which organizations are most central within the international mobilization hyperlink network for SIDS?*

Centrality is a characteristic of an actor's position in a network, a micro-level measure. Broadly defined, centrality refers to nodes that are in the "center" of the network. These centrality measures are typically used to measure power or influence of specific actors within the network. Once actor-level measures are calculated, network measures are reported as the average value for each centrality measure. The same centrality discussed here will be computed at the global-level; as such, operationalization includes both actor and network-level measures. Most often, the network level is an aggregate or average of the node values.

Degree centrality is used to measure web authority. Degree centrality identifies nodes that are the most connected within the network. This will identify nodes with web authority within the hyperlink network.

> *Operationalization:* For a given binary network with vertices v1....vn and maximum degree centrality cmax, the network degree centralization measure is S(cmax - c(vi)) divided by the maximum value possible, where c(vi) is the degree centrality of vertex vi. (Freeman, 1979)

Betweeness centrality is used to measure influence through the lens of consensus mobilization. It is typically used to measure information control. Betweeness centrality refers to node(s) located between groups of nodes (e.g., gatekeepers, brokers and liaisons).

> *Operationalization:* For a given network with vertices v1....vn and maximum betweenness centrality cmax, the network betweenness centralization measure is S (cmax - c(vi)) divided by the maximum value possible, where c(vi) is the betweenness centrality of vertex vi (see Freeman, 1979).

Closeness centrality refers to the node(s) relatively close to all other nodes. It is typically used to measure power in terms of direct bargaining and exchange (Hanneman & Riddle, 2005, ch. 10). Thus, it is conceptualized as influence in the context of resource mobilization theory. Because of some limitations related to closeness centrality measurements, this study also measures two variations of closeness, Eigenvector of geodesic distances, and Bonacich power. These are both alternative measures to closeness centrality, Eigenvector allows for measurement in a disconnected network. Bonacich power can account for directionality in the network.

Closeness Operationalization: The farness of a vertex is the sum of the lengths of the geodesics to every other vertex. The reciprocal of farness is closeness centrality (Freeman, 1979).

Eigenvector Operationalization: Given an adjacency matrix A, the centrality of vertex i (denoted ci), is given by ci = α SAijcj where a is a parameter. The centrality of each vertex is therefore determined by the centrality of the vertices it is connected to. It follows that the centralities will be the elements of the corresponding eigenvector (Bonacich, 1972).

Bonacich's Power Operationalization: Given an adjacency matrix A, the centrality of vertex i (denoted ci), is given by ci =SAij(α + β cj) where α and β are parameters. The centrality of each vertex is therefore determined by the centrality of the vertices it is connected to. The value of α is used to Normalize the measure, the value of β is an attenuation factor which gives the amount of dependence of each vertex's centrality on the centralities of the vertices it is adjacent to (Bonacich, 1987).

Additional measures of centrality are measured in order to assess cross-measure reliability, and examine any major deviations across measures as an exploratory aspect of actor-level analysis. Changes in actor position, across these measures are compared between two points in time.

Dyad-Level

At the dyad-level, relations are measured to answer Research Question 3: *To what extent are hyperlinks reciprocated in the international mobilization hyperlink network for SIDS?*

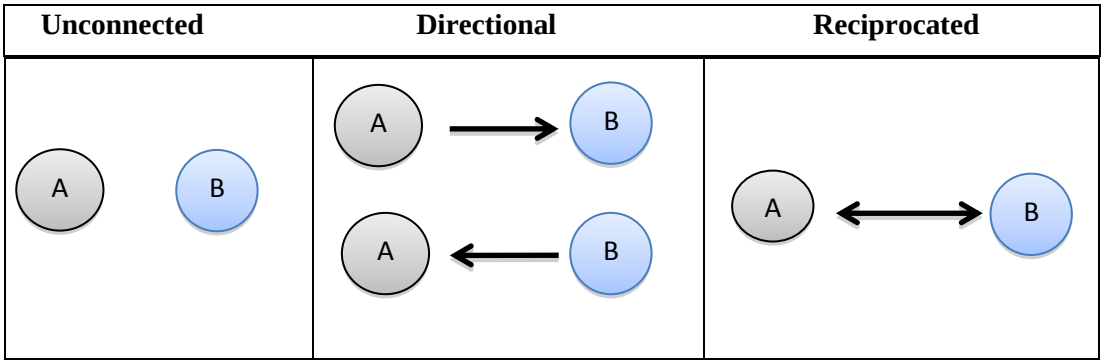
A tie is reciprocated if: when a tie is connected from actor A to actor B then there is a tie from actor B to actor A. The dyad-based method counts the number of dyads connected by a tie (which may or may not be reciprocated) and calculate the proportion of dyads that have reciprocated ties.

Operationalization: The number of reciprocated dyads divided by the number of adjacent dyads.

Reciprocity is measured as the prevalence of mutual relationships between organizations. With directed data, there are four possible dyadic relationships (1) A and B are not connected (2) A hyperlinks to B. (3) B sends to A. (4) A and B send to each other. The fourth relationship is reciprocal.

Figure 3.1

Possible Dyadic Structures



Triad-Level

At the triad-level, patterns will be analyzed to answer Research Question 5: *How do features of the international mobilization hyperlink network change over time?*

Triangles are network structures in which three nodes are all connected to one another (Robins, Pattison, & Woolcock, 2005). *Transitivity* measures a tendency for a tie from A to C to exist if a tie from A to B and a tie from B to C exist. If A→ B & B→ C & A→ C then the three are transitive. Like reciprocity, transitivity seeks to measure balance within the network, asymmetric transitive triangles may be unstable, a signature of a hierarchal structure, a signal of inequality or the formation of exclusive groups (e.g. where two actors connect, and exclude the third). The prevalence of such patterns provides insight into the potential to mobilize actors within the network, when compared over time. To answer Research Question 4, transitivity is compared between Time 1 and Time 2.

Operationalization: Three vertices a,b,c, taken from a directed graph are transitive if whenever vertex a is connected to vertex b and vertex b is connected to vertex c then vertex a is connected to vertex c. The density of transitive triples is the number of triples which are transitive divided by the number of paths of length 2 (i.e. the number of triples which have the potential to be transitive).

Triad Brokerage Roles

At the triad-level, roles will be analyzed to answer Research Question 2: *Which organizations are most central within the international mobilization hyperlink network for SIDS?*

Organizations that hold brokerage positions are identified to find influential nodes. brokerage roles are determined by a nodes position between other nodes. Brokerage roles are identified through the examination of triadic relations within the network (Marsden, 1982).

Brokerage occurs when, in a triad of nodes A, B and C, A has a tie to B, and B has a tie to C, but A has no tie to C. That is, A needs B to reach C, and B is therefore a broker. When A, B, and C may belong to different groups, 5 kinds of brokerage are possible.

Gould and Fernandez' (1989) typology of broker roles guide this analysis. This typology assigns a specific role to various formations of brokerage, to include: coordinators, consultants, gatekeepers, representatives and liaisons. Coordinates are connected within a group. Gatekeepers, consultants and representative connect between groups, in various patterns. Gatekeepers are positioned between groups, and are especially influential in terms of incoming information. Representatives are influential in information sharing from their group to outsiders. Consultants connect to and from an outside group, other than its own (Gould & Fernandez, 1989) These roles are not mutually exclusive.

Operationalization: Where G(x) is used to indicate the group that node x.

Coordinator. Counts the number of times b is a broker and G(a) = G(b) = G(c), that is, all three nodes belong to the same group.

Consultant. Counts the number of times b is a broker and G(a) = G(c), but G(b) ≠ G(a); that is, the broker belongs to one group, and the other two belong to a different group.

Gatekeeper. Counts the number of times b is a broker and G(a) ≠ G(b) and G(b) = G(c), that is, the source node belongs to a different group.

Representative. Counts the number of times b is a broker and G(a) = G(b) and G(c) ≠G(b). That is, the destination node belongs to a different group.

Liaison. Counts the number of times b is a broker and G(a) ≠G(b) ≠G(c). That is, each node belongs to a different group.

For this study, gatekeepers are especially relevant to the analysis of influence and consensus mobilization -- organizations in gatekeeping roles have the potential to constrain or facilitate mobilization.

Subgroups

At the subgroup level of analysis, the network will be tested for features to answer Research Question 1: *What structural properties best describe the international mobilization hyperlink network for SIDS?*

In some cases node cannot reach each by any path. A *component* is a part of a network that is connected within, but disconnected from other parts of a network. It is defined as a "maximal set of nodes in which every node can reach every other by some path," (Borgatti, et al., 2013, p.16) All nodes that are in the same component are more cohesive than those in separate components, even if a direct tie does not exist between two nodes. Nodes within a component are all connected, either directly, or indirectly.

Operationalization: In a directed graph two nodes are in the same weak component if there is a semi-path connecting them.

Blocks are parts into which cutpoints divide a network. *Cutpoints* are the points within the network which would break up the network into disconnected parts if a node were removed. Cutpoints may act as brokers among otherwise disconnected groups. *Bridges* are the places where the removal of a tie breaks up a network into disconnected parts.

Blocks, cutpoints and bridges describe the potential cohesiveness or fragmentation of the network. These measures will compared at two points in time to examine if the network is growing more cohesive or fragmented. Cohesiveness is measured by a decrease in the number of blocks and/or increased connectivity of nodes within blocks. Fragmentation is measured by an

increase in the number of blocks and/or decreases in connectivity among organizations within the blocks.

Core-Periphery

In order to explore the likelihood and extent of hierarchal features, the network is tested for core/periphery features. A core periphery structure has a single cohesive subgroup with a loosely connected group attached. Core members interact with other core members, while peripheral members do not interact with each other but do interact with some core actors. The core periphery model splits the nodes into either a core or periphery group, key actors are identified and the model is tested for fitness. To test the robustness of the solution the algorithm is run a number of times from different starting configurations with good agreement between these results.

Operationalization: Locates vector C such that the product of C and C transpose is as close as possible to the original data matrix. The fit function is the correlation between the permuted data matrix and an ideal structure matrix consisting of ones in the core block interactions and zeros in the peripheral block interactions. This value is maximized (Borgatti & Everett, 1999)

Global-Level

At the global-level, the network will be tested for features to answer Research Question 1: *What structural properties best describe the international mobilization hyperlink network for SIDS?*

Measures of degree and eigenvector centrality will be analyzed (operationalized above), in addition to measures of network distribution and network size. *Density* is the total number of

ties divided by the total number of possible ties. The overall density of the network is expressed as the average density of relations (Wasserman & Faust, 1994).

Operationalization: The density of a binary network is the total number of ties divided by the total number of possible ties.

In general, the standard inferential formulas for computing expected sampling variability (i.e. standard errors) give unrealistically small values for network data (Hanneman & Riddle, 2005). To determine if the observed density is statically significant, the measure is compared to a theoretical parameter of a fully connected network using the bootstrap method of constructing 5000 networks--by sampling random sub-sets of nodes each time, and computing the density each time.

Network distribution can be described by measuring the distance across nodes in the network. Measures of distribution are calculated, including average geodesic distance and average degree. *Geodesic distance* is the number of relations in the shortest possible walk from one actor to another. Average *actor degree* is the extent to which actors may be constrained by, or constrain others by summing the direct connections of each node. Geodesic distance and average actor degree are used as measures to examine the network's opportunity structure. These are compared across two points in time.

Centralization indicates how unequal the distribution of centrality is in a network or how much variance there are in the distribution of centrality in a network. These are aggregates of the actor-level measures of centrality described and operationalized above. At the network level, centrality measures represent the extent to which closeness (and Eigenvector), betweenness or degree characteristics exists on average, across the network.

Change over Time

Network features are compared at two points in time to assess variations and magnitude of change. Once network characteristics are measured and reported, network changes are measured by comparing the network in 2013 to the network in 2014. These comparisons are the basis for Research Question 5: *How do features of the international mobilization hyperlink network change over time?*

More specifically, the direction and magnitude of change is measured. Whole network changes in density, centralization and network statistics are compared at each time point. Lastly, significant nodal position changes are examined and explained. The discussion portion of this study interprets and translates the results introduced in the next two chapters (network characteristics and results). The discussion following these results describes the meaningfulness of the results for the context of the mobilization network for SIDS.

Attributes

Attributes and hyperlink patterns at the dyad-level are combined to answer Research Question 4: *Does the international mobilization hyperlink network for SIDS demonstrate tendencies toward homophiliy based on organization type, level or regional focus?*

An attribute refers to a specific property of an organization which is independent of the connections to other organizations (Wasserman & Faust, 1994) these are specific characteristics that distinguish nodes from one another. Each node in the international mobilization network for SIDS is assigned three different attributes for analysis. The nodes are classified based on: the type of organization, the level of the organization and the geographic focus of the organization's efforts among SIDS.

These attributes are tested for evidence of homiphily for each attribute. In order to explore tendency for homophily, an attribute matrix is created to reflect differences and similarities for each dyadic relationship. Attribute-based hyperlink patterns are subject to a global test of difference based on random distribution in order to test for significance of observed effects. This process is similar to a standard chi square test, except distribution is constructed using a randomization procedure across 10,000 trials, rather than using the chi-square. The expected number of ties and observed number of ties provide a measure for magnitude (i.e., the value of the observed ties relative to the expected value).

Type

The first attribute is categorical, nodes were coded based on the organization's primary function. Nodes are classified as either: inter-governmental (IGO), non-governmental (NGO), funder (FO), governmental (GOV), education/research (RES) or "other".

IGOs: Inter-governmental organizations. Members of the IGOs are governmental representatives of multiple nation states. These organizations are established by international agreement among nations.

NGOs: Non-governmental organizations whose primary aim is to influence publicly some form of social change (Khagram,et al., 2002, p. 6.) and whose members are not government representatives. The primary difference between IGOs and NGOs is that IGOs are established by international agreement among nations and NGOs are not (Jordan, Archer, Granger, & Ordes, 2001).

FOs: Financial organizations whose primary function is the distribution of funding for climate research, adaptation efforts and/or economic development efforts specifically for SIDS.

RES: Research or information agencies whose primary function is research and information sharing for helping SIDS impacted by climate changes.

OTHER: In most cases refers to commercial organizations, or telecommunication companies emphasizing information connectivity.

Data are analyzed to determine if organization type could explain observed differences in hyperlink connections within and across the 5-types of organizations. A regression model is fit to the data. The presence or absence of a tie between each pair of organizations is regressed on a set of dummy variables that represent each of the cells among the 5-by-5 table of blocks (IGO, NGO, FO, GOV, RES).

Level

The second attribute is the level of the organization. Level refers to the scope of the organization: country, regional or international. Organizations were assigned a level based on the organizational mission statement, location , and top-level domain.

Country: These are organizations affiliated with a specific problem in a specified country or country-level governmental bodies. This category was restricted to organizations and governments among the vulnerable island nations. If a specific country, which is also a SID, is noted in the organization's name, or hyperlink, the organization was coded as country-level.

Regional: Transnational groups with an organization-wide regional mission and defined geographic boundaries.

International: Groups with a global or world-wide mission statement. These also include umbrella organizations for country-level agencies.

Organization level is subject to a test of relational contingency, where observed and expected values are calculated and tested for significance. Organizational level is then recoded to represent the absolute difference between the organizational level of the two nodes. Nodes are coded (1) at the country level (2) at the regional level, and (3) at the international level. The logic of this coding is that levels represent a more precise measure of differences or similarity. That is to say, the conceptual difference between country-level and international-level is greater than the distance between regional-level and country-level; or regional level and international level. These matrices are correlated and subject to QAP analysis as outlined above.

Level is also tested using the Geary C statistic, examining the differences between the scores of each pair of actors, and weighting this by their adjacency and the Moran statistic to look for the tendency for actors who are adjacent to similarly connect with two random actors. These are only tested for level, because region and type are both treated as categorical.

Geographic Project Region

SIDS are organized into three geographic regions: the Caribbean; the Pacific; and Africa, Indian Ocean, Mediterranean and South China Sea (AIMS) (United Nations Department of Economic and Social Affairs, 2014). Nodes are classified based on either a global orientation or the specific region of focus. Organizations are assigned a region of focus based on the following criteria: (1) mission statement; (2) the number of activities or projects in a particular region as indicated in the *Directory of Development Organizations*; and/or (3) specified geographic location.

The geographic project region attribute identifies specific SIDS regions based on specific projects and goals. Thus, the third attribute is more specific than the second attribute,

organization level. The organization level captures a characteristic about the organization, while the region attribute seeks geographic specificity in terms of projects aimed at SIDS.

Global: Group is focused on at least two of the three SIDS regions – Caribbean, AIMS and Pacific.

Region-Specific: Organization only works in one of the three regions. These groups are further classified based on the specific region of focus.

- Caribbean focus
- AIMS focus
- *or* Pacific focus

In order to test for proximity-based homophily, observed and expected relationships are compared for each possible dyadic combination by region. That is to say, the test calculates the relative difference between the presence or absence of each attribute among all possible dyadic attribute combinations (e.g., both Caribbean, one Caribbean, neither Caribbean), this is repeated for each region . Observed and expected counts for each combination are calculated based on randomized permutations. The direction and magnitude of these differences provides information about the tendencies in the observed network to hyperlink with other organizations working in the same region and allows a comparison to tendencies for region-specific organizations to hyperlink outside of their own region.

CHAPTER 4

Results Part I: Network Characteristics

Networks constitute a way of thinking about social systems with a focused attention on the relationships among and across actors in the network. The network of interest is the international mobilization hyperlink network for SIDS. The observed network includes 197 organizations, with 673 directed hyperlinks among them. The characteristics describe the hyperlink network at Time 1; changes to network structure, over time, will be analyzed in Chapter 5.

Research Question 1 asks, "What structural properties best describe the international mobilization hyperlink network for SIDS?". To address this research question, characteristics of the network ties and nodes are described and measured. These elements, in combination with their conceptualizations and definitions, are the building blocks for examining network structure and actor position. More specifically, the first step of this analysis describes the nodes, isolates, ties and attributes of the observed network.

Ties

For this study, *hyperlinks* serve as the ties between organizations -- defined as identified but uncorroborated connections which allow web surfers to travel from one website to another. A hyperlink network can be described as a specific type of computer-mediated communication network, in which website authors are interconnected by hyperlinks (Park & Thelwall, 2003). Hyperlinks have been used to inter-agency mobilization. Such studies have conceptualized hyperlinks as inter-agency endorsements indicating trust (Davenport & Cronin, 2000) and authority (Kleinberg, 1999) among connected agencies.

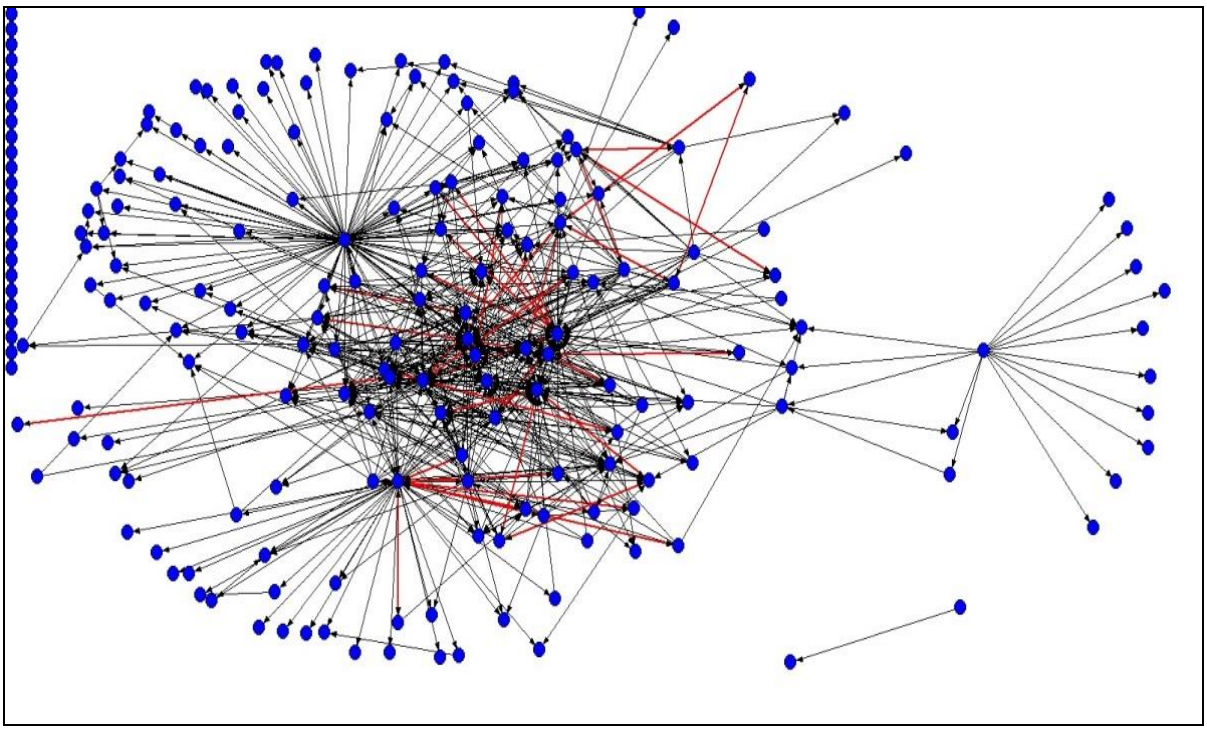
Ackland and O'Neil (2011) argue that hyperlink networks cannot proxy the exchange of real-world resources; rather, hyperlinks represent symbolic associations among groups. Further, linked sites give the impression of consensus on a topic, a sense of critical mass support, and the impression of a broad support base connecting previously disparate groups and their audiences. For example, Shumate describes the concept of connective public goods, this is the arrangement of inter-organizational hyperlinks that bring attention to network goals (Shumate and Dewitt, 2008; Shumate and Lipp, 2008).

These hyperlinks will serve as the basis for analyzing both structure and position. The hyperlink network structure consists of a group of websites connected by the hyperlinks (See Figure 4.1). The structure is not bound by the singular path followed by a web surfer; it is typically represented by a map of all possible connecting websites (Kropczynski & Nah, 2011). One way of conceptualizing networks is as graphs. For example, the link structure across websites is represented by a directed graph, in which the nodes represent organizations and directed edges represent links from one site to another.

A *directed graph* is a set of points and a set of arcs (also known as arrows or lines with heads and tails) that connect them. They are used to represent relations among nodes that are not necessarily reciprocal. This network has 197 organizations with 673 arcs among those organizations (as of March 2013). The *arc-reciprocity* value indicates the proportion of all ties that are reciprocated, nearly 12 percent for the observed network. These ties are represented as the red links in Figure 4.1. The *isolates* are organizations with no hyperlink connection to the network; these are the 25 nodes arranged along the left side of the graph.

Figure 4.1

Hyperlink Network with 197 Nodes



**Isolated nodes appear in the left corner*
**Red ties represent reciprocated hyperlinks*

The socio-graph above is *asymmetric* because it reflects the direction of ties for the observed hyperlinks graph (at Time 1), and not all organizations reciprocate ties. Hyperlink direction is indicated by the arrow between the two nodes. The absence of a tie illustrates that websites do not include a hyperlink. This is repeated for each possible binary relation. The resulting network visualization can give a sense of obvious structural features. For example, the above sociograph of all 197 nodes appears to have a number of isolates and a number of highly connected organizations. However, the sociograph is just the starting point since it does not provide substantive information about the network or pattern of ties.

Nodes

The term nodes refer to each organization collected through the webcrawl and fitting the criteria specified in the method section of this research. Nodes are sometimes called actors or vertices. The terms nodes, actors and vertices are used interchangeably in this analysis – they all refer to organizations included in the network analysis. Since this research looks at the hyperlink network, the nodes are actually the organization or agency website.

Size

Network size refers to the number of nodes in a network. Size is critical for the structure of social relations due to limited capacity of a single actor for maintaining ties. In smaller networks, nodes are likely to be connected to each other, while in larger networks connecting to everyone else becomes increasingly difficult. In a directed network, the number of possible ties is n*(n-1). As such, the number of possible relationships grows exponentially as the number of nodes increases linearly. Relatedly, the complexity of the network grows with the number of the nodes in the network which increases the number of possible relationships with each node. Of the 38,162 possible hyperlink ties, among the 197 nodes in the network, there are 673 observed hyperlinks.

Isolates

Isolates refer to a single node disconnected from the rest of the network with no flow of information, resources or influence. These are nodes that do not belong to an edge (or tie), in other words, nodes that do not hyperlink with any other organizations. These nodes were once part of the network (at the time of data collection) but no longer connect to the main component. Isolates can also help determine the cohesiveness of a network, particularly when viewed over time. More isolates suggest a less cohesive network.

There are two main explanations for isolates in the observed hyperlink network. First, the isolated organization was once part of the network and no longer hyperlinks to other organizations. Or, the isolate represents an organization with projects aimed at assisting SIDS that does not have a web presence or hyperlink connection with other organizations. Either way, the isolates represent organizations that perhaps "should be" a part of network, but are not connected. Isolates provide important information about the stability or cohesion of the network, and their inclusion is an important consideration for such assessments.

Inactive Links

The observed network has 19 inactive links. The distinction between isolates and inactive links is an important one: isolates are organizations that still maintain their websites but are not connected with other organizations, whereas inactive links are hyperlinks that no longer support internet traffic but did at the time of data collection (March, 2013). Further, inactive links cannot be calculated into some of attributes analyses because the information needed to assign the attributes is no longer available through the websites.

Inactive links can also provide insight about the strength or stability of a network. Inactive links create vulnerable networks. When isolates (25) and inactive links (19) are removed, the network has 153 remaining organizations.

Node Attributes

An attribute refers to a specific property of an organization which is independent of the connections to other organizations (Wasserman & Faust, 1994) these are specific characteristics that distinguish nodes from one another. Each node in the international mobilization network for SIDS is assigned three different attributes for analysis. The nodes are classified based on: (1) the

type of organization (2) the level of the organization and (3) the geographic focus of the organization's efforts among SIDS.

Type

The first attribute is categorical, the type of organization. Nodes are classified as either: inter-governmental (IGO), non-governmental (NGO), funder (FO), governmental (GOV), education/research (RES) or "other". The primary difference between IGOs and NGOs is that IGOs are established by international agreement among nations and NGOs are not (Jordan & Feld, 2001). The category "other" in most cases refers to commercial, or privately-owned organizations emphasizing information connectivity. There were only two of these organizations, both were telecommunication companies, and both were isolates.

Identifying isolates provides insight about what types of groups drop from the network. Six of the 25 isolated groups provided funding for projects. Most of the isolates are classified as NGOs, seven are IGOs. Table 4.1 lists the frequency of the organizations by type in the observed network.

Table 4.1

Breakdown of Organization by Type

Type	Count	Isolates	
Inter-governmental Organizations (IGO)	65	7	
Governments (GOV)	41	0	
Financial Organizations (FO)	24	6	
Non governmental Organizations (NGO)	15	9	
Education or Research Organizations (RES)	8	1	
Other	0	2	
Inactive Links	--	*19*	
Total	153	44	N=197

Level

The second attribute is the level of the organization. This attribute captures a general ordinal characteristic. Level refers to the scope of the organization: country, regional or international. Level is determined by the organization-wide mission statement or designation.

1. *Country* - Organizations at the country-level include country or national governmental bodies.
2. *Regional* - Organizations at the regional-level are those who listed a specific organization-wide region of focus.
3. *International* - Organizations at the international-level are those that indicate global or worldwide goals and initiatives. [6]

Among the 25 isolates, most are classified as regional-level, 11are international and one isolate had a country-specific mission in Trinidad. Most of the regional-level organizations that dropped from the network operated in the Caribbean. Nine of the international-level organizations operated in two or more of the SIDS regions (i.e., Caribbean, AIMS and Pacific), while one of the 10 international groups was focused only on the Caribbean -- *The Small Grants Program Tropical Forests.* Considering the proportion of regional-level isolates, it appears that regional groups are more susceptible to isolation than country level or international level groups. Table 4.2 lists the frequency of the organizations by level in the observed network.

[6] Some international-level organizations work within a specific SIDS region, despite their international status. Such groups are classified as international-level with a specified regional reach (the geographic aspect of project-regional focus is captured in the third attribute).

Table 4.2
Breakdown of Organization by Level

Level	Count	Isolates	
Country	37	1	
Regional	57	13	
International	59	11	
Inactive Links	--	*19*	
Total	153	44	N=197

Geographic Project Region

SIDS are divided into three geographic regions: the Caribbean; the Pacific; and Africa, Indian Ocean, Mediterranean and South China Sea (AIMS) (United Nations Department of Economic and Social Affairs, 2014). Nodes are classified based on either a global orientation or the specific region of focus. A regional-specific organization works only in one of the three regions -- Caribbean, AIMS or Pacific.

> *Caribbean* -- Organization has regional-specific project focused on the Caribbean.
>
> *AIMS* -- Organization has regional-specific project focused on Africa, Indian Ocean, Mediterranean and/or South China Sea.
>
> *Pacific* -- Organization has regional-specific project focused on Pacific islands.
>
> *Global* -- A global orientation means that the group is focused on at least two of the three SIDS regions – Caribbean, AIMS *and* Pacific.

Organizations are assigned a region of focus based on the following criteria: (1) mission statement (2) the number of activities or projects in a particular region and/or (3) geographic location. Groups with multiple SIDS regions are assigned a global orientation. International organizations with a regional office represented in the network are assigned the region of the

office. For example, the United Nations Development Programme has regional offices in Cuba, Guyana and Samoa. Thus, these are three nodes representing an international-level organization, each with a region-specific function. Consequently, UNDP-Cuba and UNDP-Guyana are designated as region-specific in Caribbean, while UNDP-Samoa is designated region-specific in the Pacific. Table 4.3 lists the frequency of the organizations by regional project focus in the observed network.

Table 4.3

Breakdown of Organization by Regional Project Focus

Region	Count	Isolates	
Region Specific - Caribbean	30	12	
Region Specific - Pacific	24	0	
Region Specific - AIMS	41	4	
Global	58	9	
Inactive links	--	*19*	
Total	153	44	N=197

Africa, Indian Ocean, Mediterranean and South China Sea (AIMS) have the most projects overall. However, this count might be slightly misleading because AIMS accounts for multiple bodies of water and therefore have an international quality when compared to the Pacific or Caribbean. Among the 25 isolates, 12 were involved in projects or initiatives aimed at the Caribbean. Four of the 13 regional organization isolates operated in AIMS. The remaining nine had projects in at least two of the three SIDS regions. Suffice to say, the Caribbean has the largest proportion of disconnected nodes.

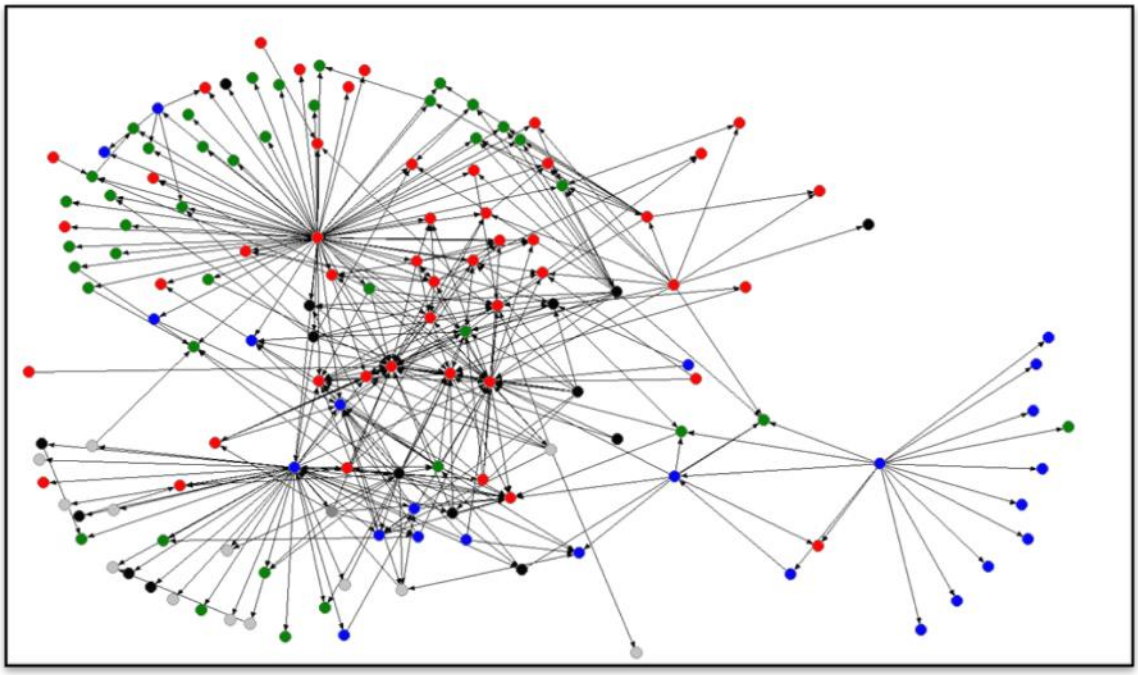
The geographic project region attribute identifies specific SIDS regions based on specific projects and goals. Thus, the third attribute is more specific than the second attribute, organization level. The organization level captures a characteristic about the organization, while the region attribute seeks geographic specificity in terms of projects aimed at SIDS. Since the

current research looks at projects specific only to SIDS, in some instances international organizations with international projects are region-specific when it comes to helping SIDS amid climate change.

Graph visualizations can help identify how the network is organized in terms of attributes. For example, when isolates and inactive links are removed, the network has 153 nodes as represented in Figure 4.2. This graph represents the network based on type of organization. IGOs are red, NGOs are black, financial organizations are blue, research and education organizations are grey.

Figure 4.2

Nodes by Type of Organizations



N=153

The graph presented above is directed and simple. *Simple graphs* have no loops or multiple edges. Loops and multiple edges were removed prior to analysis because these are features of each organization's internal link structure (e.g. links to other pages in the same organizations).

This graph consists of a (finite) set of nodes and links. A graph that is in one piece, is said to be connected, such as the graph presented above, whereas a graph which splits into several pieces is a *disconnected* network. The full network (N=197), as illustrated in Figure 4.1 (above), is a disconnected network. A *component* is a part of a network that is connected within, but disconnected from, other parts of a network.

Components

Since the hyperlink network is a directed network, the test for components looks only for weak components. Strong components require that paths respect the directionality of hyperlinks, whereas weak components measure geodesic distance in directed graphs, but ignore the directionality. The observed network consists of 27 weak components. Most of those components are isolates, 25 of them. The main component has 170 nodes, accounting for 86.3 percent of the network. Across the network, 25.6 percent of the nodes cannot reach one another.

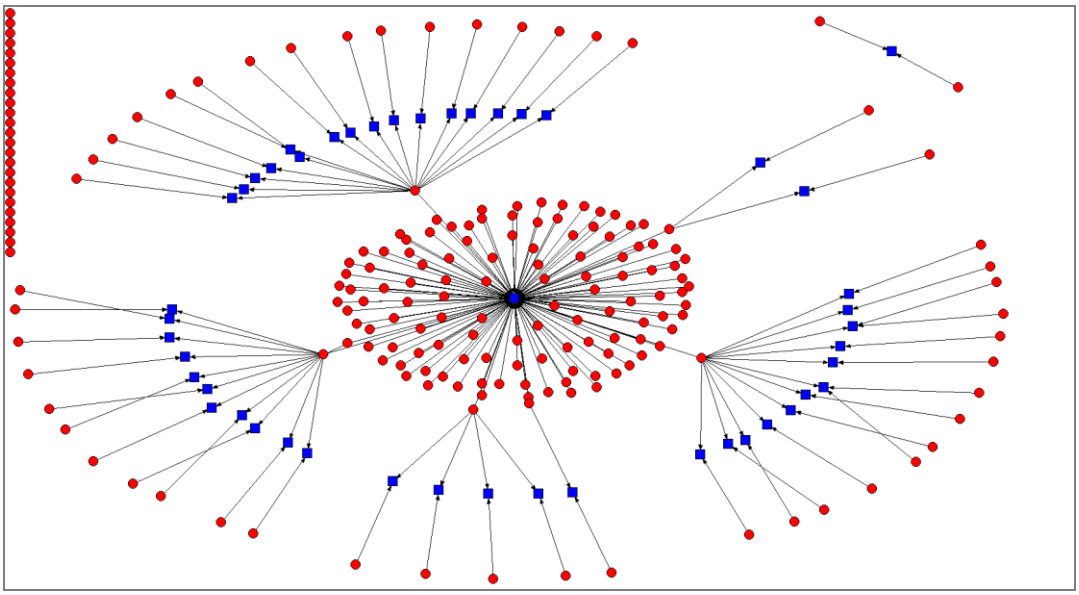
When the isolates are removed, only two components are present. One of the components has two nodes (a dyad) while the main component has 151 nodes. The main component accounts for 98.7 percent of the network. Heterogeneity, which is often referred to as a measure of inequality, drops dramatically when the 25 isolates are removed (from 0.256 to 0.026). The extent to which some parts of the network are less connected to the whole provides insights into patterns of consensus and division (Hanneman & Riddle, 2005).

Blocks and Cutpoints

Blocks are parts into which cutpoints divide a network. Cutpoints are the points within the network which would break up the network into disconnected parts if a node were removed. There are 48 blocks within the network, and seven cutpoints. Figure 4.3 illustrates the network blocks. This visualization suggests one predominant block and 47 sparse blocks. Blocks are represented by the blue squares. When isolates and inactive links are removed, 41 blocks emerge, with the same seven cutpoints.

Figure 4.3

Blocks and Cutpoints



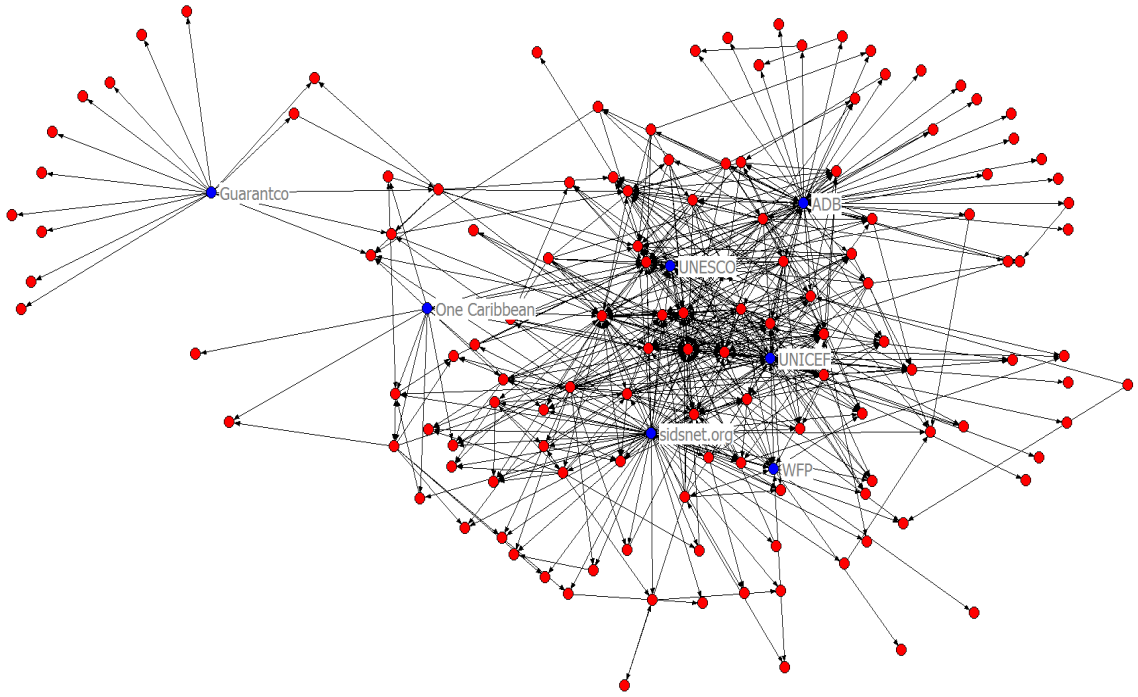
N=197

The extent to which some parts of the network are less connected to the whole provides insights into patterns of consensus and division. Weaker parts, or lines of cleavage, are often used to create opportunities for brokerage and less constrained action (Hanneman & Riddle, 2005). These are measured by cutpoints, the observed networks has seven cutpoint organizations. Cutpoints are the points within the network which would break up the network into disconnected

parts if a node were removed. Cut-points act as brokers among otherwise disconnected groups. These are crucial organizations for mobilization potential. Figure 4.4 illustrates the cutpoint organizations within the network at Time 1.

Figure 4.4

Cutpoint Organizations at Time 1



Key:
ADB= *Asian Development Bank*
Guarantco=*Frontier Fund Manager*
One Caribbean= *Caribbean Tourism Organization*
UNESCO = *United Nations Organization for Education, Science and Culture*
UNICEF= *United Nations Children's Fund*
Sidsnet.org= *Small Island Developing States Network*
WFP=*World Food Program*

Network Distribution

Network distribution can be described by measuring the distance across nodes in the network. A common approach to determining relative distance across nodes is measuring the

geodesic path distance. *Paths* are a particular kind of sequence that never revisits a node. *Geodesic distance* refers to the shortest path between two nodes.

Geodesic Distance

Geodesic distance is the number of relations in the shortest possible path from one actor to another. A long geodesic distance implies that even under the best conditions it would take a long time to get information across the network. The average geodesic distance between all actors in a network gets at the idea of how close actors are together. Among reachable pairs in the observed network (N=197) the average geodesic distance is 3.36. When isolates are removed the average geodesic distance drops slightly, (m=3.29).

While geodesic distance is considered the optimal or most efficient count of the connections between two actors, diameter describes the spread, or least efficient count of connections. In other words, diameter is the largest geodesic distance in the (connected) network, or the longest shortest path between two nodes (i.e., the maximum geodesic distance across nodes). The diameter for the full network and when isolates are removed is 8. This suggests a particularly large spread in the distribution of nodes.

Density

Strong networks tend to have high-density, illustrating a highly connected network. High-density can translate to high agreement, consensus, and equal distribution of power as the ratio of observed hyperlinks to the possible hyperlinks (i.e. the number of links that would result if every organization in the sample were connected to every other organization). The overall density of the network is expressed as the average density of relations (Wasserman & Faust, 1994).

For the observed hyperlink network the average density is 1.74 percent – in other words, this is the probability that any given tie between two random actors is present. The observed

density score illustrates weak connections among the nodes. The density grows slightly higher, to 2.51 percent, when isolates and inactive links are removed. The standard deviations measure the lack of homogeneity within the network, or the extent to which the actors vary. The hyperlink network demonstrates high levels of variance (sd = 0.131), which grows even higher when isolates are removed (sd = 0.157) indicating a possible imbalance of power.

Table 4.4

Density Full Network and Isolates Removed

Full Network			Isolates Removed		
N	Arcs	Density	N	Arcs	Density
197	673	0.0174*	153	584	0.0251*
SD		(0.131)	SD		(0.157)

** = p < .05.*

In general, the standard inferential formulas for computing expected sampling variability (i.e. standard errors) give unrealistically small values for network data (Hanneman & Riddle, 2005).To determine if the observed density is statically significant, the measure is compared to a theoretical parameter using the bootstrap method of constructing 10,000 networks-- by sampling random sub-sets of nodes each time-- and computing the density each time.

Centrality and Centralization

Centralization can provide further insight about the sources and distribution of power within a network. Centralization is a characteristic of a network, a macro-level measure. Centrality is a characteristic of an actor's position in a network, a micro-level measure. Centralization indicates how unequal the distribution of centrality is in a network or how much variance there is in the distribution of centrality in a network. This study first looks at degree, betweeness and closeness (which is later refined to eigenvector).

Network Centralization

At the network level, centrality measures represent the extent to which closeness, betweeness or degree characteristics exists on average, across the network. Closeness centrality is most often used to assess how far a node is positioned from all others. Betweeness centrality identifies which nodes are located between clusters. Borgatti (2005) notes that, betweeness assume that what flows from one node to node is indivisible (like a package) and must take one path or another, unlike eigenvector which assumes multiple 'paths' simultaneously link information (Borgatti, 2005, p. 56). Table 4.5 lists the statistics for degree, closeness, betweeness and eigenvector. Each of these centrality measures are discussed in more detail following this table.

Table 4.5

Statistics for Hyperlink Network Centrality

N	Overall Degree	Closeness	Betweeness	Eigenvector
197				
Mean	3.28	3.36	0.63	6.13
SD	(5.27)	(0.31)	(2.88)	(7.99)
Sum	646.94	578.81	125.53	1207.92
Variance	27.77	0.10	8.32	63.93
SSQ	7595.27	1964.71	1717.37	19999.99
MCSSQ	5470.76	16.89	1638.66	12593.52
Euc Norm	87.15	44.32	41.44	141.42
Minimum	0	0.51	0	0
Maximum	44.39	3.50	32.86	41.58

**Data symmetrized for these calculations*

For the hyperlink network there are 197 observations which range from a minimum score of zero to a maximum of 44 for degree centrality. The sum of the ties ranges from 578 for closeness to 1208 for eigenvector with the average value of the ties ranging from .632 to 6.132. Several measures of the variability of the distribution are also given. The sums of squared

deviations from the mean, variance, and standard deviation are computed -- but are more meaningful for valued than binary data. The Euclidean norm is the square root of the sum of squared values.

Degree

Degree centrality is often used to examine how well connected each node is to others. Due to the directional nature of ties, degree centrality is divided into in-degree and out-degree. The in-degree of node A is the number of ties received by A and the out-degree is the number of ties initiated by A. The distinction between in-degree and out-degree measures allows for comparisons between in-degree network patterns and the out-degree patterns. Table 4.6 illustrates the distribution of degree centrality.

Table 4.6

Distribution of In-degree and Out-degree

	Full Network			Isolates Removed	
N	Out-degree	In-degree	N	Out-degree	In-degree
197			153		
Mean	3.42	3.42		3.82	3.82
SD	(8.58)	(5.59)		(8.87)	(5.69)
Sum	673	673		584	584
Maximum	86	41		81	39
Overall Degree Centralization	42.35%	19.27%		51.11%	23.30%

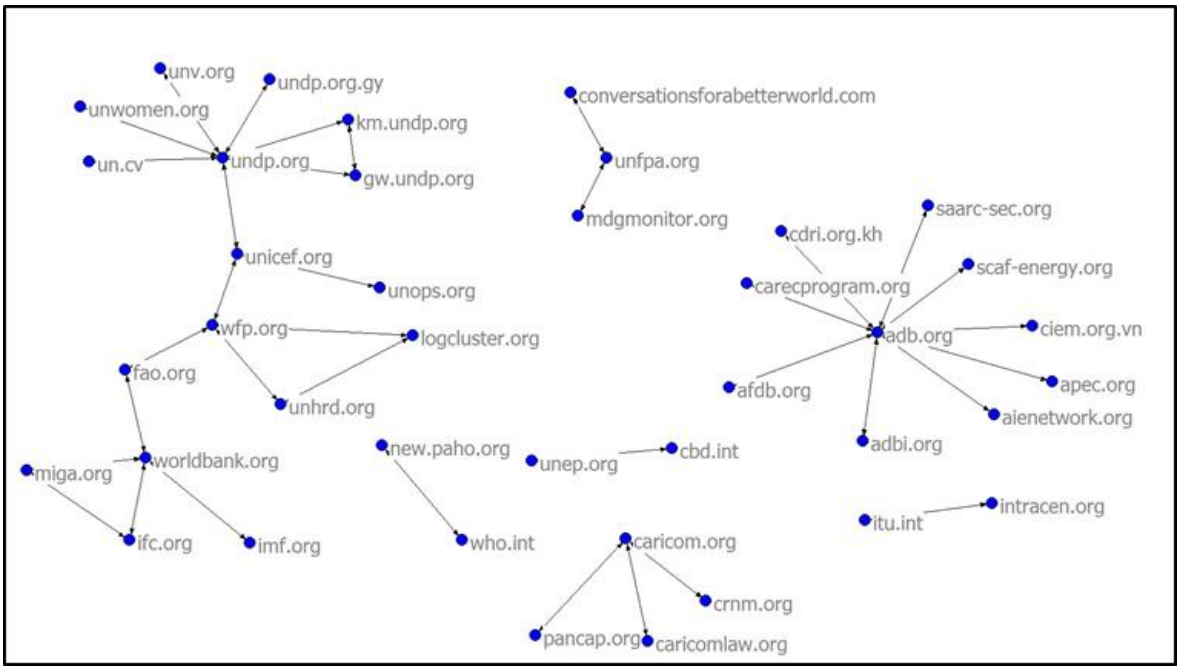
The range of out-degree hyperlinks is larger (minimum and maximum) than of in-degree with more variability across the actors in out-degree than in-degree based on standard deviations. Across the network the number of hyperlinks each node sends ranges from zero links to 86. The range for in-degree is zero to 41.

On the average, the nodes in the observed network have 3.42 direct hyperlinks. When isolates are removed, the means rise slightly (3.82 and 2.51 when normalized) as do the standard deviations. The patterns of comparison between in-degree and out-degree among the network, when isolates are removed, reflect the patterns of the full network. Still, a greater level of variance is evident for out-degree (sd = 5.83) as compared to in-degree (sd= 3.741) and an unequal distribution of hyperlinks across the network.

The network centralization expresses the degree of variability in the degrees of actors in the observed network as a percentage of that in a "star" network of the same size. Stars are structures in which a central node has connections to other nodes, but those nodes do not have connections with one another. The graph below illustrates only reciprocated connections. One important feature of this visualization is the presence of one obvious k-star (*Asian Development Bank*, adb.org), and one smaller k-star (*Caribbean Community Secretariat*, Caricom.org). Stars are structures in which a central node has ties from other nodes and ties to other nodes but the non-central nodes do not have ties with one another, these sites that have a unique set of followers that are not reciprocated among each other (Pilny & Shumate, 2011, p. 269).

Figure 4.5

Reciprocated Ties among Network Nodes



Reciprocity

Across the observed network, 6.15 percent of all the relations in the graph are part of dyadic reciprocated ties. When isolates and inactive links are removed reciprocity changes only slightly to 6.18 percent. An examination of arc-based reciprocity, which represents the proportion of reciprocated ties among all the hyperlinks, shows that 11.59 percent of the hyperlinks are reciprocated. This changes to 11.64 percent when isolates are removed. From this graph we can also see three examples of transitive reciprocated triangles.

Transitivity

Like reciprocity, transitivity seeks to measure balance within the network, asymmetric transitive triangles may be unstable, a signature of a hierarchal structure, a signal of inequality or the formation of exclusive groups (e.g. where two actors connect, and exclude the third). The

prevalence of such patterns provides insight into the potential to mobilize actors within the network.

The three transitive triangles in the network are:

- Δ World Bank, Multilateral Investment Guarantee Agency, International Finance Corporation
- Δ World Food Program, Logistic Training UN Food Program, United Nations Humanitarian Response Depot
- Δ United Nations Development Programme, UNDP Guinea-Bissau, UNDP Comoros

At a network level, triads help determine the "clustering" within the network. Transitivity measures a tendency for a tie from A to C to exist if a tie from A to B and a tie from B to C exist. If A→ B & B→ C & A→ C then the three are transitive. The proportion of transitive triples in the observed network accounts for small fraction of the triadic relations (0.02%) impacted only marginally when isolates are removed (0.03%). Figure 4.6 illustrates all the possible triadic relations for a directed network, and the number of such combinations for the full observed network (N=197) at Time 1. The number of combinations when isolates and inactive links are removed (N=153) are listed below.

Figure 4.6

Observed Triadic Combinations

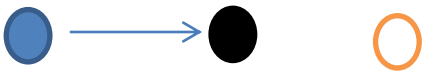
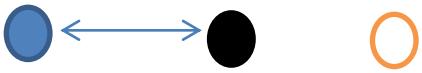
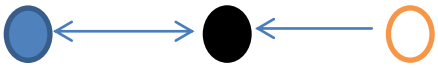
N=197	Relationship	Type
Full: 1144345 513207		A,B,C, empty triad
92525 58255		A->B, C, triad with a single directed edge
6195 3915		A<->B, C, triad with a reciprocated connection between two vertices.
6238 5259		A<-B->C, triadic out-star.
2220 1854		A->B<-C triadic in-star.
1228 946		A->B->C, directed line.
446 373		A<->B<-C
578 516		A<->B->C

Figure 4.6 (cont'd)

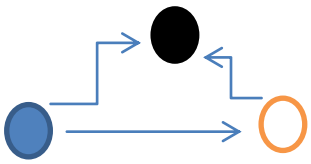
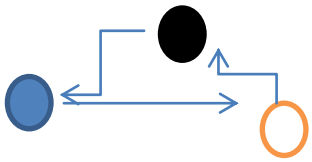
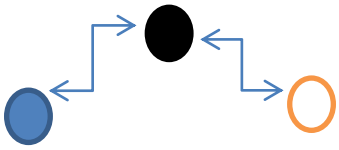
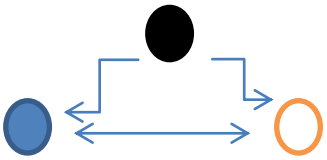
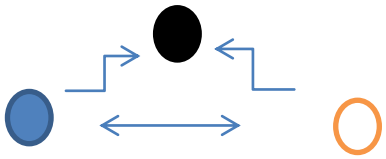
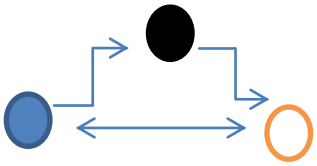
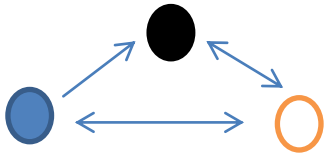
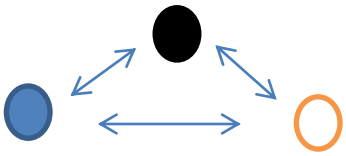
N=197	Relationship	Type
Full: 808 **713**		A->B<-C, A->C
4 **2**		A<-B<-C, A->C
50 **50**		A<->B<->C
91 **76**		A<-B->C, A<->C
110 **88**		A->B<-C, A<->C
22 **20**		A->B->C, A<->C.

Figure 4.6 (cont'd)

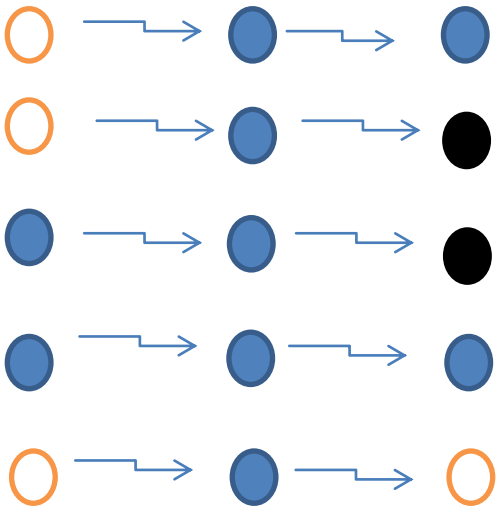
N=197	Relationship	Type
Full: 27 **20**		A->B<->C, A<->C
3 **2**		A<->B<->C, A<->C, complete triad

The observed network includes 7,529,340 triadic relations total, among which 1,331 are transitive. That is, there are 1,331 cases where, if AB and BC are present, then AC is also present. Only three complete triads emerge from the hyperlink network where each possible AB, BC and AC combination is reciprocated (one was simply the triad of parent organization UNDP and regional country-specific extensions of the UNDP).

Brokerage occurs when, in a triad of nodes A, B and C, A has a tie to B, and B has a tie to C, but A has no tie to C. Brokerage roles can be identified through the examination of triadic relations (Marsden, 1982). That is, A needs B to reach C, and B is therefore a broker. When A, B, and C may belong to different groups, 5 kinds of brokerage are possible. Figure 4.7 illustrates brokerage roles, node color represents subgroups. Table 4.7 lists the roles of organizations at each level in the observed network.

Figure 4.7

Broker Roles among Triads



Gatekeeper, B -> C from the same group.

Liaison, all nodes from different groups.

Representative, A->B from same group

Coordinator, all nodes are from the same group.

Consultant, A and C belong to a different group.

Table 4.7

Time 1 Network Brokerage Roles by Level

Full Network	Coordinator	Gatekeeper	Rep.	Consultant	Liaison
Country N=37	--	--	UN Development Programme Guyana	UN Development Programme Guyana	UN Development Programme Guyana
Regional N=57	Asian Development Bank	Asian Development Bank	Asian Development Bank	Asian Development Bank	Asian Development Bank
International N=59	UN Children's Fund	UN Development Programme	UN Development Programme	UN Development Programme	UN Development Programme
Given flow 1-->2-->3, where 2 is the broker	A-->A-->A All nodes belong to same group	B-->A-->A Source belongs to different group	A-->A-->B Recipient belongs to different group	B-->A-->B Broker belongs to different group	B-->A-->C All nodes belong to different groups

For the full network, roles are examined based on the level of organization. When directionality is taken into account, specific types of brokers can be identified. Gould and Fernandez' (1989) typology of broker roles assigns a specific role to various formations of brokerage to include: coordinators, consultants, gatekeepers, representatives and liaisons.

Coordinators are connected within a group. Gatekeepers, consultants and representatives connect between groups, in various patterns. Gatekeepers are positioned between groups, and are especially influential in terms of incoming information. Representatives are influential in information sharing from their group to outsiders. Consultants connect to and from an outside group, other than its own (Gould & Fernandez, 1989). These roles are not mutually exclusive. To help better understand if, and to what extent, certain nodes are marginalized or embedded into the network, the network is next tested for signs of cohesion and evidence of hierarchies.

Network Cohesion and Hierarchies

Interconnectivity is important for three main reasons. First, linked sites imply consensus on a topic, or at least an overlap of interests. While hyperlinks may not proxy for the exchange or distribution of resources, the representational nature of hyperlinks can certainly lend insight about affiliations and agreement. High connectivity of representational ties create a sense of critical mass support.

Second, ties across members can be leveraged to share information about movement goals. According to consensus mobilization theory, potential participants must adopt a shared meaning about a social issue and/or course of action in order to boost the size and momentum of a mobilization effort, thereby making action possible (Marwell, Oliver, & Prahl, 1988). In this case, the hyperlinks can be thought of as affirmation of agreement. If in fact hyperlinks are a strategic communication decision, organizations will only link to organizations that affirm or

further promote a similar agenda. As such, linked organizations can be used to measure the mobilization potential for the network. Higher density and shorter distances suggest movement toward cohesion.

Third, the density and average degree of a network (i.e., the average number of ties that each node has) provides insight about the extent to which organizations can access resources or experience constraint (Hanneman, & Riddle, 2005). For the observed network the probability that any two random actors will have a link is 1.74 percent. The average degree of the network, (m=3.42) and average distance among reachable pairs (m=3.36) suggest that some actors are connected only by pathways of great length. The longest distance among any two organizations in the observed network has eight edges. These findings indicate sparse connections among organizations in the observed network which is often a symptom of disagreement or hierarches.

Table 4.8 lists properties for the full network at Time 1. In combination, the features suggest that the observed network is centralized, and sparsely connected. Based on these measures, the network appears to be hierarchal.

Table 4.8

Summary Table: Full Network Size and Features

Property	Count	Centralization	Percent	Cohesion	Percent
Nodes	197	Out Degree	42.35%	Density	1.74%
Isolates	25	In Degree	19.27%	Arc Reciprocity	11.59%
Inactive Links	19	Betweeness	6.99%	Dyad Reciprocity	6.18%
Ties	673	Eigenvector	38.37%	Transitivity	0.02%
Possible ties	38162				
Cutpoints	7				
Avg. Geodesic	3.36				

The observed density score, reciprocity and transitivity levels suggest weak connections among the nodes in the full network at Time 1 (N=197).Further, there are many components (N =27), of which nearly 93 percent are isolates. Nearly 26 percent of the nodes cannot reach one another across the full network (N=197). Understandably, when isolates are dropped, fragmentation drops from 26 to 2 percent. Generally, low density, reciprocity and transitivity mean low interconnectivity, pointing toward a hierarchy or power concentrated on just a few nodes in the network.

Core-periphery

Eigenvector is considered a measure of power based on the relative dependence of nodes on one another within the network. This is also a core-periphery measure, indicating that highly centralized systems have a single cohesive subgroup with a loosely connected group attached. The overall eigenvector centralization for the observed network is 38.37 percent. The data suggest a split of the data into a core/periphery structure with 25 nodes in the core. Core members interact with other core members, while peripheral members do not interact with each other but do interact with some core actors.

Table 4.9

Core-Periphery Density

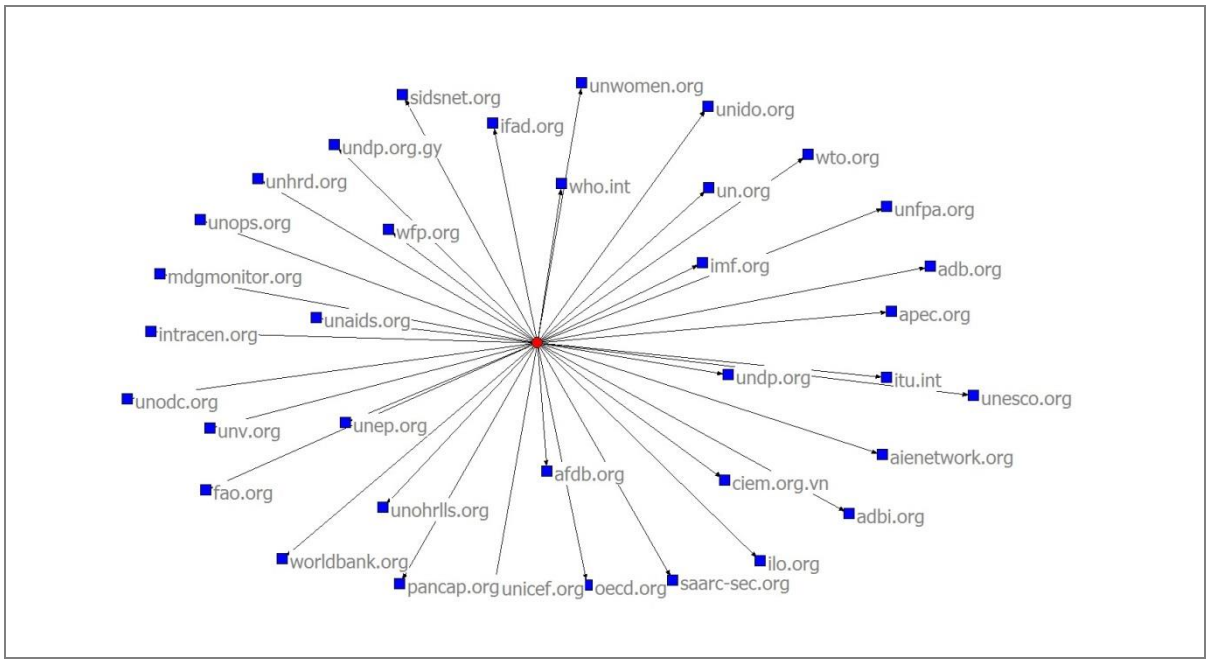
Density	Core	Periphery	Starting	Ending
Core	0.223	0.034	R 0.201	0.312
Periphery	0.017	0.004	Model Fit 0.394	0.394
			Compactness	(0.795)

**Optimization routine concluded in 1,001 iterations*
** To test the robustness of the solution, the algorithm was run a number of times from different starting configurations.*

The network was tested for core/periphery features by splitting the nodes into either core or periphery groups. The core periphery model is tested for fitness by calculating the correlation between the permuted data matrix and an ideal structure (Borgatti & Everett, 2000). Figure 4.8 illustrates the core members.[7]

Figure 4.8

Core Members Full Network



N=25

[7] Ideal structure consisting of ones in the core block interactions and zeros in the peripheral block interactions.

CHAPTER 5

Results Part II: Centrality, Reciprocity, Homophily and Change

This chapter reports answers to the research questions 2 to 5 posited in Chapter 2 and elaborates on network characteristics reported in the previous chapter. In answering the research questions, this chapter also describes changes to the network over time by comparing the network in 2013 to the network in 2014. More specifically, the direction and magnitude of change are measured across two points in time.

Throughout this discussion, three variations of the network are described. The full network refers to observed hyperlink network at Time 1, with 197 nodes, before isolates and inactive links are removed. The full network is the focus of analysis for RQ1. The remainder of the RQs focus on comparing the Time 1 and Time 2 networks. The Time 1 network refers to the transformed network, with 153 nodes, at Time 1 -- once isolates and inactive links are removed. The Time 2 network refers to the same 153 nodes, after the second data collection. The Time 1 network serves as a comparison for the emerging structure at Time 2. Data for the Time 1 network were collected in March 2013. A webcrawl was used to collect hyperlinks across the same 153 organizations in March 2014.

RQ2: Which organizations are most central within the international mobilization hyperlink network for SIDS?

One of the primary uses of graph theory in social network analysis is the identification of the most important actors in a social network (Wasserman & Faust, 1994). For this research question, influence is examined and analyzed primarily in terms of (in) degree centrality, betweeness (and network embeddedness) and eigenvector power.

First, degree centrality is used to measure web authority. This is a fairly straightforward assessment of influence based on the extent of in-degree hyperlinks, which boost visibility of highly central organization.

Second, centrality is examined through the lens of consensus mobilization theory as the ability to control information, to recruit others and/or constrain movement. This is measured as betweeness centrality. Cut points and brokerage roles are analyzed to further assess network embeddedness for consensus mobilization. Overall, this can be thought of as influence through control or mediation.

Third, centrality is examined through the lens of resource mobilization as the ability to mobilize through the process of exchange and dependence. This is measured through eigenvector power. Eigenvector can be conceptualized as positional power within the network based on access to other central organizations.

Because of the elusive nature of hyperlinks as an exchange mechanism, supplemental measures of power are considered and explained throughout the discussion of centrality. More specifically, several other types of centrality are considered in order to identify correlations and covariance across measures of power and centrality in the observed network.

Across all the various measures of power and centrality to be described in this chapter, six organizations emerged: The United Nations, United Nations Development Programme, Asian Development Bank, Small Island Developing States Network, United Nations Children's Fund, and the World Bank. As will be explained, these organizations are influential for slightly different reasons. The next sections provide a detailed analysis of the various measures of power and centrality used to produce this list of organizations.

Measures of Centrality

Broadly defined, centrality refers to nodes that are in the "center" of the network. Nodes that are central are considered important, prestigious or influential among the actors in the network because of the positions they hold in the network. For degree centrality, a node is central if many nodes connect directly to it. This is a local measure. Closeness, betweeness and eigenvector are all measures that are relative to the rest of the network. For closeness centrality a node is central, if it is close (on average) to all other nodes. For betweeness centrality a node is central, if it is between many pairs of other nodes. Lastly, for eigenvector centrality, a node is central, if it is has many central neighbors.

Each measure conceptualizes "importance" of particular nodes differently, and hence each measures centrality differently. Each measure also has conceptual and operational strengths and weaknesses. Degree centrality identifies nodes that are the most connected within the network. As such, it is a limited localized measure of centrality: it does not take into account patterns across the network. Closeness centrality refers to the node(s) relatively close to all other nodes, looking beyond direct ties to identify the distance across all pairs of nodes. However, closeness can only be examined within a fully connected network or component of the network. Betweeness centrality refers to node(s) located between groups of nodes (e.g., gatekeepers, brokers, coordinators, consultants and liaisons). However, betweeness requires additional measures of centrality to determine whether the node actually functions as a gatekeeper, broker, consultant, coordinator or liaison. Eigenvector is often described as a centrality measure, as it speaks to the relative power of certain nodes based on patterns of connectivity and the relative position of connected nodes within the broader network. Eigenvector can be more accurately

described as a core-periphery measure, assessing the patterns of connectivity across well-connected nodes and not-so-well-connected nodes. In other words, influence depends on context.

To begin this discussion, Table 5.1 lists the top 5 organizations according to the four different measures of centrality. Closeness, betweeness and eigenvector are all normalized measures to allow for comparison, while degree is a simple count of direct hyperlinks to and from the organization. Rank refers to the organization relative to all other organizations in the observed network, at Time 1, for the full network (N=197). Ties are symmetrized, so directionality is not considered in these rankings.

Table 5.1

Summary Centrality Measure and Ranks for the Full Network

	Degree	*rank*	Closeness**	*rank*	Betweeness*	*rank*	Eigenvector*	*rank*
SIDS Network	87	[1]	61.23	[1]	32.86	[1]	41.58	[1]
Asian Dev. Bank	53	[2]	53.99	[3]	18.3	[2]	31.94	[5]
UN Children's Fund	45	[3]	53.15	[5]	6.55	[5]	36.99	[2]
UN Dev. Programme	42	[4]	55.05	[2]	8.63	[3]	34.46	[4]
United Nations	41	[5]	52.65		3.7		34.67	[3]
World Bank	36		53.48	[4]	4.31		31.53	
Frontier Fund Manager	15		31.07		8.62	[4]	0.71	

Network Properties	Degree	Closeness	Betweeness	Eigenvector
Nodes	197	173	197	197
Overall Mean	6.44	38.76	0.63	6.13
(standard deviation)	(10.33)	(6.26)	(2.88)	(7.99)

**Closeness, Betweeness and Eigenvector scores normalized*
***Closeness centrality considers only the main component N=173*

The organizations listed above show the top five highest scoring nodes for each measure of centrality, clearly showing that a small number of organizations are central to the network regardless of how centrality is conceptualized. For example, *Small Island Development*

Network (sids.net) is the highest ranking organization for degree, between, closeness and eigenvector centrality. Three other organizations (*Asian Development Bank, UN Children's Fund* and *UN Development Programme*), are ranked in the "top five" in all four measures, thereby indicating high centrality of four primary actors.

Three other organizations rank in the top five in either one or two measures of centrality. *The Guarantee for Development* (guarantco.com, 2014), which serves as the operational arm for Frontier Markets Fund Manager and the Emerging Africa Fund, has high betweeness centrality, only; the *World Bank* ranks highly only in closeness centrality; and the *United Nations* ranks highly in degree centrality and eigenvector. In other words, the few ties to and from seven organizations – and four organizations in particular – are centrally important to this network.

In simple structures these measures tend to covary. In more complex and larger networks, there can be considerable disjuncture between these characteristics of a position so that an actor may be located in a position that is advantageous in some ways, and disadvantageous in others (Hanneman and Riddle, 2005, Ch. 10). Table 5.2 illustrates the correlation matrix among four measures of centrality at Time 1 and Time 2. The top of the matrix show the correlations at time 1, the bottom show the correlations for Time 2.

Table 5.2

Correlations Among Centrality Scores from Time 1 and Time 2

		TIME 1			
		Degree	Closeness	Betweeness	Eigenvector
TIME 2	Degree	---	0.485	0.823	0.932
	Closeness	0.626	--	0.360	0.581
	Betweeness	0.817	0.360	--	0.583
	Eigenvector	0.926	0.732	0.562	--

The highest observed correlation is the degree centrality and eigenvector relationship (r=0.93). This is understandable, because eigenvector centrality is a variation of (non-directed) degree centrality (Borgatti, Everett & Johnson, 2013, p.168). There is also a strong correlation between degree and betweeness centrality (r= 0.82) in the observed network. Degree centrality measures direct links, while betweeness measures the extent to which each organization falls between two other organizations. Thus, these data suggest that those with many direct links also tend to fall between any other two actors on the shortest path between those actors. The strength of the degree and betweeness correlation decreases slightly from Time 1 to Time 2, as the degree and eigenvector correlation grow slightly stronger.

In directed networks, Beta (or Bonacich) is sometimes used to substitute for eigenvector for interpretability (see Bonacich, 1987). When the data are directed, the Time 2 network illustrates strong relationships between in-degree and in- Bonacich (r=.929) as well as out-degree and out- Bonacich (r=.89). Table 5.3 illustrates the correlation matrix among five measures of directed centrality and power at Time 1 and Time 2. The top of the matrix show the correlations at time 1, the bottom show the correlations for Time 2.

Table 5.3

Correlations Among Centrality Scores Directed

TIME 1

TIME 2	Degree In	Degree Out	Closeness In	Closeness Out	Betweeness	Eigenvector	Bonacich In	Bonacich Out
Degree								
In	---	0.13	0.38	0.17	0.62	0.72	0.92	0.11
Out	0.16	--	0.03	0.7	0.42	0.72	0.08	0.83
Closeness								
In	0.28	0.04	--	0.04	0.23	0.33	0.45	0.11
Out	0.34	0.47	0.03	--	0.21	0.62	0.04	0.65
Betweeness	0.5	0.62	0.13	0.33	--	0.62	0.57	0.5
Eigenvector	0.72	0.69	0.25	0.6	0.64	--	0.65	0.63
Bonacich								
In	0.93	0.09	0.25	0.33	0.41	0.66	--	0.08
Out	0.13	0.89	0.01	0.53	0.53	0.72	0.08	--

Betweeness centrality is only modestly correlated with Bonacich measures and degree centrality measures. The out-degree and betweeness correlation grows stronger from Time 1to Time 2 while the in-degree and betweeness decreases. The in-degree eigenvector correlation is stable from Time 1 to Time 2 while out-degree eigenvector correlation grows slightly stronger. The relationship between degree and Bonacich suggest that the local measure of centrality (degree) and the global level of power (Bonacich) consistently covary in the observed network. The direction of change suggests that these measures are growing slightly stronger over time.

In-Degree and Out-Degree Centrality

High-degree centrality suggests that groups have alternative ways to satisfy needs, and hence are less dependent on other agencies; these groups may have access to more of the resources of the network as a whole (Hanneman & Riddle, 2005). From the perspective of consensus mobilization, high-degree centrality increases exposure to potential resources flowing

through the network, and the ability to bring attention to specific goals. For recruitment, high-degree centrality helps organizations gain group membership and increase overall network support (Jenkins, 1983). If there is a consensus among other organizations in the network, then the organizations with highest degree centrality will also boost visibility of the mobilization effort.

Considering the conceptual difference between a hyperlink network and an information network, out-degrees have an applied interpretation, indicating node-level activity. That is to say, hyperlinking to other groups indicates an attempt on behalf of the organization to align itself with other network member. Out-degrees can certainly indicate influence in information networks, however, hyperlinks are considered representational communication and therefore logically differ from information flow networks (Shumate, 2012). As such, out-degrees are meaningful for comparing change over time, but are not measured in terms of influence for this study.

In the hyperlink network, degree centrality illustrates index power (Hanneman, & Riddle, 2005). More specifically, for a directed network of hyperlinks, in-degree centrality is especially meaningful, considering the role of hyperlinks in search algorithms and as mechanisms to draw traffic across sites within the network. The 'most linked to' organizations (in-degrees) are important because these are the groups with the best position within the network in terms of boosting visibility of their own agenda.

The following table lists the top five organizations based on in-degree centrality. The normalized in-degree value allows for comparison between Time 1 and Time 2. The normalized degree centrality is the node-level degree divided by the maximum possible degree. In-degree and out-degrees express the raw number of links to (i.e., in-degree) and from (i.e., out-degree)

for the five most linked-to organizations. By comparing the number of in-links to out-links, the range of distribution becomes evident. In other words, disparities between in-degree and out-degree indicate the extent of exclusivity among a small group of highly linked-to organizations. These organizations have relatively few out-degree links, suggesting they rarely reciprocate or hyperlink to other organizations.

Table 5.4

Network In-Degree [Web Authorities] for Time 1 and 2

	Time 1			Time 2		
Organization	In-Degree	Out-Degree *Normalized*		In-Degree	Out-Degree *Normalized*	
United Nations	39	25.66	1	41	26.97	1
World Bank	32	21.05	6	28	18.42	6
UN Development Prog.	28	18.42	17	27	17.76	11
Food & Agriculture. Org.	22	14.47	6	21	13.82	7
World Health Org.	18	11.84	3	17	11.18	3
Network Properties	In-Degree	*Normalized*		In-Degree	*Normalized*	
Overall Mean	3.82	2.51		3.64	2.35	
SD	(5.69)	(3.74)		(5.49)	(3.58)	
Sum	584	384.21		557	359.87	
Centralization	--	23.29%		--	24.74%	

Among the organizations in the observed network, the most highly centralized tend to receive many in-links and send few out-links. This is consistent with previous research findings of power laws in the degree distribution, where a small number of pages or sites receive many in-bound hyperlinks, with the majority receiving few or none (Barabási & Albert, 1999). However, this is not the case with the *United Nations Development Programme* which has the highest overall out-degree among the web authorities at Time 1 and Time 2. It is worth noting that an examination of the UNDP ego-network found a substantial decrease in the number of ties to and

from the UNDP between Time 1 and Time 2. Overall, the UNDP lost 10 of its original hyperlinks between Time 1 and Time 2, and gained three new ties.

The same five organizations have the highest in-degree centrality at Time 1 and Time 2. These central organizations could benefit from the disparity between in- and out-degree proportions, considering that hyperlinks drive website traffic and thus rank better connected sites or pages more highly (Lusher & Ackland, 2010). However, the public does not necessarily benefit from this type of structure (Cooley & Ron, 2002).

Disparities between in and out degree can be further explained by costs and benefits specific to hyperlink networks. For the receiver, the cost of receiving information flow relations increases with each link. Receiving too many information flow links can result in information overload, leading to a practical ceiling effect in in-degree centrality (i.e., the number of links coming to an actor). In contrast, there is no corresponding cost to receiving additional representational communication links. While one might receive more internet traffic as a result of users relying on the representational link, the choice to place a hyperlink on one's website itself has no direct cost to the target of that link. As such, many networks are characterized by relatively unconstrained in-degree distributions (i.e., power law distributions), whereas information flow networks' in-degree distributions is constrained by the costs of receiving additional links (Shumate, 2012, p.121).

Betweeness

For this study, measures of information control are conceptualized as betweeness centrality. Betweeness can be thought of as a measure of information control. The idea here is the more nodes that depend on an actor to make connections with others, the more power that

actor has. Betweeness measures are compared across two points in time to assess influence through the lens of diffusion.

The organizations with the highest node betweeness are those in which an actor falls on the geodesic paths between other pairs of actors in the network. A node that lies on hyperlink paths can control flow-through web traffic, and is thus important. If the mobilization network wanted to optimize a broader consensus, locating nodes that work as gatekeepers could help advance the movement from consensus to action. Along these same lines, such gatekeepers could have the potential to disrupt or threaten operations of the network (Borgatti, Everett & Johnson, 2013, p 174). Table 5.5 lists the five organizations highest in betweeness centrality at Time 1 and Time 2. The normalized network betweeness centrality is the betweeness divided by the maximum possible betweeness expressed as a percentage (Freeman, 1979).

Table 5.5

Betweeness Centrality Time 1 and Time 2

.	Time 1			Time 2		
Organization	Betweeness	Normalized	*rank*	Betweeness	Normalized	*rank*
Asian Dev. Bank	2090.86	9.11	[1]	1883.27	8.21	[4]
UN Dev. Program	1729.19	7.53	[2]	3661.07	15.95	[1]
World Bank	1582.84	6.9	[3]	596.99	2.6	
MIGA	1494.76	6.51	[4]	0	0	
UN Children's Fund	1334.46	5.81	[5]	1021.53	4.45	
SIDS Network	52.97	0.23		3169.81	13.81	[2]
UN Cape Verde	113.44	0.49		3047.58	13.28	[3]
International Telecomm Union	87.79	0.38		1815.81	7.911	[5]
Network Properties	Betweeness	*Normalized*		Betweeness	*Normalized*	
Overall Mean	90.63	0.39		154.137	0.68	
SD	(318.63)	(1.39)		(537.59)	(2.34)	
Sum	13866	60.41		23987	104.51	
Maximum	2090.86	9.11		3661.07	15.95	
Network Betweeness	306035.484	8.77%		524170.036	15.37%	

N=153

The Time 2 network is more centralized, when measured by betweenenss, with more variation at Time 2 (sd = 2.34) when compared to the Time 1 (sd=1.39) network. There is evidence of node-level centrality change in terms of betweeness from Time 1 to Time 2. First, the *Multilateral Investment Guarantee Agency* (miga.org) dropped from the network. MIGA is a member of the World Bank Group, to promote foreign direct investment (FDI) into developing countries to help support economic growth, reduce poverty, and improve people's lives (miga.org, 2014). Second, the *Small Island Developing Network* (sidsnet.org) increased substantially in its betweeness ranking (from 0.23 to 13.81). This appears to be part of a strategic change from an "information website to a knowledge management platform," over the past year, according the organization's website (sidsnet.org, 2014).

Two other organizations, *International Telecommunication Union* (itu.int) and *United Nations Cape Verde* (un.cv) both increased substantially from Time 1 and Time 2. Both of these are mission-specific arms of the *United Nations*. Both of these groups recently ramped up efforts to assist vulnerable island populations. The ITU is working on an "information superhighways of fibre-optic submarine cables" as part of a UN initiative to monitor climate change and develop disaster warnings (itu.int, 2014). The *UN Cape Verde* is part of a pilot reform program implemented by the United Nations to advance the country from a Least Developed Country (LDC) status (un.cv, 2014).

Cutpoints and Brokerage

Like betweeness, cutpoint organizations have similar potential to threaten or disrupt the mobilization effort. Cutpoint organizations at Time 1 include: *Asian Development Bank* (ADB), *United Nations Educational, Scientific, and Cultural Organization* (UNESCO), *United Nations Children's Fund* (UNICEF), *World Food Program* (WFP) *Caribbean Tourism Organization*

(One Caribbean), *Frontier Fund Manager* (Guarantco) and the *Small Island Developing States Network* (SIDS Net). At Time 2, one more organization joins these cutpoints, the *United Nations Industrial Development Organization* (UNIDO).

Brokerage refers to five kinds of social roles proposed by Gould & Fernandez (1989) (See Method, Chapter 3). When A, B, and C may belong to different groups, 5 kinds of brokerage are possible (Hanneman, & Riddle, 2005). Roles are determined by the specific organization of triadic relations throughout the network. Brokerage occurs when, in a triad of nodes A, B and C, A has a tie to B, and B has a tie to C, but A has no tie to C. That is, A needs B to reach C, and B is therefore a broker. Table 5.6 lists the scores (and top three ranking within the specific role) of the highest ranked brokerage positions at Time 2.

Table 5.6

Brokerage Roles Time 2

.	Coordinator	Gatekeeper	Representative	Consultant	Total
undp.org	158(1)	98 (2)	71 (1)	38 (3)	365 (2)
adb.org	157(2)	245 (1)	50 (2)	66(1)	518 (1)
unicef.org	63 (3)	93 (3)	38 (3)	42 (2)	236 (3)

Three organizations dominate the brokerage roles in the Time 2 Network: *Asian Development Bank* (adb.org), *United Nations Children Fund* (unicef.org) and *United Nations Development Programme* (undp.org).

Brewington, Davis, and Murdie (2007) found that more central organizations engage in the bulk of all international advocacy and consequently exploit their brokerage role by pushing their own agenda (see Murdie, 2014). Hafner-Burton and Montgomery (2009) propose that social power actors, those that can "withhold social benefits such as membership and recognition or enact social sanctions such as marginalization as a method of coercion" (pp.11-12). From this

perspective, gatekeepers hold the most influential position. Gatekeepers buffer between groups, and are most influential in information entering a group.

The *Asian Development Bank* serves as a cutpoint and gatekeeper and consultant. Gatekeepers are those who control access of outsiders to the group. The *United Nations Development Organization* (undp.org) and *United Nations Children's Fund* (unicef.org) are international-level gatekeepers within the Time 2. Consulting organizations broker a relation between two members of the same group, but is not itself a member of that group (Gould & Fernandez, 1989). The *United Nations Children's Fund* and *United Nations Development Programme* are also positioned as consultants in the Time 2 network.

While there is some overlap across cutpoints and brokerage roles, the *United Nations Development Programme* (undp.org) is the highest ranking representative and coordinator among international agencies, however, it is not a cutpoint. Coordinators connect organizations within a group, these organizations fall on the path between two other nodes in the same group. Representatives convey information from their group to outsiders, these organizations act as the contact point between groups. Organizations that broker relations between two groups, while not a member of either, hold a liaison position (Gould & Fernandez, 1989). There are no liaisons in the observed network at Time 2, and there are no brokers among the country-level organizations.

Eigenvector

Like closeness, eigenvector is rooted in the idea that an organization's ability to get resources is increased by access to multiple networks with resources. Table 5.7 lists the eigenvalue scores for Time 1and Time 2, along with normalized measures and rank among all organizations within the observed network.

Table 5.7

Eigenvector Centrality Time 1 and Time 2

	Time 1			Time 2		
Organization	Eigenvalue	Normalized	*rank*	Eigenvalue	Normalized	*rank*
SIDS Net	0.3	43.52	[1]	0.29	41.88	[1]
Asian Dev. Bank	0.26	37.5	[2]	0.25	35.32	[4]
UN Children's Fund	0.26	36.93	[3]	0.25	36.09	[3]
United Nations	0.25	35.34	[4]	0.27	38.78	[2]
UN Dev. Program	0.24	33.89	[5]	0.2	28.55	
World Bank	0.22	31.34		0.22	31.17	[5]
Network Properties	Eigenvalue	*Normalized*		Eigenvalue	*Normalized*	
Overall Mean	0.05	7.54		0.05	7.306	
SD	(0.06)	(8.59)		(0.06)	(8.79)	
Maximum	0.31	43.52		0.3	41.88	
Eigenvector Centralization		39.41%			37.88%	

N=153

The normalized eigenvalues illustrate that four of the five highest ranking Time 1 organizations decreased slightly in terms of network power by Time 2. The *United Nations* (un.org) increased slightly in overall network power (i.e., normalized eigenvalue) from Time 1 to Time 2, while the *United Nations Development Programme* (undp.org) had the most substantial decrease over time. Overall there is minimal eigenvector power change in the observed network from Time 1 and Time 2. It is worth noting that closeness centrality is useful for predicting how long information takes to arrive. This is an important consideration for purposes of action mobilization. It can determine which actors could reach most others. However, the meaningfulness of closeness centrality in a hyperlink network is less clear. It suggests that web traffic could be directed, or more likely to reach nodes with high closeness, but this is not necessarily through direct paths. As such, eigenvector is used to measure centrality in terms of access to resources.

RQ3: To what extent are hyperlinks reciprocated in the international mobilization hyperlink network for SIDS?

The hyperlink network structure consists of a group of websites connected by the hyperlinks. This series of hyperlinks allows web surfers to travel from one website to another. The structure is not bound by the singular path followed by a web surfer; it is typically represented by a map of all possible connecting websites (Kropczynski & Nah, 2011). Park and Thelwall (2003) contend that a hyperlink network can be described as a specific type of computer-mediated communication network, in which website authors are interconnected by hyperlinks.

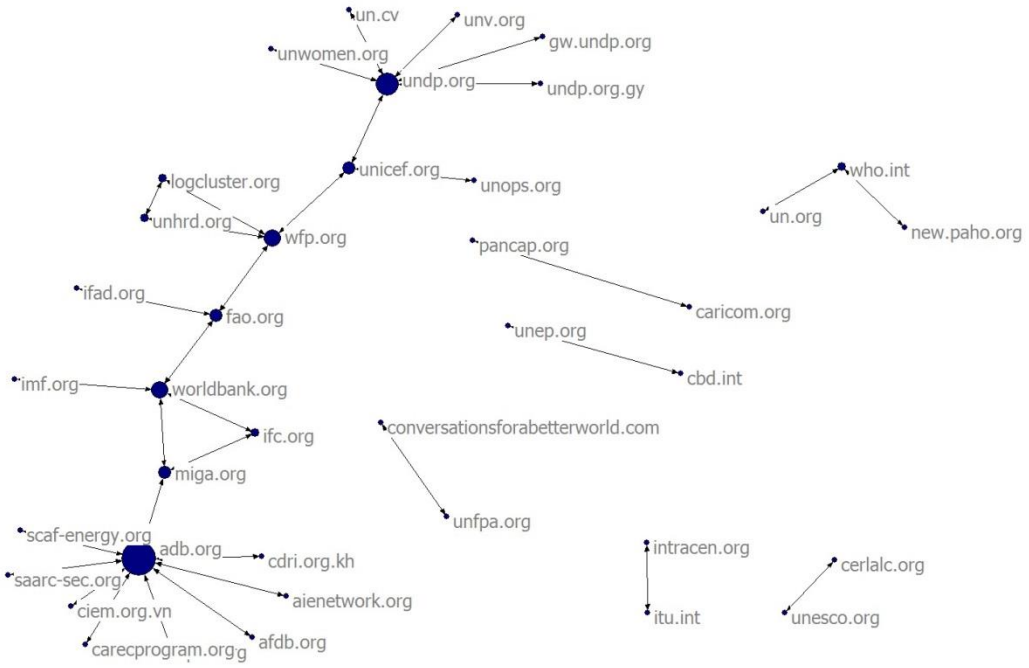
Reciprocity over Time

Reciprocity is measured as the prevalence of mutual relationships between organizations. More generally, networks with high levels of reciprocity are often considered more balanced, stable or harmonious when compared to networks with less reciprocity (Hanneman & Riddle, 2005). This argument holds that there is an "equilibrium tendency toward dyadic relationships to be either null or reciprocated," and that asymmetric ties may be unstable, or a signature of a hierarchal structure (Hanneman & Riddle, 2005).

Hyperlinks can be thought of as strategic choices on the part of site producers (Rogers & Marres, 2000). From this perspective, reciprocity is one way to assess whether organizations acknowledge each other. When isolates and inactive links are removed from the full network, at Time 1, 6.18 percent of all the relations in the graph are part of reciprocated ties. The arc-based reciprocity, or the proportion of reciprocated ties among all the hyperlinks at Time 1, is 11.64 percent. Figure 5.1 illustrates the reciprocated ties at Time 1, the node size indicates the level of degree centrality for each node among these reciprocated hyperlinks.

Figure 5.1

Time 1 Reciprocated Ties and Node Degree Centrality

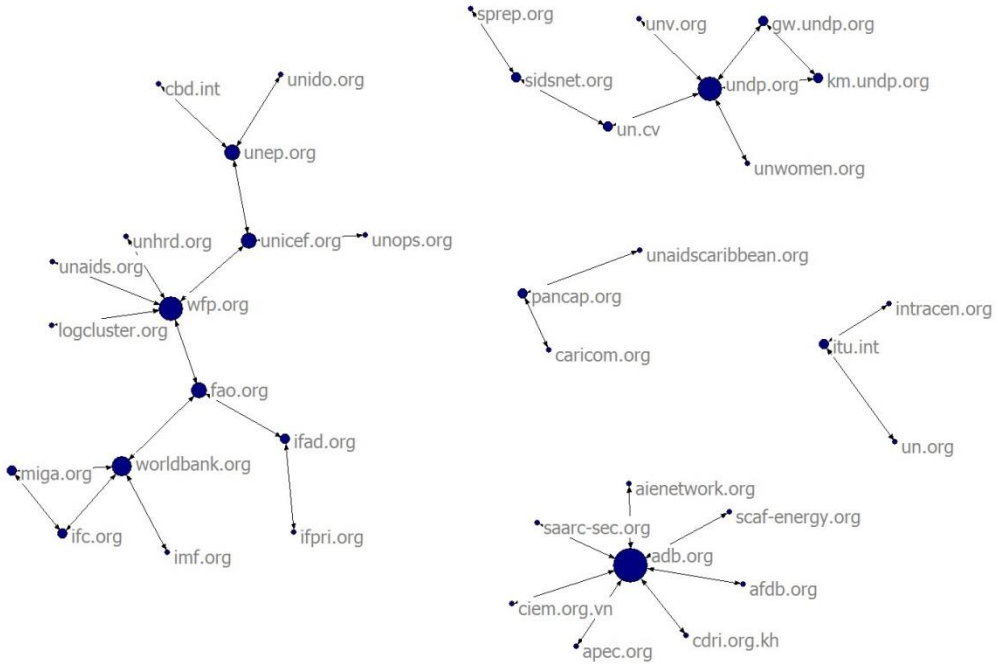


Dyad Reciprocity = 6.18% *Arc-based Reciprocity = 11.64%*

For the Time 1 network, the *Asian Development Bank* is the most central, followed by the *United Nations Development Programme*. The Time 2 graph illustrates an increased distribution of web authority (degree centrality) among reciprocated nodes. For the Time 2 network, the *World Food Program* and *World Bank* increase in degree centrality. Figure 5.2 illustrates the reciprocated hyperlink network at Time 2. Node size indicates the level of degree centrality among the reciprocated relations.

Figure 5.2

Time 2 Reciprocated Ties and Node Degree Centrality

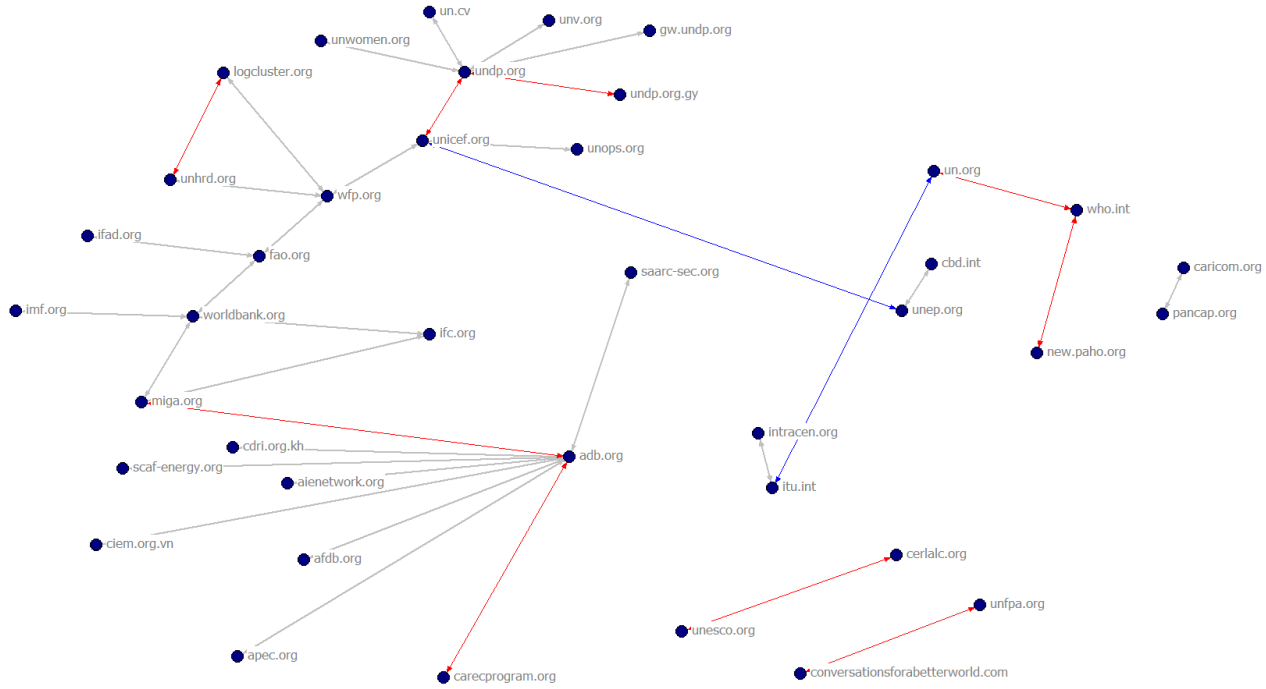


Dyad Reciprocity = 6.42% *Arc-based Reciprocity = 12. 57%*

The proportion of reciprocated ties among all the hyperlinks, and the ratio of relations that are reciprocated, increased over time in the observed network. More specifically, 6.42 percent of adjacent dyads are reciprocated, as compared to 6.18 percent at Time 1; while 12.57 percent of all the hyperlinks are part of reciprocated structures at Time 2, as compared to 11.64 percent at Time 1. Figure 5.3 illustrates changes in arc-based reciprocity from Time 1 to Time 2. The red lines indicate a reciprocated tie only at Time 1. Blue ties illustrate new reciprocated ties for the Time 2 network. Grey ties were reciprocated at Time 1 and Time 2.

Figure 5.3

Changes in Tie Relations Time 1 (Red) and Time 2 (Blue)



Arc-reciprocity Time 1 = 11.64% *Arc-reciprocity Time 2= 12.57%*

The graph above illustrates that there are more reciprocated ties at Time 1 (red ties) than Time 2 (blue ties). Among reciprocated ties, the network had a net-loss of seven reciprocated ties. Still, overall network reciprocity increased. This can be explained by the relative nature of arc-based and dyad-based measures reciprocity measures.

Measures of reciprocity are based on proportion to the network; the increase in overall reciprocity, despite the loss of ties from Time 1 to Time 2, reflects a network-level loss in dyadic relations and ties (from 584 ties at Time 1 to 557 at Time 2). That is to say, among the ties and relations that remained from Time 1 and Time 2, a higher proportion are reciprocated.

RQ4: Does the international mobilization hyperlink network for SIDS demonstrate tendencies toward homophily based on organization type, level or regional focus?

The international mobilization network is a self-organizing mechanism reflecting strategic partnerships to achieve organizational goals (Rogers & Marres, 2000; Shumate & Lipp, 2008). Reciprocity is one way manifestation of strategic collaboration (Jackson, 1997; Rogers & Marres, 2000; Shumate & Dewitt, 2008; Shumate, 2012). Evidence of homophily is another indication of such strategies (Atouba & Shumate, 2010). This research question explores homophily for hyperlinks across organizations in the mobilization network at the dyad-level. Permutations were used to test statistical significance for the attribute-driven tests for homphily.

At the dyadic level, notions of exchange and dependency may explain the pattern of interdependence among network ties (Monge & Contractor, 2003). The logic of exchange and dependency theories suggests that organizations forge ties based on their need to obtain informational or material resources, in combination with their ability to provide such resources (Atouba & Shumate, 2010). Sometimes such trends can be explained by homophily.

Homophily

Homophily can explain strategic alliances among organizations with shared qualities; theories of homophily posit a greater tendency for a tie from organizations that both share a common attribute and a lower tendency for a tie from organizations that do not share a common attribute (Monge & Contractor, 2003). For example, Brass (1995) notes that similarity is thought to ease communication, increase predictability of behavior, and foster trust. A number of attributes have been examined among international mobilizing agencies and service providers, using homophily as a foundation for analysis, including proximity (Barnett & Choi, 2011; Rosenkopf & Almeida, 2003) and status (Chung, et al., 2000; Podolny, 1994).

This analysis of homophily looks at tendencies for organizations to hyperlink based on the level of the organizations, the geographic focus of projects for small island developing nations, and types of organizations. In order to explore this research question, an attribute matrix was created to reflect differences and similarities for each dyadic relationship.

For level, each cell represents the absolute difference between the organizational-level of the two nodes. Nodes were coded (1) at the country level (2) at the regional level, and (3) at the international level. Additional matrices were generated for each type of organization. The "type" matrices were created to reflect only if the two organizations were the same (coded as 1) or different (coded as 0). Similarly, geographic project focus matrices reflected whether organizations have projects in the same region, or not. These matrices were correlated and subject to QAP (correlation) analysis. Further assessments of in-group and between-group hyperlinks are tested across attributes.

Level

Partnering with organizations of similar status, particularly among high-status organizations, serves a signaling function to sources of external resources, facilitating access to those resources (Podolny, 1994). Podolny (1994) asserts that high-status organizations create alliances to attract external resources. That is, if high-status organizations collaborate, that partnership sends cues to other groups about the quality of output, prompting investment from groups such as government agencies or financial institutions, thereby strengthening the network. Additionally, status similarity makes it more likely that both parties will share the costs and benefits of an alliance. On the other hand, organizations with unequal status are generally unable dedicate the same level of resources to an alliance (Chung, et al., 2000, p. 4).

Hyperlinks were subject to randomization test of autocorrelation for the hyperlink adjacency matrix, partitioned into groups. This test uses both Time and Time 2 data. The observed network illustrated far fewer ties between country and global organizations than would be expected, although the number of those ties increases between Time1and Time 2. There also appears to be a dramatic decrease in ties from regional-level organizations to country-level organizations between these two time points. Regional-level organizations dropped the most ties across among the levels, suggesting, perhaps, that regional-level organizations are short-term compared to global and country level. However, change over time could not be explained by homophily.

Supplemental Tests

To explore level-based homophily, the data were recoded to treat level as a continuous variable. For this test, a matrix was created so each cell represents the absolute difference between the organizational level of the two nodes. Nodes were coded (1) at the country level (2) at the regional level, and (3) at the international level. The difference in level matrix was then correlated with the hyperlink network at Times 1 and 2.

Significance is determined by the proportion of times that a random measure is larger than or equal to the observed measures. A low proportion ($p< 0.05$) suggests a strong relationship among the matrices that is unlikely to have occurred by chance. Table 5.8 illustrates the Pearson's correlation between level and hyperlink choice. There is only a weak effect based on level for Time 1 which decreases slightly by Time 2 (N=153; r = 0.047; $p <.05$).

Table 5.8

QAP Correlation Hyperlink Choices by Level of Organization

	r	*p*	Avg	SD	Min	Max	Prop >= O	Prop <= O
Time 1	0.051	0.01	-0.0	0.02	-0.07	0.07	0.014	0.987
Time 2	0.047	0.02	0.0	0.02	-0.07	0.07	0.023	0.978

Random seed:19477 *Permutations: 5,000*

The Geary C statistic is constructed by examining the differences between the scores of each pair of actors, and weighting this by their adjacency. The Geary statistic has a value of 1.0 when there is no association suggesting that there are similarities among the level of organizations and hyperlink ties (r=.74, p<.05), when level is treated as a continuous variable.

Table 5.9

Geary and Moran Autocorrelation

.	N	Geary	Expected	Moran	Expected
	197	0.740*	0.999	0.134*	-0.005
	SD		(0.098)		(0.036)

**p<.05* *Permutations: 10,000*

The Moran statistic looks for the tendency for actors who are adjacent to similarly connect with two random actors. The Moran statistic indexes the product of the differences between the scores of two actors and the mean, weighted by the actor's similarity (based on a covariance weighted by the level of actors). In these random trials, the average Moran statistic is -0.005 (sd=0.036) which is less than the observed value (0.134; p<.05). Both of these tests suggest that hyperlink choices occur among more similar organizations in terms of level, than what would be expected by chance alone. While these data suggest that similarity play some role in hyperlink choices, this is not a clear-cut indication of homophily.

Proximity

This study explores whether groups with a global orientation tend to hyperlink to other global organizations, and if regionally specific organizations hyperlink to other organizations in the shared region. Previous research suggest that proximity plays a role in the coordination among mobilizing groups because organizational populations in the same geographic area will have access to similar geography-related environmental resources; these resources might include costs, labor pool, and political opportunity structures. For example, Barnett and Choi (2011) mapped the structure of the international hyperlink network as a global communication system (see also Barnett, 2001), finding little direct communication across the regional boundaries.

Locality, or geographic similarity, has been studied in other contexts such as collaboration and innovation development, finding geographically localized knowledge flows (e.g., Rogers & Larsen 1984; Saxenian, 1990; von Hippel, 1988). Overall, these studies suggest that geographic proximity reduces the cost and increases the frequency of personal contacts that build social relations between organizations. Rosenkopf and Almeida (2003) note that distant contexts may offer ideas and insights about alliances and the mobility. These studies have broad implications in terms of power differentiation, for international level, Northern-based organizations in the global discourse of social issues and the dissemination of resources. Table 5.10 illustrates expected and observed values of dyadic hyperlink relations in the Time 2 Network. Expected refers to the average outcome of permutations. The difference between expected and observed illustrates the magnitude and direction of the hyperlink connections for the specified dyadic combo.

Table 5.10

Hyperlink Choices By Project Region Observed and Expected Dyad Relations

AIMS	Expected	Observed	Difference	P >= Diff	P <= Diff
NOT AIMS	279.046	267	-12.046	0.628	0.381
One AIMS	206.142	209	2.858	0.466	0.550
Both AIMS	36.811	46	9.189	0.272	0.747
					Random seed: 2930
Caribbean	Expected	Observed	Difference	P >= Diff	P <= Diff
NOT Caribbean	336.822	408	71.178	0.026	0.976
One Caribbean	165.650	108	-57.650	0.976	0.027
Both Caribbean	19.528	6	-13.528	0.955	0.069
					Random seed: 17936
Pacific	Expected	Observed	Difference	P >= Diff	P <= Diff
NOT Pacific	370.625	353	-17.625	0.697	0.311
One Pacific	138.985	152	13.015	0.329	0.682
Both Pacific	12.390	17	4.610	0.266	0.767
					Random seed: 12292

Permutations: 10,000[8]

In terms of homophily based on project proximity, the data did not support that organizations with AIMS-specific projects, Caribbean-specific projects or Pacific-specific projects are any more likely to hyperlink with one another than by chance alone. The only significant finding suggested that organizations with projects in the Caribbean are less likely to hyperlink with any other organization ($p<.05$).

Organizational Type

The primary difference between IGOs and NGOs is that IGOs are established by international agreement among nations and NGOs, NGOs are often founded by registering the organization in a single nation (Jordan et al., 2001). For this study, organizational type refers to either: inter-governmental organization (IGO), non-governmental organization (NGO), a

[8] *Random graphs to generate the sampling distribution for group differences*.

funding agency (or an organization responsible for distribution of financial resources) (FO), A single nation governmental agency (GOV), or a think tank, research institute or specialized information agency to educate or inform policy (RES).

The contingency analysis is a global test of difference from random distribution (similar to a standard chi-square test), except instead the underlying distribution is constructed using a randomization procedure, 10,000 random trials, in order to test for statistical significance of observed effects. The cells represent the number of ties observed between each organization type. The expected number of ties is under parentheses below the observed values. The magnitude is the value of the observed ties relative to the expected value.

The data suggest some patterns of homophily. The magnitude scores suggest tendency for homiphily among funders and IGOs in the observed network. The magnitude (value of the observed ties relative to the expected value) of these associations is highest among funding organizations (2.84, $p < .05$) followed by IGOs (2.11; $p < .05$). While NGOs demonstrate higher than expected hyperlinks to other NGOS, the magnitude score for homphily is lower than NGO to IGO hyperlinks. Governments and research organizations do not demonstrate any tendencies for homophily in the observed network.

Supplemental Tests

The test for constant homophily proposes that all groups may have a preference for within-group ties, but that the strength of the preference is the same within all groups. This model explained only a fraction of the variance across hyperlink ties (r-square = 0.003). The data suggest that there is a 1.3 percent chance that heterogeneous dyads will have a tie, whereas, when members of the dyad are from the same group, the probability that they share a tie is 2.9 percent ($p<.05$). A test for variable homophily, also found that only IGOs and funding

organizations hyperlinking within their specified group could explain variances between types of organizations (r-square .007; $p<.05$).

RQ5: How do structural features of the international mobilization hyperlink network change over time?

Many of the measures discussed in the previous research questions are examined at two points in time. The rate of variation indicates the amount of change that occurs in a given time period (Shumate, 2012). Overall, the findings can be summarized as: the network size decreased, and the internal network structure became more cohesive.

Network Change

Network structures can be seen as displaying high levels or low levels of power or cohesion as a result of variations in the patterns of ties among actors. The following structural analysis looks at how well the network, as a whole, is positioned based on consensus and resources mobilization concepts. Chapter 4 provided a basic analysis of network characteristic at Time 1. This research question delves deeper into an analysis of structural properties by comparing properties at two points in time.

In high-density systems there is the potential for greater power (Hanneman & Riddle, 2005). A network that is loosely coupled, or held together by fragmenting ties, cannot exert much power to achieve a shared goal. At the network-level, the direction of change in density, average degree, and geodesic distance, suggest a decrease in overall cohesion. However, an examination of the main component suggests that cohesion may actually be increasing among core members of the network.

For consensus mobilization, the network is analyzed in terms of cohesion. Network cohesion can be described through a variety of measures including: density, average degree,

average distance between pairs, and the number of nodes that must be removed to in order to disconnect the network. These tests are closely related to measures for potential resource mobilization. For resource mobilization, the network is checked for features indicating hierarchies, or lack thereof. Signs of hierarchies can be found by looking at a variety of network features. This research looks at the overall level of reciprocity, transitivity, density, and network centralization.

Cohesion

Networks with low density have a tendency to fall apart (Hannman & Riddle, 2005). Twenty-seven of the original 584 hyperlinks dropped from the network resulting in eight isolates and a slight decrease in density. At Time 1, the density is 2.51 percent, dropping to 2.39 percent at Time 2. While the network density changes only slightly over time, the direction of change indicates a slight decrease in cohesion at Time 2 when compared to Time 1.

Since density is inversely related to network size, it is necessary to also look at the average number of hyperlinks for each organization (Nooy, Mrvar, & Batagelj, 2005). Low or unequal distribution of degrees often predict a slow reaction to stimuli, or constraints to mobilization. A higher degree results in a dense network because nodes have more ties (Nooy, Mrvar, & Batagelj, 2005). At the network level, average degree drops slightly between Time 1 and Time 2. The low number and direction of change, suggest sparse interconnectivity, and less cohesion across the overall network.

Components

Divisions of actors into groups and sub-structures illustrate how the network as a whole is likely to behave. A component is a set of nodes in which all nodes are reachable from all other nodes in the subgraph. In a strong component, every node is reachable from every other node

following the directions of the hyperlink. The specifications for the component test, for this research, require that at least three nodes be connected in order to constitute a component. When measured this way, the strong component is larger at Time 2 compared to Time 1. At Time 1 the network has one strong component with 47 nodes, accounting for 30.72 percent of the network. The Time 2 network has one component, with 59 connected organizations, accounting for 38.56 percent of the network.

Examining the main component provides a localized measures of cohesion from Time 1 and Time 2. When directionality is ignored (i.e., weak component), the Time 1 network has one component, with 151 nodes, accounting for 98.69 percent of the network. At Time 2, the main component has 145 nodes, accounting for 94.77 percent of the network. Table 5.11 lists the network-level and main component features for Time 1 and Time 2.

Table 5.11

Network Characteristics Time 1 and Time 2

Property	Time 1	Main Component	Time 2	Main Component
Nodes	153	151 (98.69%)	153	145 (94.77%)
Isolates	0	0	8	0
Density	2.51%	2.57%	2.35%	2.66%
Ties	584	584	557	557
Average Distance	3.29	3.29	3.78	3.78
Average Degree	3.82	7.19 (10.45)	3.64	6.82 (10.3)
Arc-based Recip.	11.64%	11.66%	12.07%	12.57%
Dyad-based Recip.	6.18%	6.19%	6.42%	6.7%
Transitivity	0.03%	0.03%	0.03%	0.04%

**Proportion of the network in main component in parentheses in the first row of the table.*

Low density and high-degree separation indicates sparse connections, and is often a symptom of disagreement or hierarches. The observed network demonstrates some symptoms of sparse connectivity, and some indications of growing agreement among the main component of the network. In other words, while density increases, so do the average distance and average

degree. At the same time, transitivity and reciprocity among the main component suggest that this part of the network is becoming more cohesive.

Transitivity

At a network level, triads help determine the "clustering" within the network. Like reciprocity, transitivity seeks to measure balance within the network, asymmetric transitive triangles may be unstable, a signature of a hierarchal structure, a signal of inequality or the formation of exclusive groups (e.g. where two actors connect, and exclude the third). The prevalence of such patterns provides insight into the potential to mobilize actors within the network.

Polycentric networks tend to cluster, suggesting that the network is moving toward a hierarchal structure. The proportion of transitive triples in the Time 1 and Time 2 network, accounts for small fraction of the triadic relations (0.03 percent). The clustering potential can further be examined by calculating the number of cases where a single link could complete the triad. The number of cases where a single link could complete the triad is 36.15 percent at Time 1 and decreases to 35.72 percent at Time 2. The weighted coefficient is another way to determine tendency to cluster among triads. When weighted, the coefficient is slightly higher at Time 2 (0.131) compared to Time 1 (0.125). Transitivity among nodes in the main component at Time 2 increase from .03 to .04 percent. Together, the direction of change, and patterns across time and components, indicate that clustering across the network is low, however, core among the main component are becoming more cohesive.

Hierarchies

A polycentric structure represents a decentralized model for mobilization. Such networks are characterized by multiple clusters of exchange connected by a few sparse connections (Baldassarri & Diani, 2007). Networks with structural features leading to control of resource flows generate power inequality (Willer, 1999). Typically, scholars identify hierarchal structures as most vulnerable to these types of inequalities (Moody & White, 2003).

Generally speaking, high-density can suggest multimodal properties or distribution of power to many nodes across the network. Strong networks tend to have high-density, illustrating a highly connected network. High-density can translate to high agreement, consensus, and equal distribution of power as the ratio of observed hyperlinks to the possible hyperlinks (i.e. the number of links that would result if every organization in the sample were connected to every other organization).

Centralization can provide insight about the sources and distribution of power within a network. Degree centrality is often used to examine how well connected each node is to others. The distinction between in-degree and out-degree measures allows for comparisons between in-degree network patterns and the out-degree patterns. Once isolates and inactive links are removed from the full network, organizations have an average of 3.82 hyperlinks at Time 1 and organizations are homogeneous with regards to in-degree centrality (as measured by the standard deviations and variance). Distribution of out-degree hyperlinks is more heterogeneous in the observed network, across both Time 1 and Time 2 networks. The distribution of degree centrality for the full network is described in Chapter 4. Table 5.12 illustrates degree centrality and the normalized values for in-degree and out-degree centrality for the network at Time 1 and Time 2.

Table 5.12

Degree Centrality Time 1 and Time 2

Time 1	N	Ties	Max	Mean	Normalized	Centralization
	153	584		3.82	2.51	
Out			81	(8.87)	(5.84)	51.11%
In			39	(5.69)	(3.74)	23.3%
Difference					2.1	27.81
Time 2	N	Ties	Max	Mean	Normalized	Centralization
	153	557		3.64	2.39	
Out			81	(8.78)	(5.74)	51.23%
In			41	(5.50)	(3.62)	24.74%
Difference					2.12	26.49

**Difference refers to the gap between in and out degree normalized measures within each time frame.*

Across the Time 2 network the number of hyperlinks each node sends ranges from zero links to 81 hyperlinks. A greater level of variance is evident for out-degree as compared to in-degree and an unequal distribution of power across the network is evident at Time 1 and Time 2. While the patterns of comparison between in and out degree among the network at Time 2 reflect distribution inequality, the range between out and in variance narrows between Time 1 and Time 2.

High-degree centralization means that one or a few nodes are highly connected to a set of organizations which are not connected to one another. Out-degree is more centralized than in-degree at Time 1 and Time 2. Based on difference between the in-degree and out-degree standard deviations, as well as the range within the networks, it appears that there are imbalances, with a disproportionately low number of in-links compared to many out-links. The standard deviation indicates that the network is moving in the direction of a more even distribution of in-degree links and out-degree links. Still, positional advantages are rather unequally distributed in this network.

Centralization

The centralization used here looks at the propensity for k-stars. In other words, centralization is a function of the proportion of centralized organizations with a set of unique connections which do not connect with another. This can also be interpreted as symptom of hierarchy. Previous research suggests that hierarchies constrain mobilization, however, from the perspective of consensus mobilization hierarchies can actually facilitate mobilization. Baldassarri and Diani (2007) point out, hierarchal structures are well suited for quick action mobilization because negotiations to reach a consensus are limited, sometimes all together unnecessary.

The observed network is growing more centralized, while density decreases. One part of the network is growing more cohesive, while the overall network fragments (e.g., isolates, loss of hyperlinks, increased distance across nodes). These features indicate data that the observed network is hierarchal, and growing more hierarchal over time.

Hierarchal structures can be more volatile or at risk of failure because all or most resources are dependent on one or few actors. However, hierarchal structures might have advantages for the mobilization of resources. For example, Provan and Milward (1995) looked at the effectiveness of organization network goals based on the overall power structure of the network. These authors report that centralized hierarchal structures among mental health delivery agencies proved to be more effective than polycentric structure.

CHAPTER 6

Conclusion, Discussion and Future Research

This study has integrated mobilization theory and network analysis theory and methodology to explore hyperlink relationships among international organizations focusing on the plight of SIDS. Based on the results from the two preceding chapters, several conclusions can be drawn about structural characteristics of the network (RQ1), influential organizations in the network (RQ2), reciprocity of relationships within the network (RQ3), homophily among organizations within the network (RQ4), and changes in the network from 2013 to 2014 (RQ5).

The Network

The full network has 197 nodes with 673 hyperlinks. The network is hierarchal, and growing more hierarchical over time. The overall size of the network decreased between 2013 and 2014, while core members (those connected within the main component) became more cohesive in the same time period. The direction of change suggests that the network became less dense and less connected over time. The magnitude of change, however, was slight.

The network also shows signs of imbalance, and inequality. The number of nodes in the observed network send far more hyperlinks than the number of nodes who receive hyperlinks. When the full network was examined at Time 1, a notable finding was the gap between in and out hyperlinks. Across the network the number of hyperlinks each node sends ranges from zero links to 86 hyperlinks; whereas, the range for in-degree hyperlinks is zero to 41 hyperlinks.

Influential Organizations

The network approach emphasizes that influence is inherently relational. Because influence is a consequence of patterns of relations, the amount of influence in social structures can vary. Hyperlink research often focuses on degree centrality to measure influence in a network because the hyperlink provides a path for web traffic, which increases an organization's visibility. In-degree centrality is especially relevant in the combined context of mobilizing organizations and hyperlink research as a prestigious position, inferring credibility and exclusivity (Thelwall, 2009). Degree centrality measures also correlate with Bonacich [9] power measures, suggesting that organizations that rank high for degree centrality are also positioned to control resources within the network. The observed network had the same five web authorities at Times 1 and 2.

(1) United Nations (UN)

(2) World Bank

(3) United Nations Development Programme

(4) Food & Agriculture Organization

(5) World Health Organization

These data support Park and Thelwall's (2003) findings that organizations with more incoming links are perceived as the most prestigious. More specifically, these data illustrate that more organizations link to other organizations than receive links. As such, organizations with more hyperlinks directed toward them hold a more prominent position, particularly online where such links direct internet traffic. Organizations with the highest level of in-degree centrality are also the organizations that have the highest probability of coming up in an online search query.

[9] United Nations, Food and Agriculture Organization and World Bank have the highest In-Bonacich power. Sidsnet, and the Asian Development Bank, have the highest Out-Bonacich scores.

Network Embeddedness

Measures of embeddedness help identify which nodes are well-positioned to control or disrupt information flow (or resource). Since consensus mobilization requires agreement, access to nodes within the network is an essential element for boosting the mobilization potential. Betweeness centrality, cutpoints, and brokerage roles were all used to inform the analysis of the most influential organizations in terms of consensus mobilization. Betweeness centrality illustrated the most change between Time 1 and Time 2. As such, the Time 2 network is considered more relevant in this analysis because it is more current, and suggests that the organizations that were highly centralized, did not leverage their position or sustain their role. The most central betweeness organizations in the Time 2 network are:

(1) The United Nations Development Programme (UNDP)
(2) Small Island Developing States Network (SIDS Net)
(3) UN Cape Verde (UN CV)

From the consensus mobilization perspective, gatekeepers are arguably the most influential. The *Asian Development Bank* is the best positioned organization for gate-keeping among all the network nodes. The UNDP and UNICEF are also considered gatekeepers, albeit to a lesser extent. *Asian Development Bank* and the UNICEF are also among the six cutpoints (along with UNESCO, World Food Program, Caribbean Tourism Organization and SIDS Net). Organizations that ranked within the top 3 of multiple measures are considered among the most influential organizations in terms of consensus mobilization. These are:

(1) Asian Development Bank (ADB)
(2) United Nations Children's Fund (UNICEF)
(3) United Nations Development Programme (UNDP)
(4) Small Island Developing States Network (SIDS NET)

Network Power

In terms of resource mobilization, influence was not measured in terms of centrality. Instead eigenvector power is used to identify important and influential groups. Eigenvector power is calculated by the centrality of the nodes connected to each organization. The *Small Island Developing States Network*, *Asian Development Bank*, *United Nations Children's Fund* and *United Nations* have the highest eigenvalues. Taking the aforementioned into consideration the most powerful groups in terms of resource mobilization include:

(1) Small Island Developing States Network (SIDS NET)
(2) Asian Development Bank (ADB)
(3) United Nations Children's Fund (UNICEF)
(4) United Nations (UN)

Variations of Influence and Power

Web authorities, embedded organizations and network power are all variations of centrality. They represent different types of influence and power. Web authorities have positional advantage, hyperlinks draw web traffic to the sites of the these organizations. Moreover, web authorities are the most prestigious, they tend to have many in-degree hyperlinks and very few out-going. Embedded organizations are influential because they tend to have brokerage roles, when cutpoint organizations are taken-out of a network, the network becomes fragmented or disconnected. Whereas, network power assumes that organizations are relatively less constrained, and are generally less dependent on other organizations – since they have direct or indirect links to multiple organizations with resources. Taking these considerations into account, the most influential organizations within the network include the following:

(1) The Asian Development Bank: ADB is the top gatekeeper within the observed network. It is also a cutpoint organization, it has the highest eigenvalue, and is among the top 10 organizations for degree and betweeness measures for Time 1 and Time 2. In terms of network power the ADB remained stable from Time 1 to Time 2 (with 8.5 eigenvalue). However, the ADB dropped six ties in the Time 2 network (from 47 to 41). The domain went online July 13, 1995. The site has about 130,000 page views a day (based on Alexa estimates, as of June 25, 2014) with 55 out-going hyperlinks across the web.

(2) The United Nations: The UN is a web authority and holds the most prestigious position within the network -- it has the highest in-degree centrality among all network nodes with only one out-going hyperlink. The UN is connected to multiple country-level organization, as the parent group to locally-enacted UN mandates. The domain went online January 31, 1995. The site receives about 1.4 million page views a day (based on Alexa estimates, as of June 25, 2014). The site has only 6 outgoing hyperlinks total, across the web.

(3) United Nations Development Programme: The UNDP is among the five web authorities and is an embedded organization and gatekeeper. The UNDP has regional and country-specific projects in Cape Verde, Comoros, Guinea-Bissau, Maldives, Mauritius, Seychelles, American Samoa, Bahrain, Jamaica and Trinidad & Tobago. The website (undp.org) is the third most prestigious of the network. Among the web authorities, it has highest proportion of out-degree hyperlinks within the network. The site receives about 570,000 page views a day (based on Alexa estimates, as of June 25, 2014) and has 59 total out-going hyperlinks. The domain went online Sept. 16, 1991.

(4) United Nations Children's Fund: UNICEF is a cutpoint organization and among the highest in eigenvector centrality. Further, the organization ranked higher in eigenvector power for Time 2, suggesting it is an emergent power within the mobilization network. UNICEF provides long-term humanitarian and developmental assistance to children and mothers in developing countries. It has country and regional-specific projects in Jamaica, Barbados, Timor-Leste, Mauritius, Guinea-Bissau, Comoros and Cape Verde. The domain went online in 1993. The site receives about 380,000 hits a day (based on Alexa estimates, as of June 25, 2014). The site has 108 outgoing hyperlinks total across the web.

(5) Small Island Developing Network: SIDS Net is a cutpoint organization and has the highest out-degree centrality for Time and Time 2. Thus it ranks highly on other symmetrized measures of power and authority. SIDS Net also increased substantially in betweeness ranking (from 0.23 to 13.81) between Time1 and Time 2. SIDS Net is a knowledge platform develop in 1997, supported by the government of Spain. The organization focuses on decentralized content management and stakeholder engagement to track international meetings related to SIDS, through a partnership with the *International Institute for Sustainable Development*, the organization aims to facilitate partnerships and motivate action in support of the sustainable development of SIDS (sindsnet.org, 2014). The site receives about 730 hits a day (based on Alexa estimates, as of June 25, 2014). The domain went online May 21, 1998.

(6) World Bank: In terms of in-degree centrality, the World Bank is the second most prestigious among all organizations in the observed network. Headquartered in Washington, D.C., the World Bank was established in 1944, to provide low-interest loans, interest-free credits, and grants to developing countries. The site receives about 1.3 million page views a day

(based on Alexa estimates, as of June 25, 2014) with 165 outgoing hyperlinks across the web. The domain went online in 1991.

Network Reciprocity

The data suggest that reciprocity is growing stronger within the observed network over time. At the same time, the number of reciprocated ties and the number of dyadic relations that are reciprocated decreases. Since reciprocity is relative to the network size, and the proportion of dyadic relations, the growing tendency toward reciprocity could indicate that the organizations within the network are creating alliances, while those that are not in agreement are dropping from the network.

Shumate (2012) argues that there is a cost involved in reciprocity, in a competitive environment reciprocated tie boosts the prestige of the other organization. Carpenter (2011) argues that mobilizing organizations are often caught-up in a struggle between advancing organizational-level position and achieving a public good. Increases in reciprocated ties across the mobilization effort could therefore suggest that the network is advancing toward the public good.

Network Homophily

The data indicate hyperlink choices could be based on attribute similarities. Funding organizations (FO), in particular, were most likely to hyperlink with other FOs. Inter-governmental agencies similarly tended to hyperlink with other IGOs, when compared to any other type of organization. However, these homophily-driven choices could only explain a small fraction of the variance within the network and did not extend to NGOs, government organizations or research-oriented organizations.

Overall, tests of homophily showed only weak effects, and are deserving of further analysis before any conclusion about homophily can be made. Further, most of are based on the full network (N=197) at Time 1. Tests involving attributes for the transformed network (N=153) at Time 2 were not consistent across attributes. Weak effects and inconsistencies might have a theoretical explanation, indicating that hyperlink ties do not follow similar theoretical mechanisms as offline affiliations or partnerships.

These findings could support the distinction between instrumental ties and expressive ties. Instrumental network ties are those used to achieve a goal or task (e.g., information, advice, and resource exchanges). On the other hand, expressive ties are not necessarily task-related, they tend to be affective in nature. The current research conceptualizes hyperlink ties as representational, and it is possible that representational ties are conceptually more similar to expressive as compared to instrumental. However, this proposition warrants further research.

It is equally as likely that the this study over-simplified attributes for homphily testing. Future research might avoid blurry outcomes by creating more specific attributes, or allowing for multiple-dimensionality, particularly among the different types of organizations. Admittedly, this is a short-coming of this study.

Isolates and Anomalies

Some organizations stood out in the network for dramatic changes in node-level position. At the network-level, the most dramatic change from Time 1 and Time 2 was betweeness centrality, rising from 8.77 percent to 15 percent. With this shift, two organizations emerged, *International Telecommunication Union* (itu.int) and *United Nations Cape Verde* (un.cv). Further, the *Small Island Developing Network* (sidsnet.org) increased substantially in its betweeness in the same time period. This appears to be part of a strategic change from an

"information website to a knowledge management platform," over the past year, according the organization's website (sidsnet.org, 2014).

The two other organizations, *International Telecommunication Union* (itu.int) and *United Nations Cape Verde* (un.cv) are both UN agencies with specific goals concerning vulnerable island populations. The *International Telecommunications Union* (ITU) is a United Nations agency charged with overseeing international cooperation regarding information and communication technologies (Gale Encyclopedia of E-Commerce, 2012). The ITU is currently working on an information system to monitor climate change and develop disaster warnings (itu.int, 2014). The *UN Cape Verde* is part of a pilot reform program implemented by the United Nations to advance the country from a Least Developed Country (LDC) status (un.cv, 2014).

There were two organizations that ranked highly only in betweeness, the *Guarantee for Development*, which serves as the operational arm for *Frontier Markets Fund Manager* and the *Emerging Africa Fund* (guarantco.com, 2014), and the *Private Infrastructure Development Group.* This suggests that the few ties to and from these organization are especially important for network flow.

On the other hand, the *Food and Agriculture Organization* and *UN Women* both rank in the top 10 for degree and eigenvector, however, both of these organizations are only slightly above the mean for betweeness and closeness measures. This suggests that these organizations are embedded in a cluster, or have redundant ties.

Limitations and Future Research

Based on the isolates and anomalies, further exploration of Caribbean-specific and regional-level organizations could contribute to a broader understanding of mobilization potential and phases of network maturity. It is entirely possible that regional organizations

represent a sub-grouping of organizations that are in early or emerging stages of mobilization. Moreover, if these organizations are constantly emerging and evolving they may lack opportunity to become embedded within an otherwise "mature" network, dominated by long-standing, established IGOs.

Brokerage roles warrant further research. Brokerage assumes that directionality is meaningful, and ties infer the transfer of resources or information – meaning, the source passes along information to the broker who passes information the destination. This is a limitation to the current study since one cannot assume hyperlink networks operate from the same theoretical mechanism as information networks.

Future research might explore the role and consequences of social problem construction to examine whether social problems are framed to "fit" existing NGO and IGO organizations, or whether NGOs and IGOs have the flexibility to address emerging social problems. In terms of node-level centrality, there are a number of organizations aimed at gender equality such as: United Nations Entity for Gender Equality and the Empowerment of Women (unwomen.org), UN Women Caribbean (unifemcar.org) and the Advancement of Women (un-instraw.org). These organizations rarely ranked among the top ten influential organizations, but were generally above the mean, and have country-or regional-specific branches. For example, UN Women ranks in the top ten for degree and eigenvector, while only slightly above the mean for betweeness and closeness measures. This suggests that the organization is embedded in a cluster. Future research might examine examples of stable or "middle of the pack" organizations, and specify the nature of the organization beyond the specifications of the this study.

The issue of global climate change is one that will continue to become more urgent to inhabitants of SIDS as ocean levels rise, island resources are depleted, and communities become

fragmented. This dissertation provides a case study of a network of organizations involved in efforts to assist inhabitants of vulnerable islands and to preserve a way of life that has endured for centuries but which now faces extinction. That this network is relatively small in the face of such a global crisis is cause for concern. And yet, that the central actors in this network include some of the most powerful policy and funding agencies in the world, is cause for optimism. Future research will assess whether these efforts were sufficiently efficacious and sufficiently timely to avert an imminent loss of life, tradition, and culture.

APPENDIX

APPENDIX

Table 6.0

Network Nodes, Websites and Organizations

Website	**Organization Network Nodes N=197**
acclimate-oi.net	Adapting to Climate Change [FR]
coi-ioc.org	Indian Ocean Commission
acs-aec.org	Association of Caribbean States
adb.org	Asian Development Bank
adbi.org	Asian Development Bank Institute
afdb.org	African Development Bank Group
aienetwork.org	Asian International Economists Network
amro-asia.org	ASEAN+3 Macroeconomic Research Office
apec.org	Asia-Pacific Economic Cooperation
aseansec.org	Association of Southeast Asian Nations
aseminfoboard.org	The Asia-Europe Meeting Info Board
bids-bd.org	Bangladesh Institute of Development Studies
carecprogram.org	Central Asia Regional Economic Cooperation
cdri.org.kh	Cambodia Development Resource Institute
ciem.org.vn	Central Institute for Economic Management
csis.or.id	The Centre for Strategic and International Studies
drc.gov.cn	Development Research Center of the State Council
epu.jpm.my	Economic Planning Unit
hku.hk	The University of Hong Kong
iadb.org	Inter-American Development Bank
icrier.res.in	Indian Research Institute
ifpri.org	International Food Policy Research Institute
ilo.org	International Labour Organization
imf.org	International Monetary Fund
info.tdri.or.th	Thailand Development Research Institute
ips.lk	Institute of Policy Studies of Sri Lanka
ips.org.sg	Lee Kuan Yew School of Public Studies
iseas.edu.sg	Institute of Southeast Asian Studies
itu.int	International Telecommunication Union
kdi.re.kr	Korea Development Institute
kiep.go.kr	Korea-Pacific Economic Coop. Committee for Pacific Economic Cooperation Council

Table 6.0 (cont'd)

kimep.kz	Kimep University
ln.edu.hk	Lingnan University
mier.org.my	Malaysian Institute of Economic Research
ncaer.org	National Council of Applied Economic Research
ncdsnet.anu.edu.au	Australian National University
neda.gov.ph	National Economic and Development Authority
oecd.org	Organisation for Economic Co-operation and Development
pids.gov.ph	Philippine Institute for Development Studies
saarc-sec.org	South Asian Association for Regional Cooperation
scaf-energy.org	Seed Capital Assistance Facility
un.org	United Nations
undp.org	United Nations Development Programme
unescap.org	Economic and Social Commission for Asia and the Pacific
unesco.org	United Nations Educational, Scientific, and Cultural Organization
unfpa.org	United Nations Population Fund
unicef.org	United Nations Children's Fund
unido.org	United Nations Industrial Development Organization
unwomen.org	United Nations Entity for Gender Equality and the Empowerment of Women
who.int	World Health Organization
worldbank.org	The World Bank
wto.org	World Trade Organization
fao.org	Food and Agriculture Organization of the United Nations
gov.sg	Singapore Government
ifc.org	International Finance Corporation
iom.int	International Organization for Migration
miga.org	Asian International Economists Network
unep.org	United Nations Environmental Programme
ifad.org	Int Fund Ag Development
intracen.org	International Trade Centre
cbd.int	Convention on Biological Diversity
unisdr.org	The United Nations Office for Disaster Risk Reduction
unodc.org	United Nations Office on Drugs and Crime
bahamas.gov.bs	The Government of the Bahamas
barclays.co.uk	Barclays Bank PLC

Table 6.0 (cont'd)

bb.undp.org	United Nations Development Programme
bcstp.st	Central Bank of São Tomé and Príncipe
beit-salam.km	Presidency of the Union of the Comoros
belize.gov.bz	Government of Belize
cabinet.gov.jm	Government of Jamaica Cabinet Office
jamaica.gov.jm	Government of Jamaica
canari.org	Caribbean Natural Resources Institute
caribbean-shipping.org	Caribbean Shipping Association
caricom.org	Caribbean Community Secretariat
caricomlaw.org	Caribbean Community Secretariat Caricom Law
crnm.org	The Caribbean Community (CARICOM) Secretariat's Office of Trade Negotiations
gov.vc	Saint Vincent and the Grenadines
pancap.org	Pan Caribbean Partnership against HIV and AIDS
stlucia.gov.lc	Saint Lucia
iisd.ca	Institute for Sustainable Development
cbs.sc	Central Bank of Seychelles
ccanet.net	CCANET
dfid.gov.uk	Department for International Development
cerlalc.org	Centro Regional para el Formento del Libro en América Latina y el Caribe
clad.org.ve	Latin American Centre for Development Administration
climatechange.gov.lc	Climate Change Gov. St. Lucia
coastgis.info	Coastal Zone Management Conference
conversationsfora… …betterworld.com	Better World
cries.org	Latin America Coordinator for Economic and Social Research
dbsa.org	Development Bank of Southern Africa
deginvest.de	German Investment and Development Corporation
devinfo.org	Development goal database
dominica.gov.dm	Dominica Gov
thecommonwealth.org	Commonwealth Secretariat (COMSEC)
eclac.org	Economic Commission for Latin America and Caribbean
ecowas.int	Economic Community of West African States
governo.cv	Cape Verde Gov

Table 6.0 (cont'd)

edb.gov.sg	Economic Dev. Singapore Gov
egov.sc	Seychelles
emergingafricafund.com	Emerging Africa Fund
empwdc.com	EMP
unsystem.org	United Nations System
wfp.org	World Food Program
faopacific.ws	Food and Agriculture Organization Samoa
fiji.gov.fj	Fiji Gov
pacific.unifem.org	UNICEF Pacific
unaids.org	UN Aids
fmo.nl	Netherlands Development Finance Company
forum.forumsec.org	Pacific Islands Forum
frontiermarketsfm.com	Frontier Market Fund
g8usa.gov	G8
gcfund.net	Green Fund
gefweb.org	Global Env. Facility
Globalpartnership..	
…foroceans	Global Partnership for Ocean
iucn.org	Union for Conservation of Nature
sprep.org	Secretariat of the Pacific Regional Environment Programme (SPREP)
gov.gw	Guinea-Bissau
gov.ht	Haiti
gov.mu	Mauritius
gov.nu	Niue
gov.st	São Tomé and Príncipe
parlamento.cv	Cape Verde
guarantco.com	Frontier Fund Manager
infraco.com	InfraCo
kfw.de	German Investment Corporation
minbuza.nl	UN Cape Verde
pidg.org	Private Infrastructure Development Group
seco.admin.ch	State Secretariat for Economic Affairs SECO
sida.se	Swedish International Development Cooperation Agency
standardbank.com	Standard Bank
gw.undp.org	UNDP Guinea-Bissau

Table 6.0 (cont'd)

km.undp.org	UN Comoros
un.cv	UN Cape Verde UN
undp.org.cu	UNDP Cuba
undp.org.gy	UNDP Guyana
undp.org.ws	UNDP Samoa
unv.org	United Nations Volunteers
hewsweb.org	Early Warning Systems (HEWS)
	United Nations Humanitarian
hrdlab.eu	Response Depot-Europe Lab
iaea.org	Atomic Energy Council
icgeb.org	Genetic Engineering Biotech
	International Centre for
ics.trieste.it	Science and Tech
	International Federation of
ifla.org	Library Associations
iicacan.org	Institute Cooperation on Ag - Canada
oit.org.pe	International Org of Work
interreg-caraibes.org	Int Caribbean program
isa.org.jm	Int Seabed Authority Jamaica
itcilo.it	International Training Centre
upu.int	Universal Postal Union
	International Centre for Rain Forest
iwokrama.org	Conservation and Development
	Pan American Health
jam.paho.org	Organization-Jamaica
kabinet.sr.org	Rep. of Suriname
km.one.un.org	UN Comoros
lamoncloa.gob.es	Spain Prime Minister
logcluster.org	Logistics Cluster
	United Nations Humanitarian
unhrd.org	Response Depot
lomtec.com	Lomtec
mdgmonitor.org	MDG Monitor
unhabitat.org	UN Habitat
mediapeace.org	Media Peace.org
	Mediterranean Technical
metap.org	Assistance Programmes

Table 6.0 (cont'd)

mit.gov.in	India Gov.
naurugov.nr	Nauru
new.paho.org	Pan American Health Organization
nilebasin.org	Niles Basin Initiative
nsb.gov.sc	National Bureau of Statistics Seychelles
oecs.org	Org East Caribbean States
onecaribbean.org	One Caribbean
opnew.op.gov.gy	Hinterland energy in Guyana
pacenet.eu	Pacific-Europe Network for Science, Technology and Innovation
unaidscaribbean.org	UN Aids Caribbean
parliament.gov.gy	Parliament of Guyana
parliament.gov.ki	Secretariat for the Convention on Biological Diversity (CBD)
pfip.org	Pacific Financial Inclusion Program
rainforestalliance.org	Rainforest Alliance
redlac.org	RedLac
sealevelrise.blogspot.com	Sea Level Rise Foundation
statehouse.gov.sc	Republic of Seychelles
sel.co.uk	*Social Enterprise*
sela.org	Latin American Centre for Development Administration
senate.palauoek.net	Palau
sgdi.gov.sg	Singapore Ministry of Foreign Affairs
sgpptf.org	Small Grants Program Tropical Forests
sgsica.org	Central American Integration System
sib.gov.sc	Seychelles Investment Board
siba.net	Seychelles International Business Authority
sids-caribbean-project.com	SIDS Caribbean Project
sidsnet.org	SIDS NET
unifemcar.org	UN Women Caribbean
un-instraw.org	Advancement of Women
unops.org	UNOPS
sieca.org.gt	Central American Integration System
tnc.org	The Nature Conservancy
trinidad.net	Trinidad Net

Table 6.0 (cont'd)

unohrlls.org	UN Least Developed, Landlocked Developing Country & Small Isdlan Developing States
wefeedback.org	World Food Program We Feed

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