THE STRUCTURE OF TRANSNATIONAL SECURITY NETWORKS

by

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Volume I

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Abstract

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This dissertation maps transnational cooperation to provide security to global governance problems. It begins by outlining the context of contemporary globalization: the drivers of global security governance. It examines how the global governance of both human and traditional security has been affected by the neoliberal economics of the "Washington Consensus." There are clear markers of this transformative, de-institutionalizing change, including the privatization of the provision of security and the public assumption of risk, creating an "historical bloc." This has implications for theory building as well as policy making—security is no longer a matter only for states but a subject of global governance, requiring the cooperation of many actors. It then proposes a new way define security along four axes: source of threat, target, speed, and impact.

It reviews the evolution of the concept of networks in the field of political science in general and international relations in particular, from the analysis of simple balance-of-power systems toward more complex adaptive systems, and examines the arguments in support and against the use of quantitative network analysis for the study of international relations. The ontology and epistemology of using this approach to global governance are defined, as the definitions and conceptions of what is to be studied are affected by the choice of a formal mathematical approach. The relations to be studied are compulsory and institutional power,

which together allow conclusions to be drawn about structural power. These are tested on hypotheses on hierarchy and nonobvious relationships.

The first case study maps the construction of a traditional security transnational cooperative response network, using the response to nuclear proliferation since the end of the Cold War. The second case study uses the methods of social network analysis to discover the structural patterns of cooperation that arose in global response to a human security problem, the Indian Ocean tsunami. Finally, the dissertation compares the results of the different case studies by hypothesis, by measure, and by network in order to extract from them the different strategies that actors within networks use, and strategies that can be applied to or used by the networks themselves.

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dedicated to the memory of my father
Mervyn Arthur Kamran, 1938-1997

ABBREVIATIONS

EC	European Commission
FTS	Financial Tracking Service
G-6	Group of 6
IAEA	International Atomic Energy Agency
ICRC	International Committee of the Red Cross
IDP	internally displaced person
IFRC	International Federation of the Red Cross and Red Crescent Societies
IGO	intergovernmental organization
NGO	nongovernmental organization
NPT	Nonproliferation of Nuclear Weapons Treaty
NSG	Nuclear Suppliers Group
OCHA	U.N. Office for the Coordination of Humanitarian Affairs
OPANAL	Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean
SNA	social network analysis
TNC	transnational corporation
U.K.	United Kingdom
U.N.	United Nations
U.S.	United States of America
WANO	World Association of Nuclear Operators
WHO	World Health Organization
WMD	weapons of mass destruction (biological, chemical, and nuclear weapons)
WNA	World Nuclear Association
ZC	Zangger Committee

PART I

INTRODUCTION

The aim of this dissertation is to use social network analysis (SNA)[1] to discover the structural patterns of cooperation that arise in response to global security problems, and to use these patterns to build a theory about global governance. My research puzzle was deceptively simple, meaning it is easy to state, but difficult to answer: what is the relative position of all the actors in the system of global politics? The largest schools of thought in international relations, realism, liberal institutionalism, and constructivism, all predict different positions for actors based on their type: state, intergovernmental organization, corporation, and so on. However, the reality is that actors' positions vary from one case to another, with patterns of position becoming evident. In order to answer this question, this dissertation makes an original contribution to knowledge by outlining and demonstrating the theoretical and methodological bases for a research program to study global governance empirically using social network analysis.

Networks of actors form in response to global security problems. The idea behind this investigation is that globalization has made possible particular situational frameworks or contexts that in large part determine the structure of the emergent network. To explore the idea that network structure can be influenced by case, this dissertation conducts comparative network analyses mapping the construction of transnational cooperative response networks, using nuclear nonproliferation after the Cold War and the Indian Ocean tsunami of 26 December 2004 as case studies. It illustrates the context in which these networks form, using theoretical constructs based on the work of Antonio Gramsci; provides an overview of the dimensions of the contested

[1]In this dissertation, "social network analysis" will be used interchangeably with "network analysis," as all the networks under consideration are of social construction.

term, security; and it examines the security situational frameworks in which the cooperation took place.

Social network analysis methods allow one to quantify relationships between actors and represent them mathematically and graphically, thus gaining new insights into the intersubjective structures created by actors. "Maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world" (Barber 2005). Reading a map requires similar skills to reading words; both require symbols to be interpreted and share a degree of abstractness from the fullness of reality. This dissertation uses and develops for international relations an analytical tool that distinguishes and quantifies types of relationships so as to arrive at a better understanding of the roots of policy preferences and the conditions for collective action, while at the same time capturing the richness of non-state-centric global politics.

By mapping the relationships at the system level of world politics including individual states as well as intergovernmental organizations (IGOs), transnational nongovernmental organizations (NGOs) and think tanks, and transnational businesses, this dissertation demonstrates how a new way of thinking about the constitution of system-level world politics can process information. In other words, network analysis can be used to create maps that are as useful to foreign policy makers as a map of terrain is to generals; maps that can assist in the strategic analysis of systemic risks such as cascading failure (Watts 2002, Ramo 2009).

Network mapping can be used as an illustration of mosaic theory, or the method of piecing together data from disparate sources into a coherent narrative, used in both financial and security analysis (Pozen 2005). Mosaic theory is the flip side of steganography or the technique of hiding messages within other messages or objects (such as coding a message in the pixels of

an otherwise-innocuous digital photograph). There is so much data available—and much more to come (Lazer et al 2009)—that methods that can usefully separate signal from noise in the creation of a big picture narrative are becoming ever more important to analysts. Network analysis can make sense of large amounts of data, out to dimensions that are not readily available to first view, revealing nonobvious relationships. The dark side of both mosaic theory and steganography is apophenia, or finding patterns where there are none. The larger purpose of this dissertation is thus to demonstrate how network analysis can be used to differentiate between the false pattern recognition of apophenia and the big, yet hidden, picture compiled through mosaic theory and steganography.

Global governance has many definitions, and its etymology is explored more fully in the chapter, "Network Analysis in International Relations." Acknowledging the anarchic nature of global politics, most definitions focus on the lack of sovereign authority in processes that make and enforce rules of behavior at the global level (Rosenau and Czempiel 1992, Rosenau 1995, Finkelstein 1995, Kjaer 2004, Weiss and Thakur 2010, NIC/ISS 2010). Global governance does not denote good or bad practice but describes cooperative problem-solving arrangements at the global level of politics. They may be formal, taking the shape of laws or institutions to manage collective affairs by such actors as state authorities, IGOs, NGOs, private sector firms, other civil society actors, and individuals. But arrangements may also involve such informal mechanisms as practices or guidelines or even temporary units (e.g., coalitions). Global governance includes purpose-built regimes as well as market-driven evolutions and adaptations.

Many problems in global governance fit the definition of complex systems: multiple types of actors and processes, the structure of which is the result of past structure, actor choices, and stochastic processes. The modeling of such complex systems in international relations is

greatly facilitated by the use of quantitative social network analysis methods, used to map broad trends and patterns, which can then be used as a basis for comparison and for investigations into dynamics. However, it also means that the intellectual puzzles of researchers will change, as the questions become more oriented toward patterns of cooperation and cohesion, and less about the actions and motivations of individual actors in isolation. Different perspectives will yield different insights, because what is studied (ontology) will be affected by how it is studied (epistemology). Furthermore, the limitations of predictive quantitative modeling should also be considered: using methods that are inherently relational will not be appropriate for puzzles that are isolated, and network analysis may be best used in international relations as a means to a more qualitative model, as the maps can indicate those patterns of relationships that bear further investigation into the negotiations that create, maintain, and end those relationships.

The context determines what actors are allowed to participate in networks, and on what basis of authority (by virtue of expertise, command of resources, etc.) However, this means that power may be diffused throughout the network, making difficult the holding of decision-makers to standards of accountability. Power diffused too often becomes power hidden; conversely, power too closely held—by inhibiting the participation of actors whose goals match those of the network—can obscure the creation and growth of other actors, or even other networks. Therefore, a discussion of the implications of different types of network structure for normative governance will conclude the study.

This analysis hopes to not only describe and explain known relationships between states, IGOs, NGOs, and transnational corporations (TNCs) involved in global security governance networks more clearly and thoroughly, but also to discover previously unknown "latent" relationships, and to predict the conditions of their activation (Haythornthwaite 2005). The

shape of the cooperative network that is eventually negotiated either formally or informally is likely to vary by context; in some networks, states will remain preeminent, while in other cases less defined by traditional military concerns, nonstate actors may be of primary importance.

However, the central argument of this project is that nonstate actors play a more important role in international cooperation than they are normally credited with in the mainstream American IR theories of realism and liberal institutionalism, which see nonstate actors as either creations of states or creatures within states, in part because quantifying their contribution has been difficult in the past. Part of this is because context matters in global politics. For example, the concept of "human security" (more fully discussed in the chapter "The Contemporary Context and Dimensions of Security") has been developed to bring to the fore problems that must be solved in order to maintain the bodily integrity and dignity of humans and not the boundary or institutional integrity of states. Threats to human security can include discrimination in access to resources and opportunities, poverty and disease as well as violence. I show that on human security issues, such as natural disaster relief, the presence and influence of nonstate actors will be greater than on traditional security issues, such as nonproliferation. However, the specific patterns that these cases exhibit indicate that these patterns are highly and uniquely structured, and that both ideal types of security are highly permeable to the inclusion of heterogeneous actors.

The networks of disparate types of actors that govern global security issues can be mapped to create a middle-range theory of global governance. I hypothesize that how the issue is framed (narrated) in the media and in academic literature determines the patterns of security networks. Both social network analysis and thick description narrative can be used to map these

networks that mix quantitative and qualitative techniques to triangulate and verify the validity of the ties and of the overall structure.

In the following sections of this chapter, I describe the current main schools of thought in International Relations: Realism, Liberal Institutionalism, English School, Constructivism, and Global Governance. I then look at my selection of cases, explaining the reasoning behind them. Next, I state my argument in terms of hypotheses: background conditions, intervening variables, independent variables, and dependent variables. Following that, I introduce the method of network analysis to this study in the description of my research design and data collection. Finally, I outline the rest of the dissertation's chapters.

LOCATING THIS PROJECT WITHIN INTERNATIONAL RELATIONS

Most international relations theory really only describes, explains, and makes predictions for the behavior of states—a specific species of actor. However, when studying a process like politics, it makes more sense to look at the forest rather than just the trees—looking at the types of relationship rather than focusing on one set of *a priori* differently-defined actors. This project will not discover new facts, but look at existing facts in a new light. This is analogical to ecological studies that, for example, study trophic roles (feeder/food relationships) and positions in food webs. Rather than simply studying one species at a time, ecology studies holistic systems (Luczkovich et al 2003, Ostrom 2007). Most international relations literature looks at the relationships between states such as the U.S. and the U.K.'s "special relationship," or between states and one other type of actor, for example, the often contentious relationship between the U.S. and the U.N. However, in a "neomedieval" world (Bull 1977, Cerny 1997, Kobrin 1998, Khanna 2009), where nonstate actors have amassed enormous wealth and power, it would be a mistake to *a priori* exclude these others from analysis. These nonstate actors are not

mere “victims” of the structure created by states; they can be active agents in the structure's creation. One cannot understand a forest if one only studies trees; animal (including human) and insect behavior, the presence of fungi, weather, climate, and so on are just as important.

This emphasis on whole, complex, systems of actors can also lead political science in the direction of the kind of assumptions that a formal theory of global governance by transnational networks should have. Right now, too little is known about the structures of these networks (especially as compared to each other) to have an idea of what behavioral assumptions a formal theory would have to embody, to say nothing of testing those assumptions.

This project is significant to the discipline because it presents a tool that is capable of answering the meta-question of how much weight should be assigned in the international system to states that are not great powers and to actors that are not states. It also maps the evolution of cooperative structures to meet transnational problems in the field of security. And it uses a relatively new (to the discipline of international relations) methodological tool that allows one to visually present formal relational data. The shape of the cooperative network that is eventually hammered out varies by context; in some networks, states remain preeminent, while in other cases less defined by traditional military concerns, nonstate actors are of primary importance. “Context” refers to the situational framework in which actions take place. This framework decides what the issues at stake are, and therefore which actors should be involved in decision-making. Frameworks are constructed, and their parameters are continually negotiated by actors (Goffman 1974). I also expect that previous cooperation makes future cooperation within the network easier, even if two actors have not cooperated with each other previously to joining the network—once cooperation has been started, future cooperation is easier.

The theoretical context in which this work is situated is largely within the constructivist school of international relations. Unlike realists or liberal institutionalists who would expect states or intergovernmental institutions to take the lead in building a response to an event or problem (although they allow for nonstate actors to feed ideas to governments), constructivists allow for situations of complex interdependence in which other actors or ideas may be more important in implementation. They therefore avoid overly parsimonious statements of causality, preferring to retain context and contingency in their models.

For years, the dominant paradigm in the American academic field of political science has been realism. Realism depends on power and self-interest in survival for explaining the actions of states, which are the units studied. Realism, especially structural realism, as defined by Kenneth Waltz (Waltz 1979) says that the behavior of functionally undifferentiated states is based on their positions in the system—the distribution of power capabilities. However, this theory leaves out a great deal. For example, realism assumes one type of actor, the state; and one organization type for the international system, which absent hierarchy is anarchic. Structural realists assume that anarchy generates a self-help environment, where the paramount interest of the state is survival, and that anarchy is without order. This makes for an elegant and parsimonious model, but it is one that resembles reality not in the slightest because it fails to explain how nonstate actors in the international system, such as intergovernmental organizations and nongovernmental organizations, affect the system. An important anomaly that realism failed to predict was the demise of the Soviet Union—a change in power at the unit level which led to a change in the distribution at the system level.

This failure has led to a proliferation of theories that attempt to link behaviors within the state and behavior between states. It has also led to theories that attempt to define, explain, and

predict the behaviors of nonstate actors. The liberal institutionalist and constructivist schools of international politics, best exemplified by theorists such as Robert Keohane and Joseph Nye (Keohane and Nye 2001) for the liberal institutionalists, and Alexander Wendt (Wendt 1995) and John Ruggie (Ruggie 1998) for the constructivists, think that international organizations play a role in the way that a state's identity and interests are formed. They do this through the transmission of ideas, the negotiation of norms, and the provision of information and expertise.

Liberal institutionalists also assume anarchy, the primacy of the state as an actor at the international level, and believe the state's identity and interests are given. They believe that cheating between states jockeying for relative advantage leads them to create intergovernmental institutions to provide the information, repeated interaction, and so on that facilitates cooperation. For them civil society institutions are separate from, and support (or oppose) the state. Civil society, of which NGOs are a part, is *domestic* society in both the realist and the liberal institutionalist view, and has a structural effect at the international level only through the state.

The English School of international relations also views states as the primary actors. In "The English School, International Relations, and Progress," Balkan Devlen, Patrick James, and Ozgur Ozdamar, write a lucid summary of the school's axioms, primarily derived from the work of Hedley Bull and Martin Wight. Primary actors in the international system are sovereign states; there is a "system of states" in IR whenever states interact with and impact on each other; the international system is anarchic, meaning there is no common government; and states recognize common interests and common values, and conceive themselves bound by a common set of rules governing relations with one another and share in the working of common institutions—in other words, there is a possibility of international society. The second and fourth

axioms are particularly important to the concept of global governance because the "world society" concept builds on English school by adding to the units: in addition to states, there are individuals, global population, and nonstate actors such as IGOs, NGOs, and businesses (Devlen et al 2005).

Constructivists, on the other hand, argue that the formation of identity and interests is not exclusively determined by the distribution of material capabilities (as realists might say). They see state and civil society as being socially constituted by each other in an ongoing discourse, just as the state and the international structure are constituted. In particular, the assumption that constructivists make is that anarchy and power are mediated through and negotiated in a particular social context, while international interactions and practices affect state interest and identity formation, and therefore behavior.[2] Behavior in turn can affect the structure of the system, by changing both the functions of actors and the distribution of capabilities. International organizations are mechanisms for discourse and therefore for producing changes in identities as well as interests (and ultimately, for constructing a new *structure*). Until now, constructivism has had more use as a theory of the formation of state interests and identities (a theory of the unit-level), than as a theory of structure; however, the concept of global governance can be used to bring structure back to the argument.

The first step in building a global governance network theory of international relations is to explore the idea that other actors, beyond the state, are more prevalent in world politics than realist and liberal institutionalist theories have previously suggested. Therefore, it is imperative

[2] For example, a material power like weaponry has to be understood to be used as a threat – if one's adversary does not know (or worse, does not care) what the consequences of a nuclear attack is likely to be, then threatening them with one is not going to be effective as a deterrent. As is said of the character of the Joker in "Dark Knight:" "Some men aren't looking for anything logical. They can't be bought, bullied, reasoned or negotiated with. Some men just want to watch the world burn." ("Dark Knight" http://www.imdb.com/title/tt0468569/ 2008)

that scholars and others be very clear about who makes decisions, on what authority, and in what relation to each other.

In summary, both realism and liberal institutionalism are materialist theories, while constructivism focuses its analytical energy on the power of ideas to mold perceptions and behaviors, and thus realities. The English School gives equal time to materialism and idealism, but still focuses on states. Debates among scholars of different schools, particularly about the relative importance of nonstate actors, often degenerate into arguments where they talk past one another, as in the Winter 1994/95 debate in *International Security*, a tradition that continues today in the debates between the complex system, Political Realism, and English School approaches to global governance (Kustermans 2011). This is often because they use different methodologies to present their cases. A major advantage of network analysis as a methodology is that it can be used to measure multiple dimensions of power, and can move the project of theory building farther along.

If we take "governance" to be the process by which binding rules for behavior are made and enforced, then appending "global" gives us the plane on which this process takes place.[3] To date, global governance is a largely descriptive (*not* normative) label for the complex, heterogeneous processes and actors of world politics. It has been used qualitatively to map the burgeoning relationships at the system level of world politics (including individual states as well as intergovernmental organizations, transnational NGOs and/or think tanks, and transnational businesses) that have been made possible by the processes of globalization. In *Global Governance 2025: at a Critical Juncture*, the U.S. National Intelligence Council and the E.U. Institute for Security Studies agree that

[3] It is the process that takes precedence in this concept—not every interaction that takes place globally will be governance-related.

> The term "global governance" as used in this paper includes all the institutions, regimes, processes, partnerships, and networks that contribute to collective action and problem solving at the international level. This definition subsumes formal and informal arrangements as well as the role of nonstate actors in transnational settings. Regional cooperation may also be regarded as an element of global governance insofar as it contributes to broader efforts. Governance differs from government, which implies sovereign prerogatives and hierarchical authority. Global governance does not equate to world government, which would be virtually impossible for the foreseeable future, if ever (NIC/ISS 2010, 1).

Global governance thus considers world politics to be constituted by multiple types of actors, as well as multiple types of relations.

Indeed, global governance is "the complex of formal and informal institutions, mechanisms, relationships, and processes between and among states, markets, citizens and organizations, both inter- and non-governmental, through which collective interests on the global plane are articulated, rights and obligations are established, and differences are mediated" (Weiss and Thakur 2010). Global governance as a concept thus emphasizes five components that are essential for analyzing contemporary international relations: the level of analysis, which is transnational; the issue area under question, such as environment or peace and security; the presence of actors other than states; the dynamics of governance itself; and the interdependent yet loosely-coupled complex system (rather than simple aggregation) of the whole (Perrow 1985). The latter three components are what make global governance a network concept.

A key aspect of the rise in global governance is the creation of global networks in which not all the actors are governments: global governance can be studied by examining network slices at different geographical, temporal, and issue junctures, or how the interrelationships between actors differ according to frame. Using the way the issue is narrated by the media, scholarly literature, and policy makers, I define security along four dimensions: source of threat,

target, speed, and impact.[4] This location frame can tell observers about primary effects of structural constraints on the kind of network of actors will form. Networks are thus found in "slices" of the security space. Global security networks are categorized by the actors involved and how they interact. The primary effect of structural constraints on the governance of security is the kind of network of actors will form in response to a given threat. This in turn tells us which actors play which roles in a network—a secondary effect of structural constraints.

A middle-range theory created using these elements would not only connect theory with reality, it would also offer a clear future research agenda. Global governance would look at patterns of relationships to determine the structural constraints and opportunities of individual actors, and at those patterns for their effectiveness in meeting their stated goals as well as any normative ideals. The patterns that especially provide predictive power are those of hierarchy and nonobvious relationships, both of which are defined in the chapter "Methodology and Research Design." Researchers would be encouraged to look at additional slices of this multidimensional space, not only for comparison among cases, but to conduct longitudinal time-series analyses within cases, as well as of nested level-of-analysis relationships.

Many problems in global governance fit the definition of complex systems: multiple types of actors and processes, the structure of which is created by the interaction of past structure, actor choices, and random processes (Jervis 1997). The structure of the network thus evolves from the interactions of actors: the more the situational frame of the issues is traditional national security, the more hierarchical and dense (with stronger and more frequent ties) the network will be. As will be explained in the chapter "Methodology and Research Design,"

[4] This definition owes much to the multi-author discussion in *Security Dialogu*e, Volume 35, Issue 3 (September 2004), and is further developed in the chapter on the contemporary context of security.

hierarchy can be defined in several different ways; states may have *de jure* primary authority, but that does not necessarily mean they will have the *de facto* authority.

As world politics is increasingly peopled by nonstate actors, government networks must increasingly interact with nonstate actors on an equal or even superior basis according to functional area. States are still responsible for meeting many functions: justice, security, economic development, etc. (Holsti 2004). The null hypothesis is that states will continue to deal with nonstate actors as subordinates, regardless of functional area. Evidence that will invalidate the null hypothesis includes states taking inferior structural positions in the response networks: as receivers of material aid and expertise or as peripheral as opposed to central actors.

The problems of global governance are those that cross national boundaries and affect more than one state. They require more information, expertise, political consensus, and money than one state alone, or even many states working together can marshal. The situational framework determines what actors are allowed to participate, and on what basis of authority (expertise, resources, etc.) However, this means that power may be diffused throughout the network, making it difficult to hold decision-makers accountable. Again, power diffused is power hidden; thus, a discussion of the implications of different types of network structure for normative governance will conclude the study. Conversely, power too closely held—by inhibiting the participation of actors whose goals match those of the network—can obscure the creation and growth of other actors, or even other networks.

My intellectual puzzle is a thus a combination of theory proposing, theory-testing, and description. I use empirical evidence to describe global politics, evaluate existing system theories in International relations against that evidence, and propose a theory that explains that evidence and makes predictions for the future.

CASE SELECTION

The political subject I explore is the shape and construction of security networks. By comparing two case studies; the post-Cold War nuclear nonproliferation network, and the Indian Ocean tsunami of 26 December 2004 disaster response network, I map and explain the patterns of cooperation that arise to meet transnational problems in security. This is the first step in building a network theory of international relations: nonstate actors are more prevalent in world politics than when realist and liberal institutionalist theories were first formulated. Therefore, it is imperative that scholars and others be very clear about who makes decisions, on what authority, and in what relation to each other. Network structure will affect relations by enabling or constraining them; we need to find out how.

This project examines case studies towards the extreme ends of the security spectrum: the effort to contain/constrain nuclear proliferation (traditional security) and the humanitarian response to the Indian Ocean tsunami (human security). I will also be making predictions about other networks. The choice of cases rested on several factors. First, I chose cases that matched to extremes (almost "ideal types") on the dimensions of security space in order to test my theory of network formation (the concept of security space is more fully explained in chapter 2). Testing on the axes of this multidimensional space should be expandable to other cases in the future (such as financial crisis, influenza, intelligence gathering, pollution, climate change, and the small arms trade) that are not extremes. Each case study therefore represents an extreme slice of security space.

Second, I chose cases for which I was able to generate data relatively easily: much of the record-keeping is available online. This will also make it easier for others to replicate or question my findings, as well as to advance the research agenda I outline. Third, I wanted to

juxtapose a relatively new topic for security studies (a response to a threat to human security) to one that is well covered, but whose analysis usually excludes nonstate actors. Finally, I chose these cases because I am personally interested in them; to me they exemplify Perrow's "dread risks" (Perrow 1985). Dread risks are those events that are improbable, but with consequences so horrible and severe that they must be considered—such as a meteor striking Earth.

STATEMENT OF THE ARGUMENT

For the purpose of policy making in the future (as well as for theory-building in the field of international relations), we need to have a better picture of what actually happens. Anne-Marie Slaughter's theory of vertical and horizontal governmental networks suggests that networks of government-based humanitarians, while nested in larger policy networks, will lead the way in any response: they should decide what to do and why, and then they should be the ones to do it. Furthermore, because of the needs for accountability and legitimacy, sovereign states should be the ones to lead (Slaughter 2004). But is this what actually happens? Global governance suggests that other actors like think tanks will be equally important in deciding why, and the existence of NGOs like Médecins Sans Frontières (MSF) suggests that the "doing" part, implementation, is also heavily dependent on other actors. Furthermore, if network structures are indeed complex, it suggests that similar actors will play different roles in a given network according to the frame.

Explanation of Variables

The independent variable is the framing of the security situation and the dependent variable is the shape of the network that is constructed as a result: my hypothesis is that as the framing moves away from traditional and more towards human security, the flatter and less

hierarchical the network will be. The project aims to use network analysis to demonstrate that this pattern holds.

The theoretical reasoning for why we should expect states to play a dominant role on traditional security issues is because that is exactly how security has been defined: the referent object is the state. Essentially, I will be testing the argument that changing the framework changes the structure and composition of the network. The argument that framework changes structure has been made by others who have investigated the construction of the framework, but who have not sufficiently verified the argument from the other side: from the point of view of the structure created by the framework (Price 1998, Slaughter 2004). Similarly, the argument that composition of the network changes based on framework has been made by those who have studied the changes in types of actors, but not empirically verified by close examination of the structures they create (Keck and Sikkink 1998, Mathews 1997).

This is a test of how we suspect these networks will look and act; if the structure can be reasonably measured, the assumptions made about structure can be tested. This is an essentially constructivist argument: if we know the rules, we can understand the nature of the game, and make better predictions. For instance, for use in Bayesian predictions: given that *x* things are known about the threat, what is the probability that this shape will evolve? If the situational framework is a reliable indicator of network structure, it can be used to monitor structure (like GDP is used to monitor an economy), and thus to change it. For example, a framework context may evolve that calls for more openness and accountability—for a flatter, more flexible network. Such calls are not necessarily met by actual changes in structure, as local actions will not necessarily "tip" the entire structure. While an individual actor's options may be constrained by

the structure of the network, choices for the exercise of agency will remain, and the outcomes of those choices will affect the structure.

Globalization, which *Mapping the Global Future* defines as "growing interconnectedness reflected in the expanded flows of information, technology, capital, goods, services, and people throughout the world" (NIC 2004) is thus a background variable—the context in which transnational security networks are built, maintained, and dismembered. In this study, the assumption is that globalization is a condition with which individual actors must contend but cannot individually halt, and that enables but does not require a framework to include nonstate actors. This is the result of the particular type of globalization we experience today, which has been analyzed in Gramscian terms by many observers (Castells 2000, Bobbitt 2002, and Murphy 2005). Their analysis gives a vivid picture of the forces of globalization presently at work in contemporary society while not precluding the existence of other types in the past or future.

Finally, the network analysis method is used to map the transnational security networks. This can answer questions such as how influential are nonstate actors? How isolated or central are certain actors? Which actors perform as brokers between others? And, to change the structure, what connections must be made or cut? The map of the network will tell us not only if an actor is influential or not (a binary distinction), but also how influential (an ordinal distinction). In addition, it can tell us things that are not necessarily readily apparent from a more qualitative analysis, such as how one network compares to another and how complex interactions work in the networks. In other words, I intend to study networks both as the structure in which members act, and as actors in their own right (Kahler 2009).

I use the key measures of social network analysis: density, centrality, and cohesion (Wasserman and Faust 1994); to both visualize the security space, to measure, and to compare

the interactions in networks of actors. Social network analysis methods allow one to quantify relationships between actors and represent them mathematically and graphically, thus gaining new insights into the structures created by actors.

By graphically mapping the patterns of specific kinds of relationships among different types of actor, we can get a clearer picture of what is actually happening. A map of the structure created in this particular historical context can direct agency. Such a map can give policymakers the tools to change the system, showing them where their efforts would be best placed to achieve particular outcomes; just as a map of physical terrain can show an army where to march or where to best place a dam on a river.

This dissertation will address the question: under what conditions do nonstate actors become key participants? My first hypothesis is that in a world of globalization (defined as a world with high rates of speed, ease, and intensity of transportation and communication), situational framing is a causal mechanism that impacts whether and how actors decide to involve themselves in the response to a security threat, and that will affect the relative degree of actor authority and thus their structural position in a network (NIC 2004). Globalization is the development that makes networks of different types of actors possible; the frame is what makes the creation of a network probable.

H1: the more the situational frame of the issues is akin to "high" politics,[5] the traditional province of national security, the more likely it is that state actors will retain their authoritative position. The less the situational frame is concerned with high politics, the more states are willing to cede responsibility for decision-making to nonstate actors. The unit of analysis for this

[5] "High" politics is the informal designation for traditional security policy, concerned with the survival of the state, while "low" politics is the designation for everything else: economics including finance and trade policy, culture, and social policy (Barnett 1990, Thacker 1999).

hypothesis is the actor, and therefore this hypothesis still fits in the liberal institutionalist interdependence framework (Keohane and Nye 2001).

background condition independent variable intervening variable

Globalization ----------> Situational Framework -------> Position in Network

This leads to a related hypothesis about the structure of the network that evolves from the interactions of actors:

H2: the more the situational frame of the issues is traditional national security, the more hierarchical and dense (with stronger and more frequent ties) the network will be. The unit of analysis for this hypothesis is the network itself, and thus takes a constructivist approach to global political structure.

independent variable intervening variable dependent variable

Situational Framework -------> Position in Network ---------> Network Structure

(Additional hypotheses on hierarchy and nonobvious relationships will be developed in chapter 3.)

Lack of a relationship between actors in networks, also known as a structural hole in a network (Burt 1992), stops the flow of information and resources in a network. A comparison of networks on the security continuum is necessary to discover structural similarities and differences. Do the same actors play similar roles no matter the context? Or are they different? How does difference in structure account for the difference in effectiveness?

Such "heteropolarity," (Der Derian 2004, 2009) or actors who differ in power, kind, and connection is seen in global nuclear networks. The official nuclear "haves" attempt to halt nuclear proliferation—a case of traditional national security, where states have attempted to control knowledge and materials that have both peaceful and deadly uses. The construction of

nuclear nonproliferation networks has been tightly controlled by states. However, the presence of other actors in the efforts to prevent proliferation cannot be ignored: for example, there are many companies and other institutions with relevant expertise and access to materials. Nuclear energy provides a fungible skill set for nuclear weapons, and corporate networks are neither regulated nor even monitored as closely as the treaty nonproliferation networks.

The response to the Indian Ocean tsunami demonstrates global governance in microcosm—how a global response to a problem is addressed in a decentralized, anarchic world. Despite the implications this disaster had for the political communities that it affected, and despite the fact that military forces were mobilized in the response, this was a case of a human security political frame: the politics of emotional, physical and economic recovery dominated, rather than solely the politics of military and security affairs.

The network created in response to the Indian Ocean tsunami self-organized. The impulse to "do something" mobilized individuals and organizations around the world, even before the magnitude of the disaster was known. This required a coordination of efforts, especially for those who had no prior knowledge of humanitarian relief practices or of the area affected by the disaster. The easiest way to have a positive impact for most of these actors was to act in concert with established relief agencies, or with other organizations that had logistical and geographical reach and expertise. This has implications for the network's effectiveness: in a human security frame the number of actors, as well as the type of actor involved could be increased, allowing for an openness and transparency that could be met by communication among the actors. This in turn allowed accountability: progress, or lack thereof, could be openly tracked through the media.

By comparing these networks, I hope to come up with some conclusions and generalizations that can then be applied to further cases. One such case is the transnational cooperation in the fight against avian influenza. The prevention of disease has traditionally been the responsibility of the state (Kraut 1994, Poku and Graham 1998), making it a traditional national security frame. This is because death tolls would threaten national cohesion. Based on what is learned from the first two cases, infectious disease prevention networks may be more likely to be both state-centered and hierarchical—and thus inflexible and un-transparent. Another likely case would be the financial cooperation that led to cascading economic collapse in the trade of credit default swaps.

Research Design and Data Collection

A comparison of networks on the security continuum is necessary to discover structural patterns. Evidence of framing was taken from scholarly works, media reports, speeches, and similar documents in major world media outlets on the web and in print. These sources were scanned for indications of how different actors viewed the context, and how pervasive that view came to be. This resulted in a narrative explaining the specific context of the network. The narrative thus serves as a check on the data generated in the network mapping, as detailed below.

The actual relationships are power relationships. Power in the international relations literature is usually measured in absolute terms, even when the purpose is to compare the relative strengths of two or more states (Grieco 1988). However, it is possible to measure the power of the relationships themselves, using the typology developed by Michael Barnett and Raymond Duvall (Barnett and Duvall 2005). Network terms can be translated into international relations via the measures of power in global governance, and vice-versa. Two types of power relations defined by Barnett and Duvall between specific actors will be considered for each case study:

compulsory power and institutional power. Briefly, compulsory power is the ability to compel behavior, while institutional power is the ability to influence at a distance, through shared membership in organizations. Mapping these networks should give a good indication of the structural power of actors in them.

Mapping the traditional security transnational cooperative response network in the case study of the response to nuclear proliferation since the end of the Cold War will also have two measures. The first will be the regulation of transnational businesses and contracts (compulsory power), and the second will be the transnational associations and treaty alliances (institutional power). The contracts were generated from news reports in industry media in the Business Source Premier database, and the treaties were generated from the listings maintained by the United Nations.

The response to the Indian Ocean tsunami was a case of a human security political frame: emotional, physical and economic recovery dominated, rather than the "bombs and bullets" of military and security affairs. The first network power relationship measure of the tsunami are the transnational humanitarian aid flows, available online from ReliefWeb, the database maintained by the U.N. Office for the Coordination of Humanitarian Affairs (OCHA). The flow of money indicates the presence of compulsory power, as money is directly given with a specific purpose, and to organizations that will ultimately be held accountable for its use or waste. The second measure will be the coordination of transnational organizations' response as found in their situational reports on the event, also available on ReliefWeb. This coordination of action by institutions is evidence of affiliations, and as such indicates institutional power.

PLAN OF THE DISSERTATION

Chapter One, "The Contemporary Context and Dimensions of Security," is concerned with the context of globalization: the drivers of global security governance. It examines how the global governance of both human and traditional security has been affected by the "Washington Consensus." There has been a neoliberal economic push to privatize security functions and infrastructures that were formerly the province of states. This has created what Gramsci would term an "historical bloc." This chapter argues that the drivers of global security governance are the privatization trends that have created the present state of globalization, and that previous writers discussing this phenomenon using solely qualitative methods miss important parts of the picture. There are clear markers of this transformative, de-institutionalizing change: privatization of the provision of security, public assumption of risk, and so on. This has implications for theory building as well as policy making—security is no longer a matter only for states but a subject of global governance, requiring the cooperation of many actors.

It also proposes a new way to look at the human-traditional security spectrum: security space. This is an analytical framework of the global governance of security. Through frame analysis it defines security along four axes: source of threat, target, speed, and impact: thus locating security governance in a multidimensional structural space. This location frame can tell observers about primary effects of structural constraints on the governance of security—the kind of network of actors will form in response to a given threat. These networks are categorized by the actors involved and how they are organized.

Chapter Two, "Network Analysis in International Relations," consists of a review of the literature, examining how the field of political science in general and international relations in particular has developed the concept of networks. This evolution has gone from the analysis of simple balance-of-power systems toward more complex adaptive systems. During this process,

the field has developed definitions of complexity and systems analysis that are particularly useful in network analysis, and that can be extended to other disciplines. It then examines the arguments in support and against the use of quantitative network analysis for the study of international relations.

Chapter Three, "Methodology and Research Design," examines using this approach to global governance, which requires careful examination of both ontology and epistemology, as the definitions and conceptions of what is to be studied are affected by the choice of a formal mathematical approach. It also requires an account of terms and equations, which is appended. This chapter therefore explains how to use the key measures of social network analysis: density, centrality, and cohesion, to visualize the security space, to measure relationships, and to compare the interactions in networks of actors. Networks will be treated as "slices" of the security space at different geographical, temporal, and issue junctures. This tells us which actors play which roles in a network, which is a secondary effect of structural constraints. Based on these measures, I develop a series of testable hypotheses on hierarchy and nonobvious relationships in global governance.

Chapter Four, "The Network Response to Nuclear Proliferation," maps the construction of a traditional security transnational cooperative response network, using as a case study the response to nuclear proliferation since the end of the Cold War. By mapping the relationships at the system level of world politics, including individual states as well as intergovernmental organizations (IGOs), transnational nongovernmental organizations (NGOs), and/or think tanks, and transnational corporations (TNCs), this chapter finds a third relation among these actors, namely, structural power. It uses two measures of power: transnational regulation and contracts (compulsory power), and transnational associations and alliances (institutional power), to find

the third measure of network position (structural power), triangulated against the narratives as reported in media and in the arms control literature.

Chapter Five, "The Structure of the Tsunami Response Network," uses the methods of social network analysis to discover the structural patterns of cooperation that arose in global response to a human security problem. It does this by mapping compulsory and institutional power relations among actors of the construction of a human security transnational cooperative response network—the response to the Indian Ocean tsunami of 26 December 2004. It also demonstrates how this new way of thinking about the constitution of system level world politics can produce knowledge not available to traditional methods by finding two striking results: first, the role played by an organization cannot always be predicted by reference to its attributes, and second, depending on the context, organizations of different types will play similar (structurally equivalent) roles. Finally, this chapter compares the network formed in response to this disaster with the network that formed after a disaster of similar magnitude in the past.

Chapter Six, "Network Strategies for Global Governance," compares the results of the different case studies by hypothesis and by measure in order to extract from them the different strategies that actors within networks use, and strategies that can be applied to or used by the networks themselves. I then compare the two sets of networks to each another, in an intersectional analysis taking network participation as a descriptor of actor identity, which focuses on specific actors and demonstrates the ability of the multidimensional space to provoke questions as well as answer them. Intersectionality can thus be used in creating an actor profile as well as in formulating questions asked of multiple networks. The chapter then presents a framework for using social network analysis in order to move toward a qualitative middle-range theory of global governance with two major assumptions: first, by becoming expert in both issue

area and/or the process of cooperation itself, it is possible for an actor to hold an influential hierarchical position in global politics that does not necessarily depend on control of resources; and second, that nonobvious relationships among actors allow for the flow of resources and ideas, but also create exploitable gaps in security infrastructure and doctrine.

The world is globally networked in particular ways, making an understanding of the structure of the network imperative for global security policy as well as for academic research. From predicting terrorism opportunities to preventing the spread of disease, the social network analysis of global security governance is very important. It then seeks to examine both the network as agent and the network as the structure within which agency is exercised. It ends with a future research agenda to refine the technique of examining networks in global politics by applying dynamic clustering techniques to find community structures (Mucha et al 2010), longitudinal analysis, and thick description to formal network analyses.

Finally, I include a brief appendix, which defines and explains the use of different network analysis concepts and formulae. This is in no way meant to be comprehensive; it is meant simply as an aid to reading the dissertation. The network matrices and associated data are provided in separate appendices.

CHAPTER ONE

THE CONTEMPORARY CONTEXT AND DIMENSIONS OF SECURITY

Gramsci's concept of hegemony refers to the dominance of an ideology that is so entrenched it no longer requires conscious coercion to enforce it. However, in an intersubjective, dialectical cycle, this can engender intense frustration, which is the beginning of counterhegemony.

The neoliberal ideology of the "Washington Consensus" is just such a hegemonic construct, with antecedents in the liberal world order of the post-World War II era, which has served to shape global politics by allowing multiple types of actors to participate. This includes the contemporary security environment, in which the provision of security is no longer the sole province of states. The Washington Consensus has also generated a counterhegemonic response, in which the very definition of security has also been expanded to include nonstate actors as the objects of security provision.

This chapter examines the contemporary definition of security with a view to its impact on global security governance. First, it examines the context of globalization and drivers of change in how the global security governance of both human and traditional security has been affected by the Washington Consensus. There has been a neoliberal economic push to privatize security functions and infrastructures that were formerly the province of states. Antonio Gramsci's intellectual constructs of hegemony and historic bloc are particularly useful in describing the background context of contemporary globalization. There are clear markers of this transformative, de-institutionalizing change, which has implications for theory building as well as for policy making—security is no longer a matter only for states but a global governance matter, requiring the cooperation of many different types of actors. The chapter therefore argues

that the drivers of change are the privatization trends that have created the present state of globalization. Previous writers discussing this phenomenon that have used solely qualitative methods to create a narrative explanation, or that have focused solely on states when using quantitative methods miss important parts of the picture.

The Washington Consensus is a hegemonic idea that had far-reaching consequences in security. The markers of change in security are the use of the private sector for state ends, assumption of private financial risk by the state, and the growth of income inequality within states. These new actors and actions led to a new historic bloc, where both the provision of security and the ends of security included actors other than the state. This in turn provided a dialectic opening: state security's instruments and goals allowed expansion in what could reasonably be included under the umbrella of state security. This opening has become the recognition of new dimensions of security—a new hegemonic idea, and a new historic bloc. This bloc is the shape of contemporary global governance, and has security implications for the state.

This chapter defines hegemony and historic bloc; explains the Washington Consensus (especially its emphasis on the virtues of privatization); explores the markers of this privatization: the growing use of private security contractors and the assumption of elites' private financial risk; and traces the effect that this expansion had on the definitions of security. It ends by introducing a research methodology and agenda for both studying and regulating the new historic bloc that resulted from this hegemonic configuration.

HEGEMONY AND HISTORIC BLOC

Antonio Gramsci (1891-1937) was an Italian Marxist who mused widely on political thought while he was imprisoned by the Fascists. He died of the illness he contracted in prison before he could finish these thoughts in published works. However, some of his concepts have proved so useful to political science that they have thrived without polishing, and beyond the context in which they were first developed (Sassoon 1987). Indeed, Adam David Morton warns against an "austere historicism" that fossilizes the past, and says that Gramsci can be used as an inspiration if not a blueprint (Morton 1999). Two of those helpful concepts are hegemony and historic bloc.

In Gramsci's political thought, *hegemony* refers to the nexus between an idea and the class that supports it/is supported by it. A hegemonic class dominates the network of relations of social forces. A popular, persuasive ideology is wedded to the fortunes of a particular class that then gains control over both the state and over other groupings in civil society—not just class, but also race, gender, family, etc. According to James Joll, "Gramsci saw, in a way that few other Marxists have done, that the rule of one class over another does not depend on economic or physical power alone but rather on persuading the ruled to accept the system of beliefs of the ruling class and to share its social, cultural, and moral values" (Joll 1977, 8). Hegemony thus structures the interactions among classes peacefully; as Roger Simon puts it, hegemony "is a relation, not of domination by means of force, but of consent by means of political and ideological leadership. It is the organisation of consent" (Simon 1982, 21).

Hegemony breaks down in periods of crisis, with a new one created by a socially homogenous ruling class that first establishes moral and intellectual leadership, then obtains political power. Gramsci writes that changes "can come about either because a situation of well-

being is threatened by the narrow self-interest of an opposing group, or because hardship has become intolerable and no force is visible in the old society capable of mitigating it and of re-establishing normality by legal means" (Gramsci and Forgacs 1988, 208). Joll finds that there are three versions of this dialectic process: the reciprocal interaction of one thing on another, the Hegelian thesis/antithesis/synthesis, and the relation between the structure and the superstructure (the ethics, law, philosophy, art and so on that are associated with the particular mode of production). In his words, "the dialectic is something more than the blind clash of physical forces" (Joll 1977, 83).

Simon also makes the point that economism according to Gramsci's thought is "the interpretation of Marxism which holds that political developments are the expression of economic developments" (Simon 1982, 11). In other words, the arrow of causation goes one way only; there is no feedback. Gramsci (and Lenin) disputed this mechanical determinism, and cited instead the importance (primacy) of politics, of human agency. Furthermore, the institutions of parliamentary democracy are classless in themselves—they are the terrain that the classes fight over. The class that succeeds in building hegemony wins the control of the institutions.

Hegemony thus creates through the unification of leaders and followers an *historic bloc*. In Gramsci's own words, "Superstructures form a 'historical bloc.' That is to say the complex, contradictory and discordant ensemble of the superstructures is the reflection of the ensemble of the social relations of production" (Gramsci and Forgacs 1988, 192).

The International relations theorist most commonly associated with Gramsci is Robert Cox. In his chapter from *Neorealism and its Critics* (Cox 1986), Cox explains that the state and civil society are today interpenetrated, and thus that problem-solving theories such as neorealism are akin to "normal science" (Kuhn 1970), in that they accept uncritically the prevailing

structure, and simply try to make it work more effectively, are insufficient. He calls instead for critical theory, which asks how prevailing structures came into being, and what they would look like if change were introduced.[6]

For Cox, historical materialism is the theory that seeks to both explain change in social relations and to normatively promote specific kinds of change. Structure is the result of the interaction of the following forces: ideas, material capabilities, and institutions. The latter is closely connected with hegemony: institutions minimize the use of force by the dominance of the strong with the consent of the weak. Structure is not determinism, but it does impose constraints on actors that have agency. The historic bloc is thus a concept with dialectical properties: "its interacting elements create a larger unity" (Cox and Sinclair 1996, 131) that embody hegemony politically, economically, and socially.

Of the hegemony current in the 1980s, which Cox calls the pax Americana, he asks what mechanisms maintain that order, and what is generated within that would eventually destroy it? The answer to that question is contained within the Washington Consensus.

The Washington Consensus

The term "Washington Consensus" was coined by John Williamson (Williamson 1990) at a propitious time to become a catchphrase: 1989, when the Cold War was ending. It thus provided an imperfect but shorthand expression for the generally neoliberal economic policy recommendations that were being considered at the time, aimed at Latin America in particular, but also at Asia and the newly independent former Soviet republics. Williamson gathered ten general policy prescriptions: fiscal discipline, reordering public expenditure priorities, tax reform, liberalizing interest rates, a competitive exchange rate, trade liberalization, liberalization

[6] One could argue that the Gramscian hegemonic idea is similar to Kuhn's scientific paradigm except for the ways in which they end: Kuhn's normal science accumulates anomalies, while Gramsci's hegemony can end with a crisis.

of inward foreign direct investment, privatization, deregulation, and property rights. Broadly, it advocated the pursuit of macroeconomic stability through the control of inflation and reducing fiscal deficits, the opening of economies through trade and capital account liberalization, and the liberalization of domestic product and factor markets through privatization and deregulation (Gore 2000).

Moisés Naím explained that the Washington Consensus was never a coherent ideology; it was always a work in progress, lurching from crisis to crisis while at the same time continually moving the goal posts for development policy. Indeed, the list of necessary but often politically impossible as well as insufficient policies kept growing in a feedback loop. The first stop in the loop was the discovery of economic orthodoxy, then the discovery of the importance of institutions, then the discovery of the importance of globalization, and the rediscovery of underdevelopment. Naím pointed out that sound macroeconomics had turned out not to be a goal, but actually a precondition of prosperity—"The difficult paradox, of course, is that any country that is capable of meeting such stringent requirements is already a developed country"(Naím 2000, 522). He recommends baby steps toward development that are actually achievable.

For these reasons, the Washington Consensus has always been a contested idea. However, while dominant it made significant inroads on policymakers in both the developing world and the developed world. According to Gore (2000), the impact on development markers included the globalization of analysis in terms of liberal norms, but with methodological nationalism; and a shift from historicism to ahistoricism in performance assessment, which was disaggregated by sector and compared to unlike others' performance. According to Colin Crouch and Wolfgang Streeck (1997), a global effect was to whittle down the diversity of capitalism: the

alternatives for core institutions such as competitive markets and property rights available within capitalism were killed off, and the mechanisms of economic governance (state, formal associations, and informal associations) were hobbled. The "embedded liberalism" (Ruggie 1998) of the post-World War II period, when the United States led the effort to create institutions to actively manage the global economy for political and social goods as well as profit, was transformed.

The idea in the Washington Consensus most successful at winning broad acceptance was privatization. Privatization as a concept expanded its hegemony from the "sale" of the state's assets in the former Soviet Union in the early 1990s, to the U.S. outsourcing of core activities of the state with its monopoly on the legitimate use of violence in war by the early 2000s. Privatization as a concept then spread to the assumption of elite private investor risk in the late 2000s with the state bailouts of financial firms in 2009.

Markers of Privatization

The markers of privatization in security are the growth of human misery as a result of the pursuit of the Washington Consensus in the developing world and former Soviet Union, the end of the monopoly on the legitimate use of violence, the assumption of private risk in the developed world, and the growth of income inequality. These are indicators of the hegemonic change in the assumptions and methods underlying the provision of global security.

The suffering that the pursuit of these policies has brought to millions of poor people around the world—those least able to bear the imposition of macroeconomic stability and trade liberalization—has been well canvassed by many authors. Two who give moving descriptions as well as provide prescriptions for alternatives are Joseph E. Stiglitz's *Globalization and its discontents* (Stiglitz 2003) and David Held's *Global covenant: the social democratic alternative*

to the Washington Consensus (Held 2004). The limits of space compel me to refer readers to these works for more detail; my concern here is to link the deliberate infliction of wretchedness by the very governments that were supposed to manage the economy in the interest of the people—the biggest threat to bodily integrity in these countries was being forced into poverty. This same period thus saw the exponential growth of nongovernmental organizations that tried to alleviate the situation (Mathews 1997). The actors involved in situations of threat and protection from threat were multiplied.

Nowhere is this abundance of actor type more obvious than in the appearance of the modern mercenary or private military contractor. As a second marker of privatization, Hoffman and Weiss in *Sword & Salve* note that "Although the growth of private military sector is usually correlated to increasing concerns over security—in fact, neoliberal pressures and globalization also spurred development of this industry" (Hoffman and Weiss 2006, 67). According to a summary of a Congressional Research Service report in *The Christian Science Monitor*, as of March 2009, contractors made up 57 percent of the Pentagon's Afghanistan personnel (Grier 2009). At the same time, there were more contractors than uniformed soldiers in Iraq, six years after the initial invasion (Lubold 2009). Deborah Avant predicted the privatization of security would change states, markets and civil society, forcing institutional innovation: "The privatization of security promises change in the practice of sovereignty. We should expect this change to affect not only states, but also the markets and societies that have built themselves around the state system" (Avant 2004, 157).

Hoffman and Weiss explain that these contractors are different from mere mercenaries in that they are formal business entities that "seek official acknowledgment, if not sanction, from political authorities" (Hoffman and Weiss 2006, 67). Eugene B. Smith argued for the use of

private military contractors (PMCs) in "The New Condottieri and U.S. Policy: The Privatization of Conflict and Its Implications," writing that PMCs could be used in cases where U.S. forces did not have the capabilities—which begs the question; why send troops in the first place?—as a sort of force multiplier.

Because of the growth of types of actors involved in the provision of security, there is no longer an *a priori* connection between securer and secured, so the relationship between them is the source of security information, not the actors at either end of that relationship, neither of which may be states. Implicitly, this calls for more effective global governance of these relationships, as state regulation of these relationships may not be adequate, as the parties may be based in the nominal jurisdiction of different states.

Paradoxically, the third marker, the assumption of private risk refers to the efforts of states to assure financial stability. The public assumption of private risk is the separation of risk from profit—the profits remain private.[7] The state bailouts in the current financial crisis included A.I.G. by the United States, which also benefited the shareholders of Goldman Sachs, which held large contracts with A.I.G. (Walsh 2010); Northern Rock, Lloyds Banking Group, and Royal Bank of Scotland (RBS) by the United Kingdom (BBC 2009a, BBC 2009c); Landsbanki by Iceland (Lewis 2009); and Dubai World and Dubai Holding by fellow emirate Abu Dhabi. Iceland made a $5.5 billion commitment that was scuttled in a nationwide referendum to repay the governments of the United Kingdom and the Netherlands for making whole British and Dutch depositors in the failed bank Landsbanki (The Economist 2009a, The Economist 2010). Dubai had to be rescued by loans from other states and from regional banks

[7] This assumption of risk minus the accompanying profit is not a new phenomenon. For example, the British armed forces assumed the task of providing the protection for the private interests of the East India Company in India after 1857. The separation of risk and profit may in fact be a natural part of the business cycle.

(The Economist 2009b, The Economist 2009c). Such bailouts embodied what is known as "moral risk," or the tendency of investors to make extremely unwise investments serene in the knowledge that they will not lose their money. It is called "moral" risk because it undermines the very idea that the market will reward informed investing and punish gambling that results in losses.

The last marker of contemporary privatization is the growth in income inequality. At the same time that profit has been separated from risk, the distribution of that profit has been skewed. According to Firebaugh (2006), global income inequality peaked in the last third of the 20th century and has been decreasing since, as developing nations catch up to the developed world. This conclusion is firmly disputed by the 2010 Human Development Report, which measures growing inequality along multiple dimensions. However, even if global inequality were receding, both agree that inequality has certainly risen *within* nations. Levine et al (2010) find that this relative inequality has the capacity to stimulate expenditure cascades, with the poor spending an increasing percentage of their income to try to keep up with the consumption of the rich. This has led to financial distress in the United States, as they found links between inequality and the likelihood of filing for bankruptcy, the likelihood of filing for divorce, and commute times. I would simply add that since they do not actually have the money to keep up with the rich, consumption by the poor has been financed by debt—which has had consequences for financial stability.

A change in the hegemony and thus the historic bloc within the banking industry was also observed during this period. The executive director of financial stability for the Bank of England defined the new driving ideas as twofold: "originate and distribute," and "diversification of business lines" (Haldane 2009). The first referred to the treatment of risk as a commodity that

could be packaged and sold on, getting loans off the originating institution's books and on to someone else's. The second referred to the increasing tendency of financial institutions to act like a herd following the profits into new and strange territory. Overall, the effect was to make the financial network both more complex, in terms of relationships, but more homogeneous, in terms of institution type.

In the case of private security contractors, the state gave up its monopoly on the legitimate use of violence, creating a security threat: people can now be legitimately threatened by something other than a state, and they can also require (or acquire) defense from these new actors. In the case of risk assumption, the state guaranteed the security of some investors over others. Together, these trends have led to a paradox: by stretching security to include nonstate instruments by which security is obtained and nonstate objects for which security is sought, beyond the bounds of traditional sovereignty, the very definition of security has been stretched, allowing it to be applied even farther afield.

Defining Security

The change in outward markers of security governance should compel a change in the conception of security. The problem of defining security in the post-Cold War era has been relating traditional security challenges to the territorial and institutional integrity of the state to non-traditional security challenges such as drugs, disease, pollution, population growth, ethnic and religious conflicts, gender violence, transnational terrorism, and migration. Globalization fosters and speeds the interconnection between today's threats—but it also fosters and speeds the interconnection between the organizations that respond to them.

This argument is not meant to imply that human security issues such as those raised in feminist or development arenas were not important before, nor that scholars were unaware of

their significance (Tickner 1992). Rather, as in Cox's critical theory, it is that with privatization exercising hegemony and opening the territory to nonstate actors, rhetorical space within the security establishment for discussion of non-traditional types of security has also been opened and settled.

Security has more than one dimension. For academics and policymakers traditionally, the question of "Security for whom?" was answered "the state." And yet, this does not fully capture the concept of security. MacFarlane and Khong traced the development of the idea of human security from its beginnings in the Cold War, through the 1990s in development and in the need for protection. Starting in the mid-1980s, security has been redefined to include other dimensions: not only may the threat come from outside or from within the community to be protected; but it may be natural or human. It may have agency (MacFarlane and Khong 2006).

According to Paris, the basic questions to be answered are "Security for whom?" and "What is the source of the security threat?" The answer to the first question may be either states or other collectivities and individuals. The answer to the second question may be military, nonmilitary, or both (Paris 2001). At one diagonal of his matrix there is human security, which is protection from environmental and economic threats to the survival of societies, groups, and individuals. At the other diagonal is traditional national security, which is the protection of the territory of the political community of the state from a military threat emanating from another state. However, as Krause puts it in a trenchant piece in the *Security Dialogue* debate published in 2004, the former end of the matrix consists of protection from "all bad things" (Krause 2004), and as MacFarlane and Khong agree, does not provide an intellectual toehold for analysis. Owen adds that the severity of the threat ought to be considered; he argues convincingly that severity is

a better category than simply violence because a threshold can be defined, such as that by ICISS report *The Responsibility to Protect* (Owen 2004).

This change in conception of security can be traced in the publications of the U.S. National Intelligence Council. The first (publicly released) National Intelligence Estimate that relates to nonstate phenomena appeared in 1948, with "The Significance of the World Federation of Trade Unions in the Present Power Conflict" (CIA 1948). With the first forward-planning publications that took long-term views of the future, starting with *Global Trends 2010* but especially with *Global Trends 2015*, the NIC put human security considerations squarely in the middle of security analysis, highlighting the dangers that could accrue when issues such as demographics and natural resources are ignored (NIC 2000).

The debate that was canvassed in *Security Dialogue* was answered by a forum in the *World Policy Journal* in 2009. This group of essays considers various aspects of human security, as well as exploring how these security needs have, or have not been met, as well as the concept's future prospects. For example, will the concept retain its universal, all-inclusive aspect as power continues to shift to Asia (Kim et al. 2009)? It also prompts thoughts of blind spots in the way the concept has been applied—to food (Mousseau 2009), but not to small arms. As the forum shows, policymakers and activists appear to be more comfortable with the analytical "messiness" of the concept of human security than are academics. I posit that this academic resistance most likely stems from the remnants of neorealism, and its insistence on reductionism. Human security is fundamentally an attempt to explicitly link surface threats to underlying trends, and as such, probably is more familiar to those who are not trying to explore any one dimension very deeply.

Security can also be defined as a common pool resource: a resource system in which it is possible but costly to exclude potential beneficiaries from obtaining the resource units of that system (Ostrom 1990). For example, in terms of global financial governance, one way to see it is that the system is the environment of local, national, and regional regulation (or lack thereof), while the resource unit is the credit that flows through that system. An alternative way to see it is with credit being the system and individual links through which credit does or does not flow being the resource unit—those that provide reliable links contribute to the system's security, while those that do not injure the system's security. It is possible, but costly, to exclude certain financial actors from this system. Finally, as Ostrom points out, there are institutions capable of governing such a commons without resorting to the extremes of either top-down control or atomized market.

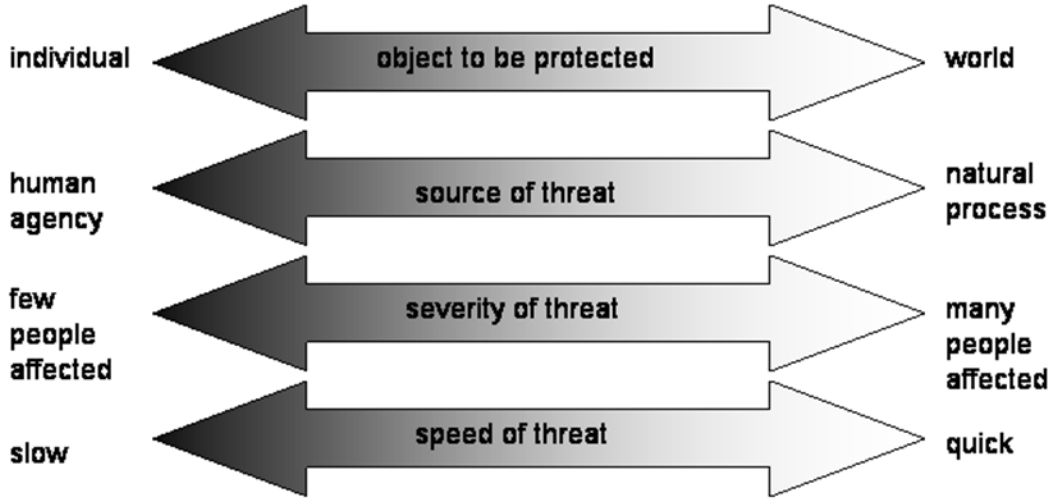
The previous sections outlined the theoretical justifications for using an approach to analysis of security governance that can handle multiple actor types and relationships. In the following section, the paper discusses the methodological underpinnings of the network analysis approach to mapping security cooperation, which emphasizes patterns and structures.

GRAPHING THE HISTORIC BLOC

To take advantage of the multiple dimensions of security, I propose a new matrix, one that includes speed. The speed at which a threat moves is critical: it may strike with or without warning. Threats may therefore be imminent, as in a nuclear strike, or insidious, as in poverty. This is a situation that is exacerbated by globalization: the Black Plague took four years (1347-1351) to spread through and decimate Europe; the Spanish influenza took two years (1918-1919) to affect the entire world; while SARS took only weeks to circle the globe. This is the sense of threat as crisis (Thakur 2004). The source, object, severity, and speed of the threat all help to

determine the type of policy instrument used to counter it, and especially in the case of transnational threats, may require that different institutions react in concert. The threat may come from outside or from within the community to be protected; it may be natural or human, with or without warning.

Figure 1: Security Matrix



In reading the matrix, one should keep in mind that the arrows are dimensions of security that list dichotomous choices of how security is measured, and are extremes on a spectrum. To use the most obvious example, the object of security according to the traditional definition is the state. In this matrix, the state would appear in the middle of the spectrum between the extremes of the individual and the world.

The dimensions of security are not static: issues may move on these spectra. A chilling example is gendercide: the abortion and infanticide of females. What is initially a human

security problem, with a severe but slow-moving threat to individual women and girls, may become a threat to international peace and security if societies in which this is prevalent develop no means of dealing with/disposing of the excess males (Hudson et al 2009). These excess males, or "bare branches," thus have consequences not only for the relative peacefulness of states domestically and the negotiation of international conflict, but have historically been a cause of violent aggression to the point of imperialist behavior (Hudson and den Boer 2005).

The counterhegemonic idea has created a new historic bloc in global security governance. Authors qualitatively tracing the development of hegemonic ideas through dialectic and their resulting historic blocs include Philip Bobbitt, Craig N. Murphy, and Manuel Castells. In Bobbitt's *The Shield of Achilles* (2002), the strategic innovations that prove decisive in epochal wars interact with the struggle over the constitutional order, creating new forms of government and new tactics, with the caveat that epochal wars do not have to be great power cataclysms—they could be low intensity conflicts leading to economic and social collapse.

Murphy's *Global Institutions, Marginalization, and Development* (2005) explains that this relationship at the international system level has led to the coevolution of modern intergovernmental organizations and capitalist industry, creating an historic bloc similar to Bobbitt's era of market states, in which global level private actors regulate both states and much of transnational economic and social life (as in the case of bond-rating agencies). He uses a similar system for defining the generations of international economic regimes: revolutionary communications require new agencies, which appear before a crisis. The ends of crises are punctuated by new agreements and institutions that both create and sustain order in the world's economic relations.

In *The Rise of the Network Society* (2000), Castells traces the impact of the technology of knowledge generation, information processing, and symbol communication in the emergence of a new global social structure which takes on various flavors depending on the mix of cultures and institutions in which the technology can be found. The productivity of these technologies is the result of a new informational mode of development. The network society is institutionally "for the time being, a capitalist society" (Castells 2000, 502). But it represents a qualitative change in human experience, and is transforming the material foundations of society, and the way we encounter space and time.

These are all important contributions to scholarship, advancing the knowledge of the structure of particular historic blocs. However, as a basis for writing plans for action, these qualitative studies are too diffuse. Because the concept of security now includes nonstate actors, it is necessary for policymakers to have some way of considering the multiple types of relationships among every type of actor, not just states, and to do it in a way that does not take hundreds of pages while still exposing nonobvious relationships. I propose using network analysis to map these relationships, using power as the relation. As Sassoon writes,

> A precise understanding of the relationship of different groups which are allied under the hegemony of the dominant class is necessary for the party so that it can formulate its tactics bearing in mind the ethical and cultural *form* of the hegemony of its opponents but also the economic consequences which provide the limits or boundaries of compromises by the 'leading group'" (Sassoon 1987, 116).

Even more to the point, Cox writes "At its most abstract, the notion of a framework for action or historical structure is a picture of a particular configuration of actors" (Cox and Sinclair 1996, 97). In other words, to know where you are, and where you want to go, it helps to have a map. A network graph is just such a map of relationships, showing distances and possible routes among nodes/actors (Wasserman and Faust 1994). It would also be helpful to have stringent,

theoretically-based definitions of what is to be considered a relationship. An example would be the matrix of types of power developed in *Power in Global Governance* (Barnett and Duvall 2005).

A network responding to transnational threats to either human or national security requires connections and coordination—cooperation among actors. With a network analysis research agenda, scholars can make clear the existing relationships between actors, thus suggesting areas in which improvements can be made. We may also be able to show that the structure of the network makes a difference in how effective it is in meeting the threat it was created to resolve.

A graphic representation of security space would show the multiple dimensions in which security issues can be mapped; a four-dimensional map of an historic bloc, a particular configuration of power in space and time. For the purpose of this investigation, the four axes of security are source of threat, target, speed, and impact: thus locating the networks of security governance in a multidimensional structural space (MacFarlane and Khong 2006, Paris 2001). This would look like a 3-D box, with length, height, and width representing source of threat, target, and impact. To represent speed, actors involved in security efforts would appear and disappear in the box over time. These actors would be connected by lines representing their relationships. Once an event or issue is located on these axes, the resulting plane or slice of security space is known. This slice is the frame (Goffman 1975) through which the security threat is thought about and responded to, and thus can tell observers about primary effects of structural constraints on the governance of security—the kind of network of actors that will form in response to a given threat. These networks are categorized by the actors involved and how they are organized.

Importantly, this security space also gives us multiple ways to think about security. We can look at the slice to see which, if any, actors are present; and we can look at the actors to see in which slice they are located. To some extent, the slices could be pre-determined, meaning that the dimensions of known security issues could be decided ahead of time by defining it along the axes. For example, pandemic disease (in the World Health Organization's definition) is a fast-moving threat without human agency that affects many individuals. Once the broad outlines of the slice are known, we can look to see if there is a network responding to it. This approach would be useful to see where security is and is not being provided. It would thus also be useful in order to examine relatively neglected issues such as women's security, and to create new approaches on the basis of critical theory.

An example of such inquiry of security space would be to examine the slice corresponding to financial stability, to see which actors are present and how they are connected to each other. As many other scholars have remarked, the role business plays in the state is not merely that of an interest group (although business does play that role as well), but it also has a function in governing: providing economic stability, a minimum threshold of unemployment, and growth (Mills 1956, Lindblom 1977, Dahl 1982). In fact, as Mizruchi notes, the Marxist project of mapping power elites through interlocking corporate directorships petered out due to a lack of methods and data, not from lack of interest (Mizruchi 2007). In the eyes of government, business is not merely a special interest, but the performer of the indispensable function of employment—adverse effects like unemployment are unacceptable to government. When this role is not performed, the resulting economic crisis threatens the state's legitimacy. In a democracy, this means throwing out the ruling party, while in non-democratic systems it can

mean revolution. Financial instability is a human-origin threat that moves quite slowly (at first), but that affects the integrity of the state.

This leads to a condition of "interdependent security," in networks as defined by Kunreuther in "The Weakest Link: Managing Risk Through Interdependent Strategies":

> In a networked world, the risks faced by any one agent depend not only on that agent's own choices but also on those of others. More specifically, the economic incentive of any agent to invest in protection depends on how she expects others to behave. The strategies can be risk-reducing measures as well as information-gathering and preparedness activities. The fact that such events are typically probabilistic, and that the risk that one agent faces is often determined in part by the behavior of others, gives a unique and complex structure to the incentives that agents face to reduce their exposures to these risks that come under the heading of interdependent security (IDS) (Kunreuther 2009, 384).

Interdependent security thus fits into the dimensional matrix of security on the following axes: the proximate threat may be to a nonstate entity but the ultimate threat is to the state; and it can move very quickly (for example, electronic finance almost literally moves at the speed of light).

The method of network analysis can thus be fruitfully applied to international relations. The ontology of network analysis includes the assumption that institutions are not the only important aspect of social life; rather, it is the fact that actors interact with each other, creating a pattern of relationships which may or may not have been formally institutionalized. This pattern can be quantified and analyzed using the methods of graph theory, allowing us to see the pattern of hegemony in action. Such a mapping can produce insights unavailable to a narrative overview, such as the location of second- and third-degree effects of events. Network analysis thus is a potentially useful tool for both regulators and investors; what remains is for policymakers to make institution-level data available to the public.

Mapping the positions of the actors in this historic bloc using solely qualitative methods such as narrative takes a lot of time, requires access to people and data, and can still miss

important structural features, especially if they are second- or third-order relationships. However, by using network analysis, researchers could at least partly reconcile historicism and positivism like Cox, creating a snapshot of an individual network that is static/synchronic (Cox and Sinclair 1996), while multiple slices of the space can show diachronic or developmental progression like MRI slides. The results of the network analysis can then be presented either narratively or graphically. A network graph is a visualization or map of a mathematical matrix of relationships, but it can also be described with words. Ultimately a map of relationships can illustrate where an actor's efforts can be best focused: in helping to decide where to create or cut ties to others. It can also be used to analyze the whole system at once: in seeing the most likely paths for the flow of information or resources.

CONCLUSION

Antonio Gramsci's concepts of hegemony and historic bloc can be used to describe and explain both the shape of contemporary global security governance, but also the processes that make it dynamic. The current context is driven by the results of and reaction to the Washington Consensus: privatization, the end of the state monopoly on violence, the assumption of private risk at public cost, and the growth within societies of income inequality.

This context has led to a rhetorical opening, allowing the re-definition of the term "security." No longer limited to the state, security can now have a range of referents. This range makes mapping the historic bloc involved with the provision of global security difficult by qualitative methods, and calls for the introduction of a quantitative method well-suited to dealing with multiple actors and actor types: network analysis.

CHAPTER TWO

NETWORK ANALYSIS IN INTERNATIONAL RELATIONS

Ontology and epistemology have to be specified in advance of research, otherwise both the subject and the method become attenuated—so distant from the question to be answered that any process is as good as random, and any answer arrived at is meaningless. In order to see the innovative aspects of the planned study of global politics, it is necessary to define exactly what is meant by "networks" in international relations. How have they been defined in the past? And to answer the epistemological question: how have they been studied in the past?

This chapter consists of a literature review, first situating network analysis within the larger field of international relations, and then examining how the field has developed the concept of networks. This evolution has gone from the analysis of simple balance-of-power systems toward more complex adaptive systems. On the way, the field has developed definitions of complexity and systems analysis that are particularly useful in network analysis, and that can be extended to other disciplines.

I then examine the previous qualitative network analysis works in the study of international relations (see for example, Keck and Sikkink 1998, Price 1998, Braithwaite and Drahos 2000, Braun and Chyba 2004, and Slaughter 2004), and compare them to quantitative approaches. Using this approach to global governance requires careful examination of both ontology (Kjaer 2004, Barnett and Duvall 2005) and epistemology, as the definitions and conceptions of what is to be studied are affected by the choice of a formal mathematical approach.

Theoretical Context

The theoretical context in which this work is situated is largely within the constructivist school of international relations. Unlike realists or liberal institutionalists, who would expect states or intergovernmental institutions to take the lead in constructing a response to an event or problem, constructivists allow for situations of complex interdependence in which ideas, or other actors, may be more important. For both realists (such as Grieco 1988 and Walt 2000) and liberal institutionalists (such as Doyle 1983 and Oye 2000) only states are endogenous to their models of global politics—other actors are exogenous, and if they should have an effect on the system's politics it is because a state is ultimately guiding and responsible for their actions.

An ecological approach looks at the entire system of interactions, both among actors and between actors and environment. In international relations theory in political science, this approach to global politics is best known as "global governance," and fits the definition of a complex system: multiple types of actors and processes, the structure of which is the result of past structure, actor choices, and stochastic processes. The modeling of such complex systems in international relations has its roots in sociology and English School international relations theory. It is greatly facilitated by the use of quantitative social network analysis methods, used to map broad trends and patterns, which can then be used as a basis for comparison, for finding "communities" of similar actors, and for investigations into dynamics. To demonstrate this, examples from a range of global security governance issues will be explored.

However, using social network analysis to study global governance requires careful examination of both ontology and epistemology, as the definitions and conceptions of what is to be studied are affected by the choice of a formal mathematical approach. In contrast to both realism and liberal institutionalism, which look at the pattern of interaction among the members

of only one or two types of organization, the ecological approach assumes that all the organizations that demonstrate agency, or the ability to choose, count as actors. These actors interact with each other and with their environment, which refers not just to the strictly material or ideal, but also to background trends such as globalization that do not exhibit agency. In this sense, it draws upon the heritage of English School theory. This approach also means that the intellectual puzzles of researchers will change, as the questions become more oriented toward patterns of cooperation and cohesion, and less about the actions and motivations of individual actors, or of specific types of actors. In other words, networks in global politics consist of actors connected by a specific relationship that crosses national boundaries.

This project examines networks or connected samples of the cloud of actors involved in global security issues (for the purposes of demonstration, this paper looks at networks from different issue areas, but the concept applies to geographical and temporal slices as well). The actors belong to different sets (because they are different types of organizations—states, NGOs, companies, etc.), but there are also connections among and between sets.

As developed in chapter one, a driver of change in global security governance has been the "Washington Consensus." The neoliberal economic push has privatized security functions and infrastructures that were formerly the province of states. This has created what Gramsci would term an historical bloc (Murphy 2005). These privatization trends have created the present state of globalization. There are clear markers of this transformative, de-institutionalizing change (Holsti 2004). This has implications for theory building as well as policy making—security is no longer a matter only for states but a global governance matter, requiring the cooperation of many different types of actors (Held et al 2000, Castells 2000). This ecological method for describing global politics known as global governance is relatively new to

the study of international relations, which to this point has focused mainly on state-to-state interactions.

System-level Theorizing

System-level networks seem to be primarily concerned with policy development, so the question that needs answering here is "Who makes the decisions?" For example, in the case of nuclear nonproliferation, decisions must be made about who is allowed to pursue the development of nuclear weapons, and about the enforcement of those decisions. Who is entitled to enforce decisions, and how intrusive are they allowed to be in their task? In the case of the tsunami, this decision-maker question refers to determining the overall shape of the global response: would aid offered be coordinated on a state-by-state basis, by an intergovernmental agency, or some other actor, or some combination of the above? Where was power (the ability to make decisions that are binding on others) exercised?

Previous examples of system-level theorizing about world politics dealt only with nation-states, and only with the leaders of the system; those states that were so large and mighty that they were known as "great powers" (Morgenthau 1948, Waltz 1959, Singer 1961, Easton 1965, Kaplan 1969, Deutsch and Singer 1969, Waltz 1979, Gilpin 2001). States that were not great powers were either ignored or assumed to be at the mercy of the much stronger great powers, which led to such basic structural strategies as balancing and bandwagoning (Walt 1996). Liberal institutionalists expanded the actors in the arena by adding IGOs that could act as agenda-setters, induce coalitions, and allow weak states to forum-shop (Keohane and Nye 2001: 32). An interesting development in theorizing came with the Prebisch-Singer Thesis about inequalities in world trade flows: the "world systems" approach, which differentiated between "core" and "periphery" (Wallerstein 1979, Toye and Toye 2004). This latter approach

acknowledged that small states had agendas that did not necessarily refer to the great powers. Network analysis in international relations can be seen as growing out of this strand.

Networks are complex systems (Jervis 1997, Flake 1998), a type of relationship between multiple actors. They are composed of actors who have agency: the ability to act and react. Depending on the framing of the issue area (peace and security, human rights, international trade, economic development, and environment are all examples of issue areas in world politics), network actors can include states, sub-state governmental units (such as a ministry or provincial government), IGOs, NGOs, TNCs, social movements, and individuals. A network analysis, therefore, does not privilege the structural attributes of the actors, but studies great and small, core and periphery alike.

Power relations of actors in networks are just as likely as not to be asymmetric. Hierarchy is one possible "configuration" of policy networks, but so are clusters and hubs. For realists, there is only one type of power—compulsory—to be mapped, for other schools of thought there are many. Power in a network has several dimensions: "the control over strategic rigidities in tight or loosely coupled systems, the conditions of entry/exit, inclusion/exclusion/expulsion, membership or other adherences, etc." (Marin and Mayntz 1991, 16). ("Strategic rigidities" refers to the differences in constraints on actor agency, which are stronger in tightly coupled systems.)

Complexity and Complex Systems

A simple way to define complexity as a characteristic of an object is that it is internally heterogeneous: on dissection (like Swiss cheese) slicing through it in one direction will reveal a different structure than a cut in another direction. This is not necessarily the case for other solids: slicing cheddar horizontally will reveal the same internal structure as slicing it vertically.

David Easton pioneered the complex systems approach to international relations in *A Framework for Political Analysis* (1965). He defined politics as a system of behavior, separate from its environment, which responds to internal and external stimuli, and in which feedback loops occur (Easton 1965, 24-5).

For Jervis in *System effects: complexity in political and social life* (1997), in a system "(a) a set of units or elements is interconnected so that changes in some elements or their relations produce changes in other parts of the system, and (b) the entire system exhibits properties and behaviors that are different from those of the parts" (Jervis 1997, 6). The result is that systems are often nonlinear, as well as dynamic. Researchers cannot hold everything else constant while studying one part, because the parts are interdependent.

Finally, James Rosenau, writing on global governance, defined a complex adaptive system as one that is

> distinguished by a set of interrelated parts, each one of which is potentially capable of being an autonomous agent that, through acting autonomously, can impact on the others, and all of which either engage in patterned behavior as they sustain day-to-day routines or break with the routines when new challenges require new responses and new patterns. The interrelationships of the agents are what make the system. The capacity of the agents to break with routines and thus initiate unfamiliar feedback processes is what makes the system complex (since in a simple system all the agents consistently act in prescribed ways). The capacity of the agents to cope collectively with the new challenges is what makes the system adaptive (Rosenau 2009, 5).

This definition can be compared to a definition in a mathematics/computer science text: a complex system is "a collection of many simple nonlinear units that operate in parallel and interact locally with each other so as to produce emergent behavior" (Flake 1998, 446). The problem, as Flake notes, is that complexity itself is hard to define, and hinges on how "interesting" a system is—how much information it contains that is neither completely random nor regularly patterned (Gell-Mann 1994)—or as "structure with variations" (Goldenfeld and

Kadanoff 1999, 87). Note that these definitions, which were created for different fields, both contain the concept of dynamics—complexity is not static.

Complex systems are also subject to interaction effects. In systems that are tightly coupled, processes happen very fast, they cannot be turned off, and the failed parts cannot be isolated from other parts, making recovery from initial disturbance impossible—it spreads quickly and irretrievably. This is called a "normal accident," meaning that the system will inevitably produce such events. The opposite is a loosely coupled system, in which elements are involved in the same production sequence, but one does not cause the other (Perrow 1985). Such a system is robust. If networks are tightly coupled, they will exhibit dense, strong links among actors. For example, interactive complexity and tight coupling leads to normal accidents in nuclear weapons, a situation that will be made worse by small, weak and unstable states (Sagan and Waltz 1995).

Jervis also notes that complex systems demonstrate system effects such as emergent properties: the whole is different from, not greater than, the sum of the parts. A point he shares with Perrow is the opinion that the fact of interconnections makes a difference: density makes a system complex and hard to control. This has several effects: it can defeat purposive behavior, it matters whether the system is tightly or loosely coupled, the chains of causation may be short or long, and there can be a variety of rigidity of variance in the connection—in the extent to which changes in this part cause changes in that part in inverse proportion (Jervis 1997).

Complex Systems and Global Governance

Networks are one type of complex system—a type of relationship between multiple actors. They are composed of actors who have agency. Depending on the framing of the issue area (peace and security, human rights, international trade, economic development, and

environment are all examples of issue areas in world politics), network actors include may states, sub-state governmental units (such as a ministry or provincial government), IGOs, NGOs, TNCs, social movements, and individuals.

Again, system-level networks seem to be primarily concerned with policy development, giving rise to the question "Who makes the decisions?" Resultant actions (as opposed to rhetoric) should be counted as evidence, meaning it is the relationship itself that is of importance, not the actor type. Both cases studied are examples of complex adaptive systems, with different structures and types of actors involved. Efforts to prevent nuclear proliferation are led by one type of actor in the system (states), but require the cooperation of other types of actors (companies, etc.). In the case of the tsunami, the global response was coordinated by two disparate groups of actors, and power was exercised by disparate types of actors within those groups. They are both examples of global governance.

Definitions

Global governance is too new a notion to be defined in many political science lexicons, or even in the *Oxford English Dictionary's* online edition. However, in its inaugural edition in 1995, the journal *Global Governance* contained definitional attempts by James N. Rosenau and Lawrence S. Finkelstein.

Rosenau, building on his life's work, wrote that governance is concerned with the mechanisms of control (both trans-national and sub-national practices and institutions) that are essentially related to one another, and when taken together constitute systems of rule. He emphasizes the exponential growth of interdependence as actors proliferate to meet the new needs that are created. The existing world order remains without overarching authority, which does not mean that there is no structure: "Governance encompasses the activities of

governments, but it also includes the many other channels through which 'commands' flow in the form of goals framed, directives issued, and policies pursued" (Rosenau 1995,14). There is no global ordering principle, but global governance is usefully seen as the sum of the formal and informal mechanisms that ensure partial ordering—what Rosenau poetically calls a "crazy-quilt" (Rosenau 1990: 299).

Finkelstein wrote that "global" denotes a world in which actors other than states play an increasingly important role, and in which decision-making processes are multilevel, connected both within and between states. "Governance" is an ambiguous term that refers to governing without government, the title of Rosenau and Ernst Czempiel's earlier set of influential essays (Rosenau and Czempiel 1992). "Global governance," for Finkelstein, is "any purposeful activity intended to 'control' or influence someone else that either occurs in the arena occupied by nations or, occurring at other levels, projects influence into that arena." It is a process of activity, and to differentiate it from other terms, its descriptive rather than normative nature should be emphasized: "global governance is governing, without sovereign authority, relationships that transcend national frontiers" (Finkelstein 1995:368-9).

More recently, Anne Mette Kjær examined the term "governance" and its usage in different fields of political science including comparative politics, international relations, and public administration policy. She found that most definitions refer to something broader than government alone: to the "steering" and rules of the game as well as to institutions and institutional change. Increasing use of the same term among fields, in her opinion, reflects the erosion of boundaries. All versions address the importance of networks, of reciprocity, accountability, and democracy.

However, Kjær found that different fields are addressing different problems, and the views of global governance held in international relations vary strongly depending on whether or not contemporary globalization is seen as a transformation of economic, military, environmental, and socio-cultural interactions. Theorists tend to fall in two camps: those who believe states are the most important actors, and those who do not. Neorealists and pluralists (of the English school) believe that global governance is no more than what states agree, while what she calls solidarists look to the collective action of states in defense of human security as global governance. However, solidarists differ from neo-realists and pluralists in believing that globalization has been transformative. Finally, liberalists believe that not only are many global governance processes underway at subnational, national, and supranational levels, but that the regimes thus created are likely to be flat non-hierarchical networks with no one actor in clear control. Thus, for them, global governance refers to the totality of all regimes (Kjær 2004).

Margaret Karns and Karen Mingst in *International Organizations: The Politics and Processes of Global Governance* define the term as referring to "the collection of governance-related activities, rules, and mechanisms, formal and informal, existing at a variety of levels in the world today…the cooperative problem-solving arrangements and activities that states and other actors have put into place to deal with various issues and problems" (Karns and Mingst 2004: 4). This definition includes different levels of analysis, from the local to the global.

This author agrees with Weiss and Thakur that global governance is "the sum of laws, norms, policies, and institutions that define, constitute, and mediate relations among citizens, society, markets, and the state in the international arena" (Weiss and Thakur 2010: 6). This definition emphasizes five components that are essential for analyzing contemporary international relations. First, the level of analysis is global, concerning governance processes

that cross national and even regional boundaries. Second, the issues are themselves problems that cross boundaries, such as cyberspace, pollution, health, trade, war, and so on. Third, there is the presence of nonstate actors; actors that have agency and the ability to affect the governance processes whether through states or not. Fourth, there is the element of dynamics in governance; the sense that it is an ongoing process and not a one-time event. Finally, there is what Charles Perrow called the interdependent yet loosely-coupled nature (Perrow 1985) of the complex international system, in which actors and events may be involved in the same sequence, but one does not cause the other, and there is a tendency to interact, which is a characteristic of a system, not of a part or of an operator. In a tightly coupled system processes happen very fast, and cannot be turned off, failed parts cannot be isolated from other parts, and recovery from the initial disturbance is not possible—it spreads quickly and irretrievably. The international system before World War I was just such a tightly coupled system, as is the financial system today (Haldane 2009).

Structure and Agency in Global Governance

Global governance is about understanding and creating structures through repeated relationships, or patterns of authority. It is a heuristic device that allows us to pay attention to a range of activities and actors in contemporary world politics. States remain the most important actors, but a host of other actors are increasingly crucial; and all of the actors in any case are interdependent to some degree. And interests are partly a result of an actor's attributes and identity, and partly of its structural role and position within the extant world order. Global governance is therefore concerned with both structure and agency.

Collectivities are organized to achieve goals, and they draw on different sources of legitimacy. For example, a state is organized differently from a corporation, and for different

purposes. A state has sovereignty, which provides an interest in defending a given territory. A corporation is organized to make a profit, which gives it an interest in certain people (its market). Global governance thus recognizes that human beings create many kinds of organizational structures that interact with one other and evolve constantly.

This is structure as the Gramscian idea of *historic bloc*: the superstructures formed by the unification of leaders and followers around a particular mode of production, and the social relations it engenders (Joll 1977, Sassoon 1987, Gramsci and Forgacs 1988). In international relations, the "product" may be a process such as war, or it may be a service like humanitarian aid. *Hegemony*, then, is the point where the ideas that govern that product meet the class of actors that both supports the ideas and is supported by them.

In other words, the structural position of actors depends on the framing of an issue, or how it is categorized by actors that are paying attention to it. A state active in peace and security may not be as engaged on environmental issues, or the other way around—for example, Israel is active in security issues, but is not known for its stand on the environment, while Japan's involvement in security is not as well-known as its activity in environmental issues. Or an NGO can have tremendous impact on rule-making but not on enforcement or the other way around—for instance, the International Campaign to Ban Landmines' lobbying led to a multilateral treaty, while Amnesty International's reporting and shaming have been effective at protecting human rights.

This framing of global governance allows us to pursue a constructivist research agenda that fits Jeffrey T. Checkel's criteria for building "middle-range theory," or efforts to link theory to reality. In essence, it consists of making one's ontology consistent with one's epistemology, and vice versa. Checkel seeks a constructivist theory that can test reality in comparison and in

contradiction to theory; compare among cases; be used to study socially constructed outcomes that are negative and not just positive; and formulate standardized definitions (Checkel 1998).

Structure and Agency in Other Schools of Thought

Realists study state vs. state behavior. Liberal institutionalists scrutinize state interactions with international institutions. Rather than placing constructivism in opposition to either, it is best viewed at the other end of a spectrum. The lessons from realism and liberal institutionalism are pertinent to explain actor behavior, but they are misleading or insufficient to understand the ever-changing behavior of the international system as a whole, and unexpected outcomes. That requires the sum of all such relationships. Structural realism, while it considers actors as part of a system, measures actors by their material capabilities without also considering the strength of interactions between and among them (Waltz 1979). In this view, a coalition would only need to have more materiel to win a conflict, and the pattern of relationships among coalition members would not matter. In contrast, a network view of global politics, interaction is what creates structure.

Returning to Checkel's criteria, we need to look more closely at multiple slices of global governance, investigating simultaneously as many different types of ties between and among actors as possible. We also need to examine the ties (or lack thereof) between different types of actors, and to study entire networks. To that end, I propose to look at how actors do or do not interact in global governance.

Not all MRI-like slices provide the same picture of the evolution in international society because the patterns of relationships and institutions vary by issue, geographic location, and historical period. For instance, calculations about international peace and security are not the

same for major and minor powers, not similar for nuclear weapons and drugs, and not comparable before and after 9/11.

Global governance is often conducted by different types of actors, depending on an issue—for instance for international security, members of the U.S.'s 82nd Airborne Division (national armed forces) or U.N. peacekeepers (international armed forces). At the same time, actors that are *a priori* viewed as distinct may actually play similar roles—for example, soldiers or Oxfam personnel in a war zone may both be caring for or protecting refugees. Because there is such a range of actors and of relationships, it is necessary to have methods and perspectives that can take this richness into account.

NETWORK ANALYSIS

The social network analysis perspective includes the following aspects: actors and their ties are interdependent; ties between actors are channels for the flow of information and resources; network ties both enable and constrain actions; and structure is viewed as iterated patterns of relationships among actors (Wasserman and Faust 1994). What makes a network "social" is the fact that it is constituted by actors with agency, rather than being constituted exogenously, like a computer network designed by a human.[8]

The most important aspects of the social network paradigm are that it is concerned with structure, which is relational (cooperation); it is based on empirical evidence; it is graph theoretical, which is visual; and it embodies a formal, statistical model. For example, networks measured in these ways can be compared and contrasted easily, and these comparisons can continue over time. This study will use the basic measures of social network analysis: density, centrality, and cohesion, to visualize the security space, to measure and to compare the

[8] Proponents of actor-network theory such as Bruno Latour (2005) and John Law (2000) might disagree with this formulation. In actor-network theory, the network consists of the interactions of humans, machines, plants, animals, and so on, and thus the creators and users of a computer network cannot be considered exogenous to the network.

interactions in networks of actors. The measures and their equations are presented in Appendix A.

Networks are thus "slices" of the security space at different geographical, temporal, and issue junctures. This is an "ecological" approach to global politics, examining the interrelationships of all the actors in an environment (Ostrom 1990, 2005, 2007, Moran and Ostrom 2005, Luczkovich et al 2003), rather than examining only one type of actor or relationship (Knoke 1990). Actors in the networks under investigation are thus defined as those organisms, whether individual or collective, that demonstrate agency, or a choice in behavior that is neither totally constrained by the structure in which they are embedded nor by genetic or other programming.

Actors in networks are interdependent, and often cooperate. Cooperation is defined as "[t]wo agents cooperate when they engage in a joint venture for the outcome of which the actions of each are necessary, and where a necessary action by at least one of them is not under the immediate control of the other." (Gordenker et al 1995, 11) The concept of networks assumes that social structures matters as much in explaining outcomes as do personal attributes such as material resources. The concept of *geopolitical* networks assumes that there is no central institution or idea that controls international relations (even in a specific issue area). The network consists of the pattern of formal and informal interactions among states, IGOs, transnational NGOs, and TNCs. It also assumes that according to the issue area, actor relationships can and will change. Networks consisting of governmental entities, especially in democratic societies, may find it easier to work with other types of actors to fulfill their functions, because they have a history of establishing cooperative relationships (Lindblom 1977). Cooperation at the beginning of a relationship makes subsequent cooperation more likely

(Axelrod 1997). One actor's decision of whether or not to engage with a particular other actor is therefore critical to the type of structure that is created.

This ecological approach opens the door to the consideration of nonobvious relationships. Charles Darwin, in *The Origin of Species*, illustrated nonobvious relationships by explaining how the incidence of a specific kind of plant around a village could depend on the presence of cats—even if the two species never directly interacted:

> I am tempted to give one more instance showing how plants and animals, most remote in the scale of nature, are bound together by a web of complex relations… I have found that the visits of bees, if not indispensable, are at least highly beneficial to the fertilisation of our clovers; but humble-bees alone visit the common red clover (Trifolium pratense), as other bees cannot reach the nectar. Hence I have very little doubt, that if the whole genus of humble-bees became extinct or very rare in England, the heartsease and red clover would become very rare, or wholly disappear. The number of humble-bees in any district depends in a great degree on the number of field-mice, which destroy their combs and nests; … Now the number of mice is largely dependent, as every one knows, on the number of cats; … Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district! (*The Origin of Species*, chapter 3, pages 38-39).

The aggregation of individual actor agency leads to specific structural outcomes. In turn, this leads scholars to two interrelated ways to study networks: as actors in a particular structure, and as collectives working toward a shared goal (Kahler 2009). This dissertation looks at networks in both senses, in order to find a more complete representation of reality. In the case studies, the unit of analysis is the actor in the network, which is relevant to questions of individual strategies. In the concluding chapter, the unit of analysis will be the network as a whole; at the macro level or the system level of world politics.

"Network" refers to both interorganizational structure and function; this study focuses first on structure (the behavior of discrete actors in the case studies), then on function (the efficiency of the networks themselves). The relationship between actors may be financial, legal,

social, or whatever. (The actor need not be aware of a particular relationship for the link to exist.) The number of actors varies, but cannot be infinite: there is a practical limit to how many discrete actors can interact without some form of aggregation.[9]

NETWORKS IN THE STUDY OF INTERNATIONAL RELATIONS

Most network analyses have been done in the fields of sociology and mathematics. These fields pioneered both the methods and applications. Sociologists focused mostly on mapping networks of individuals, such as Granovetter's study of the socially distant links individuals activated in order to find work—the "strength of weak ties" (Granovetter 1973), or Milgram's "six degrees" study of acquaintance links in American society (Milgram 1967). The network studies from mathematics until very recently did not reference the literature from sociology (Watts 2003; Barabási 2003).

The use of network analysis, using quantitative graph theory, in the American political science literature is quite recent—mostly within the past decade. This lack is likely a result of the insular turn to "quantitative, behavioral, rational choice, statistical and formal modeling approaches" borrowed from economics in the late twentieth century (Monroe 2005, 1). To the extent it has been used, qualitative network analysis is more commonly found in the literature of American and comparative politics (as examples from different eras, see Truman 1971; Heclo 1978; Marin and Mayntz 1991; Tichenor and Harris 2003). Prior to the 21st century, the network analyses of international politics that have been done by American scholars were almost all

[9] A suggestion for future research would be to follow the networks at the micro level, where the actors in the network are more likely to be national and regional governments, as well as local NGOs and businesses. The micro level seems to be more concerned with policy implementation; in the case of the tsunami, this would be the assessment of need and the actual distribution of aid. Going down to micro interactions requires thought about how to link macro to micro – what is the bridge between IR theory and national studies-federalism? Also, using local networks as a lab requires thought: if only one case, that raises selection issues – how can only one be generalized?

qualitative, using few if any of the quantitative techniques or theoretical assumptions about networks that have been developed in other fields.

The state of network literature in American international relations field ranges from using network as a mere metaphor to explicit use of social network analysis techniques. Exemplifying this range of analysis are studies by Anne Marie Slaughter, Leon Gordenker et al., Keck and Sikkink, Richard Price, Elke Krahmann, and Mette Eilstrup-Sangiovanni, which can be categorized as network-as-metaphor qualitative studies: on vertical and horizontal governmental networks (Slaughter 2004), mapping a transnational network of activists in a particular context (Gordenker et al. 1995, Keck and Sikkink 1998), the qualitative effect of context on a network of actors (Price 1998). Qualitative studies also have used explicitly network analysis terms and concepts such as the implications of network topology on low-intensity conflicts (Arquilla and Ronfeldt 1996), the network topology that had developed among global Salafi jihadists (Sageman 2004), and the structure of North Korean smuggling networks (Chestnut 2007). Furthermore, there has been much variation in the application of SNA, from studies that use the occasional technique to those few that wholeheartedly embrace SNA (Knoke 1990, Chen and Barnett 2000, Maoz et al 2006a, 2006b, 2007, Choi et al 2006, Hafner-Burton and Montgomery 2006, Kim and Barnett 2007, Carpenter 2007, Montgomery 2005, 2009, and Hafner-Burton et al 2009). Generally, the studies have been either qualitative, or focusing on ties between people. Very little work has been done on relationships between multiple types of organizations, even less using quantitative methods.

Slaughter's *A New World Order* (2004) is a liberal institutional variant that takes anecdotal evidence of horizontal (between governments) and vertical (between national governments and "supranational" entities such as the European Union) networks to develop a

theory of disaggregated state functions. However, she does not attempt to map the full extent of these networks, making a normative judgment about her recommendations difficult. She argues that the functions of a state can be disaggregated, without significant loss of accountability, given proper intergovernmental network design. This assumes a great deal of control over the conditions of network participation and process.[10] This could be described as a very democratic structure (Barabási and Bonabeau 2003). However, we do not know if this is actually the case, as the examples given are mostly from the United States, which could be an indication of a scale-free network where a few nodes have most of the links, or it could just be an indication of an incomplete research methodology.

In contrast, Gordenker et al. in *International Cooperation in Response to AIDS* (1995) take a more thorough approach by not only mapping the network, but also by exploring the context in which a single transnational network formed in response to a transnational problem. The transnational agenda has gone through several frames: AIDS has been viewed in the frames of the medical approach, stigmatization, human rights, and socio-economic development. Actors that emerged when one frame was dominant (such as a Congressional hearing on security) generally stayed active even when the frame changed (such as when meeting with donors), and even if their position in the structure changed. The dominant frame at any one time can encourage or constrain the actors involved. The authors found that in the network that was ultimately mobilized, some actors displayed leadership and took roles as what they called "linking pins, " the cutpoints joining different components of the network (Gordenker et al 1995: 19), while other actors followed that lead. Keck and Sikkink's work *Activists Beyond*

[10] She also appears to assume that the network created by disaggregation will be randomly connected: that most nodes will have approximately the same number of links. This is not clear from the text, but it is important to network analysis: random networks behave very differently than structured networks in terms of cascades of resources or information (Watts 2002).

Borders: Advocacy Networks in International Politics (1998) followed this methodological path as well, as has the literature on Transnational Activist Networks (TANs) they inspired.[11]

Price's study, "Reversing the Gun Sights: Transnational Civil Society Targets Land Mines" (1998), also investigated the effect the frame of human security had on the constellation of actors involved in the treaty banning landmines. He found that the ability of nonstate actors to actively manipulate the frame from a traditional national security paradigm, which is the sole province of state actors, to one of human security, gave the nonstate actors entrée to the network that had previously been off-limits. The treaty was a significant short-term test of the new network's ability to create an institution; a necessary but not sufficient step in the long-term test of compliance: an actual reduction in land mine production and usage.

The Advent of Netwar (1996), by Arquilla and Ronfeldt addressed in very general terms the implications of network topology for lower-intensity conflicts. But it was not until 2004, when Sageman's survey of terrorist networks appeared, that American analyses of international politics began to be published using social network analysis techniques. Sageman found important implications for the network topology that had developed in the global Salafi jihadists. For example, the network that grew was not a planned network, directed consciously. The self-selective process of attaching to particular "hubs" (or nodes), which figure in most communications, created a "small-world" network. This type of network is robust, meaning it could withstand the removal of many nodes without breaking down, and flexible, meaning that innovations could be discovered and communicated to others, although this type of network is vulnerable to a coordinated attack on the hubs. However, Sageman cautions that coordination in

[11] They define "transnational activist networks" as networks of actors including scientists, experts, activists, and firms that interact with each other, with states, and with international organizations that make the resources from the international system available to domestic struggles, and that allow domestic actors to influence international policy making (Keck and Sikkink 1998, 1).

an attack is extremely important: take out only a few hubs and the network will be able to reconstitute itself.

There has also been a contextual difference in the literatures and research agendas of varying interests in international relations. For example, Krahman's analysis of global governance and network analysis literatures found that both refer to policymaking done by state and nonstate actors in horizontal as well as hierarchical relationships. The differences she found were that global governance has been more concerned with theorizing the transformation of governance from the Cold War paradigm to a multipolar world, while network analysis has been more concerned with interactions between public and private organizations at different levels. The connection between the two literatures is that "the fragmented governance arrangements facilitates, or perhaps even requires, the adoption of networked forms of coordination among state and nonstate actors." (Krahmann 2005, 21).

For example, the evolution of cooperation to respond to the South Asian tsunami began with an event, a tsunami in the Indian Ocean. The response network that was created was not started from scratch, however: the South Asian communities of states, businesses, and nongovernmental organizations already existed. To create the response network, not only did these pre-existing groups have to negotiate structure and authority, but they also had to incorporate many new groups who wanted to assist.

By the same token, the evolution of cooperation to respond to nuclear proliferation began with Eisenhower's Atoms for Peace speech, in which he held out the promise of sharing American energy sources and expertise at the price of foregoing the weapons path. The response network that was created was not started from scratch, however: the international community of states, the United Nations, already existed; the International Atomic Energy Agency (IAEA)

could be negotiated from that starting point. To create the present response network, not only did these pre-existing groups have to negotiate structure and authority, but they also had to incorporate many new groups (businesses and nongovernmental organizations) who were related in some way.

The two cases illustrate the need for flexibility in terms of network participation. Had either network proved too rigid to accept new members and scale up, it is not unlikely that parallel networks would have emerged, at a waste or duplication of resources and the possibility that coordination *between networks* would have been problematic.

THE USE OF QUANTITATIVE NETWORK ANALYSIS IN INTERNATIONAL RELATIONS

Work using the techniques of quantitative social network analysis has been less common in international relations. Hafner-Burton and Montgomery (2009) have characterized three waves of international relations research using the methods of quantitative network analysis. The first wave, from the late 1960s to the early 1970s mapped trade, IGO and diplomatic exchange networks, but did not theorize much about the effect of network structures on behavior. An example of this "wave" would be Steven J. Brams' 1969 work "The Structure of Influence Relationships in the International System."[12] A notable exception to this is the first use of network analysis in political science in the 1950s: Ithiel de Sola Pool introduced the concepts into the political science literature beginning in the 1950's with a working paper co-authored by Manfred Kochen on the effect of "small world" networks on questions of power, participation, and access (de Sola Pool and Kochen 1978). This paper was widely circulated, but unfortunately for the field not formally published until 1978 (Deutsch 1989).

[12] Demonstrating the utility of this approach to the scientific study of global politics, this study was replicated (and extended) by Charles W. Kegley and Eugene R. Wittkopf in "Structural Characteristics of International Influence Relationships: A Replication Study," *International Studies Quarterly* 20, no. 2 (1976): 261. Unfortunately, the success of this assay into network analysis was almost immediately forgotten.

The "second wave" in international relations characterized by Hafner-Burton and Montgomery started in the late 1970s with a more sociological/world systems focus on international inequality and dependency theory. Exemplifying this wave was David Knoke, with *Political Networks: The Structural Perspective* (1990). In this text, he outlined the structural point of view's history in political science theory, and suggested several uses for the types of measurements available in social network analysis in political science. In international relations, he discusses mapping dependency and world systems theory in these terms, but it is my belief that mapping the Prebisch-Singer thesis etc. will not add anything new to the debate (indeed, Hafner-Burton and Montgomery note that this thread of international relations theory is outside the mainstream of the discipline). Knoke concludes with the insight that measuring international transactions in terms of state activity alone will not provide a complete picture of reality.

Finally, starting in late 1990s, there has been an attempt to integrate the tools of network analysis with the core questions of the discipline: "Two issues regarding network power are particularly important to international relations: whether actors can increase their power by enhancing and exploiting their network positions, and the fungibility of power—whether network power can be used to supplement or offset other forms of power." (Hafner-Burton and Montgomery 2009, 573). Examples of this era include tests of the democratic peace hypothesis by Benson (2004) and Maoz et al (2006, 2007), in which the network concept of transitivity (which is the extent to which the statement "the friend of my friend is my friend" holds true) is tested against state relations.

In general, the more recent network analysis scholarship in international relations has in common the following properties: a focus on a single type of actor, the mistaken notion (among

qualitative researchers) that the opposite of hierarchy is network, the use of regression analysis, and differing levels of reliability and validity.

Each study only looks at one type of actor at a time, instead of focusing on one type of relationship at a time. While actor type may be constrained by the relationship—for example, only states can belong to treaties—there is no reason why it should be assumed *a priori*. Indeed, given the multitude of actor types that demonstrate agency across international borders (Rosenau 1990), there are compelling reasons not to disqualify actors from inclusion in the network based on their attributes. As Bulkeley (2005) notes, networks may be scalar but not necessarily hierarchical or territorial, and we must develop an alternative account of "geographical" governance using networks that operates between, among, and across traditional spatial and scalar geographies.

Many qualitative researchers (Eilstrup-Sangiovanni and Jones 2008) persist in posing the market/hierarchy dichotomy as a *network*/hierarchy dichotomy. This is false, and rests on an incomplete understanding of dynamics. Networks can be hierarchical (a star network consists of a single central actor who is connected to all other actors, none of whom are connected to each other), and they can be densely connected with all actors connected to all actors. Most are somewhere in between. Both markets and hierarchies are networks; however, the difference is that markets are based on transitory interactions while hierarchies are based on stable patterns of interaction.

This is not to say that network analysis cannot be used to answer the big questions in the field as they are currently framed. Many researchers have used regression analysis on network properties to test hypotheses about conflict: Maoz et al (2006) used network analysis to test the democratic peace hypothesis, empirically testing realist and liberal hypotheses on conflict using

affinity to test realist and liberal institutionalist hypotheses, and whether and why intransitive relationships among states exist (Maoz et al 2007). Their method and findings were broadly replicated by Kim and Barnett's test of interstate conflict (2007). Hafner-Burton and Montgomery tested conflict using IGO membership, finding that IGOs do influence states, but more through the network they create than through the simple fact of membership—they produce asymmetry (and therefore inequality, sometimes radical) among states, which can either provide incentive to keep the peace or provide motives to go to war.

Even more peripheral questions have been answered using the pattern of network analysis coupled with regression analysis. Chen and Barnett (2000) empirically tested Wallerstein's world systems theory using relational patterns and found evidence that it is dynamic. Choi et al (2006) also used network analysis to test world systems theory, finding evidence that it exists for both people and information.

An important test of network analysis is if it is both reliable and valid. A method is reliable if it is replicable by other researchers; it is valid if it measures what it is supposed to be measuring. Previous researchers have been careful to make sure that their studies were reliable several ways: through the use of coding teams (Carpenter 2007); through the use of well-known datasets such as the Correlates of War, regime data from Polity IV, and Militarized Interstate Disputes (Hafner-Burton and Montgomery 2006, Maoz et al 2006, Maoz et al 2007, Kim and Barnett 2007, Dorussen and Ward 2008); or through the use of public data such as trade, and passively collected "sensor" data (Chen and Barnett 2000, Choi et al 2006, Kinsella 2006, Maoz et al 2006, Kim and Barnett 2007, Bach and Newman 2010). Because network analysis is relatively new to the field of international relations, issues of validity have not been explored in-depth. For example, the use of Issuecrawler (Carpenter 2007) to find links between webpages is

not necessarily evidence of either interaction or of agreement. Furthermore, the focus has remained on examining specific types of actor, not on examining specific types of relationship, ignoring the fact that many different types of actor can exhibit agency in global politics. This means that the conclusions drawn from studies of states, or of activist networks or whatever, may have been generalized to an unacceptably wide degree—as if what holds true for states holds true for all other actors.

Network analysis can offer a way to reframe the "levels of analysis" problem that Singer describes in "The Level-of-Analysis Problem in International Relations" (1961). Because the analysis of a network can be framed to focus on the relationship, rather than on the type of actor involved, it does not depend on *a priori* definitions of actors. In other words, for the division between "foreign policy" as the choices of a state in response to a particular historical context and "international relations" as the actions of the community of states on behalf of a shared goal, we can substitute the options available to an actor under a particular set of circumstances and the activity of a collective to effectively frame a problem, establish a policy and enforce it.

Finally, network analysis can be used to predict behavior. Goddard (2009) finds the inability of network analysis to identify actors who will become norm entrepreneurs *ex ante* to be a disqualifier for the method to be used as a way to predict behavior. However, this is applying too stringent a standard. Network analysis can identify those who occupy brokerage positions, but not those who take advantage of position to become entrepreneurs. This is not abandoning prediction, so much as being aware of epistemology—individual actor propensities are not the province of network analysis. Furthermore, being able to say X is more likely than Y *is* in fact a prediction, it is just couched in the language of probabilities (as are most of the physical sciences), rather than that of certainty. For example, one of the network strategies available to

North Korea was to cut all ties to enforcement by exiting the network of the nuclear Non-Proliferation Treaty (NPT), which it did in January 2003 (Friedman 2003). Because predictions from network analysis are being made from quantitative models, they should offer a greater degree of precision in communicating those probabilities to both experts and the public at large. Very basic models of social networks have already been constructed that predict splits into bipolar factions or conversely, transitions from polarization to harmony (Marvel et al 2011).

CONCLUSION

"Global governance" is the latest iteration of system-level theorizing in international relations, and it contains the element of complexity. By marrying the concept of global governance to the methodology of network analysis, we gain new insights into that complexity, without sacrificing the quality of abstraction that allows comparison among disparate cases.

Network analysis is an underutilized method for exploring the social structures that result from global interactions. Because it makes possible the measurement of interactions, rather than of actor attributes, it is an ideal method for studying politics. Furthermore, it makes it possible to study different types of actors (states, IGOs, etc.) on an equal footing, without privileging one type *a priori*, by focusing on the relationship between the actors—an important feature of a methodology to be used on twenty-first century global politics.

Finally, network analysis can make sense of the sheer numbers of actors in global politics (Lazer et al 2009). This is not really an issue in either realism or liberal institutionalism, because the number of states and relevant intergovernmental organizations can be easily imagined and held in the mind. However, the proliferation of actor types (Rosenau 1990, 1997), as well as of actors (Mathews 1997), also calls for new methodologies.

CHAPTER THREE

METHODOLOGY AND RESEARCH DESIGN

We can have great control over the design of our research, but what we find in the course of that research may still surprise us. In network analysis the importance may be in the lack of links between and among particular actors—brokers, bridges, and holes are as important in network analysis as the presence of ties (Burt 1995). Research design is generally the province of what Thomas Kuhn referred to as "normal science": formulating testable hypotheses based on well-known models of how the world works (Kuhn 1970). While the accumulation of unexplainable anomalies can force a revolution in paradigms, one can also come about as the result of using different tools to examine phenomena. Using a methodology such as network analysis that is relatively unknown to the American field of International relations should therefore yield new insights into global politics.

The case studies will offer a mix of narrative and observational data. This is important, as I wish to avoid the appearance of cherry-picking data based on the method used. If the narrative and observational data are severely out of sync, it will be an indication that the methodology is inappropriate and must be either refined or abandoned.

TRADITIONAL AND HUMAN SECURITY NETWORKS

Traditional security is a hegemonic idea that engendered human security, a counterhegemonic idea, as established and elaborated in chapter one. They have thus engendered different but related historic blocs. The historic bloc of all the actors (particularly states and their alliances) that was associated with traditional security operated in clear hegemony up to and during the Cold War, while the bloc of actors that questioned the definition of traditional security and became associated with human security is still evolving in response to

the traditional security bloc. International peace and security—whether the more expansive human security variety of protection against threats to individuals, or the more traditional "bombs and bullets" one of protection for national boundaries and institutions—has been viewed as the exclusive preserve of states (MacFarlane and Khong 2006). Protecting public health normally also is viewed as a state responsibility, and measures taken against the spread of disease have been among the most draconian (Kraut 1994). The state has also been responsible for infrastructure and its failure—which is why the Netherlands invested billions to hold back the North Sea and why the breach of levees in New Orleans (as well as the ineffectualness of the overall response) was viewed as a government failure.

Dangers resulting from public health and infrastructure failure thus are viewed as threats to human security as well as to traditional sovereignty, when they lessen or destroy the legitimacy of government making them vulnerable to revolution from within or capture from without. This makes them ripe for consideration under a global governance lens; examining the cooperative problem-solving arrangements of multiple types of actors at the global level. The effort to prevent nuclear weapons proliferation since the end of the Cold War demonstrates global action to meet a security threat that penetrates national borders. The Indian Ocean tsunami of 26 December 2004 demonstrates global action to meet a security threat that transcended national borders. Analyzing them illustrates better the strengths and weaknesses of global governance—in theory and in practice—than pointing to the obvious lack of adequate political will or international military force to intervene in places like Darfur. Lack of cooperation is not a case that requires analysis with network methods that are suited to complex systems as it can be readily analyzed by existing methods.

The response to the proliferation of nuclear weapons illustrates the problems that traditional security frame, state-driven global problem-solving mechanisms have in confronting issues that globalization has made more diffuse. Thanks to the contemporary iteration of the globalization of trade, more actors have access to the materials, technology, and expertise required to make, buy or take nuclear and/or radioactive weapons than ever before. However, the state-based networks are reluctant to include other types of actors at all, let alone allow them to take leadership positions in developing and enforcing policy.

States in the nonproliferation network, by attempting to hold onto their *de jure* authority, may be denying the network as a whole the flexibility and transparency it needs to counter proliferation. The need to protect state secrets makes it very difficult to match the fluidity of proliferation networks: "The relationships between the DPRK [North Korean] and Khan networks show the shifting roles that ring members may play, with the DPRK acting on different occasions as a buyer, seller, and supplier to mutual partners" (Braun and Chyba 2004). Stopping or at least controlling proliferation is important; as Sagan explained, more nuclear states will be worse for the world. Novice nuclear states lack either adequate military or civilian political organizational controls, and therefore have a higher risk of either deliberate or accidental nuclear war. Deterrence strategy took the U.S. and U.S.S.R. years to work out; many new nuclear states seem completely unaware of the depth of thinking necessary. Furthermore, deterrence may not work, because novice nuclear states' capability may not survive to make a second-strike (Sagan and Waltz 2003).

The response to the Indian Ocean tsunami provides a microcosm of global governance and how a global problem is addressed in a decentralized world. The responses by a constellation of relief organizations, national governments, militaries, and private individuals

around the world illustrate the strengths and weaknesses of global governance. An overall response network (states, IGOs, and NGOs) was in place, but the creation of the tailored network for the tsunami required negotiating a structure among existing groups as well as procedures to incorporate others that joined later.

The provision of emergency supplies to affected populations was available almost immediately, reflecting a long-standing moral commitment to react quickly and generously in the face of natural disasters. As people in the affected regions began calling, texting, and uploading images and movies, massive relief began. In a natural disaster, the acceptance of outside humanitarian action was virtually automatic, which is not the case in wars because aid can be seen to be benefiting the enemy rather than the common good. As a codified modern international institutionalized response, humanitarianism can be traced back to the Battle of Solferino (1859), when Henri Dunant's actions led to the formation of the International Committee of the Red Cross, to his lobbying for Napoleon III to proclaim the rights of the wounded, and to the 1864 Geneva Convention. Norm evolution since then has both sought to constrain state actions and enable international succor for natural and many human-made disasters (Weiss and Collins 2000). In the case of the tsunami, we have seen that "competitive compassion" resulted in what many even saw as excess resources for the tsunami victims.

In a human security frame, the network is more likely to be self-organized; meaning the criteria for inclusion was not pre-set: the number of actors, as well as the type of actor involved could be increased, allowing for an openness and transparency that could be met by communication among the actors. In contrast, the organization of the actors in the networks that prevent nuclear proliferation is for the most part, not self-organized, which has implications for its effectiveness. This in turn allows accountability: progress, or lack thereof, could be openly

tracked through the media as in the case of the Indian Ocean tsunami (Telford and Cosgrave 2006), or through nongovernmental organizations such as the World Nuclear Association. A network that is more formally organized, by treaties and executive agreements, may be more stable and permanent, but it is likely to be less open, and more rigid in responding to new attempts at proliferation. By choosing the tsunami and nonproliferation cases, I hope to test the plausibility of the causal mechanism I have hypothesized that the frame influences the network's structure. These two cases map onto the opposite extremes of object, source, and speed in Figure 1 in chapter 1, while they more or less match in severity.

SOCIAL NETWORK ANALYSIS METHODOLOGY

In order to model global networks, mathematical tools are necessary. SNA or network analysis is the best method for exploring the social structures that result from global interactions because it makes possible the measurement of interactions, rather than of actor attributes. Network theory is an ontological question; network analysis is an epistemological stance. The social network analysis perspective includes the following aspects: actors and their ties are interdependent rather than independent, autonomous units; ties between actors are channels for the flow of information and resources; network ties both enable and constrain actions; and structure is viewed as enduring patterns of relations among actors (Wasserman and Faust 1994). The most important aspects of the social network paradigm are that it is concerned with structure, which is relational; it is based on empirical evidence; it is graph theoretical, which is visual; and it embodies a formal, statistical model.

SNA allows analysis of both the big picture, as well as local conditions. Techniques such as blockmodeling in particular can map the way different actors may play structurally similar roles in networks (White, et al. 1976, Luczkovich, et al. 2003). SNA also allows the

tracking of multiple relationships between different types of actors and between different levels of analysis, without losing coherence. By making the interrelationships explicit and visible, lack of connection as well as duplication of effort can be seen with greater precision, thus allowing decision-makers to concentrate their efforts. A social network analysis may reveal properties of networks that are not visible through other methodologies, such as the cutpoint—a node that connects components of a graph—the key actor that connects other actors. Knowing the structure (which both enables and constrains action) allows actors more freedom of agency: knowing *where* to influence is vitally important to being able to exercise influence at all. Furthermore, social network analysis methods allow a range of comparison studies, such as comparing similar ties in different networks, different ties among the same actors, and the dynamic mapping of networks over time.

However, network analysis is not suitable for examining the form and content of the tie itself, which is determined *a priori* by the researcher (Knoke and Yang 2008). Network analysis allows for shadings of meaning of the tie: it can be dichotomous, directed, and/or weighted, but one of the assumptions underlying all of political science (indeed, probably all of the social sciences) is that all relationships are intersubjective and negotiated (Dessler 1989). But the form or mode of interaction is selected by the researcher before beginning to generate data. Examining in depth any single tie between two actors, whether membership in a treaty organization or a business contract would require exploring the content, or interests and motivations of the actors involved, the resources and attributes they possess (aside from their network positions), and the give-and-take of the compromises made or rejected in the course of their negotiations. Such detailed nuance is beyond network analysis, which is why the method

should be supplemented with others, such as qualitative methods that explain the history narratively.

Network analysis is also not suitable for studying actors in isolation. A particular actor's psychology or culture, aside from its position in society (Moreno and Jennings 1934, Durkheim 1951) is by definition an attribute of the actors in network analysis, and not of the relationship that actor may or may not have with others. In global politics as it is mapped in this exercise, internal deliberations of actors are assigned by the researcher on the basis of evidence other than the network ties, whether collective entities such as states (with the example being domestic politics) or natural individuals (for example, interior monologues). In addition, the sampling unit of a network analysis must be specified ahead of data generation by the researcher (Knoke and Yang 2008). There must be strong theoretical reasons for choosing the actors to be included in the analysis.

Finally, the level of data analysis must also be specified ahead of data generation (Knoke and Yang 2008). This does not refer to the level of analysis in the content being studied, such as foreign policy of a single state vs. international politics among states, but to the level of network being examined: ego networks (consisting of a single actor and its immediate relationships), dyads, triads, and complete networks. Not only are different measures used at the different levels, but the levels correspond directly to the questions asked. For example, this study looks at complete networks in order to find relative positions of actors vis-a-vis all the other actors in the network. Emergent properties, such as transitivity (the likelihood that friends of friends will be friends in triads), cannot be discovered in either ego networks or dyads.

"Heteropolarity," or actors who differ in both power and kind connected in networks instead of through states (Der Derian 2004, 2009), is seen in global nuclear networks.

Globalization has made the process of connecting to form networks easier and speedier than it was previously, and it has introduced new actors to global security: it is no longer a question only of rogue states gaining access to these weapons through espionage or the weakness of state supervision and management; but also criminal groups and terrorists gaining access (Russell 2008). The organization of these different types of actors in the nonproliferation network is for the most part, not self-organized but driven by states, which has implications for its effectiveness.

If human security networks are relatively self-organized, flexible, and transparent, traditional security networks are less inclusive, less permissive of deviation from norms, and more permanent. The former allows a kind of accountability: progress, or lack thereof, could be openly tracked through the media as in the case of the Indian Ocean tsunami of December 2004 (Telford and Cosgrave 2006), or through nongovernmental organizations such as the World Nuclear Association. However, the latter offers stability, and thus predictability, as well as increased ability to enforce network norms (not least because exit from the network can be as difficult as entry).

Because there is such heteropolarity in actors, these networks are better studied by looking first at the relationships among actors. An ecosystem is "the community, including all the component organisms together with the abiotic environment, forming an interacting system" (Hanson 1962). By focusing on the type of tie, rather than the type of actor, one can get a more complete picture of the ecosystem. This is analogical to ecological studies that, for example, study trophic roles (feeder/food relationships) and positions in food webs. Rather than simply studying one species at a time, ecology studies holistic systems (Luczkovich et al 2003, Ostrom

2007). Mapping these relationships among actors is best done with the methods of social network analysis.

Networks are complex systems—a type of relationship among multiple actors. They are composed of actors who have agency: the ability to act and react. Depending on the framing of the issue area (peace and security, human rights, international trade, economic development, and environment are all examples of issue areas in world politics), network actors include states, sub-state governmental units (such as a ministry or provincial government), IGOs, NGOs, TNCs, social movements, and individuals. Complex systems are also subject to interaction effects. In systems that are tightly coupled, processes happen very fast, they cannot be turned off, and the failed parts cannot be isolated from other parts, making recovery from initial disturbance impossible—it spreads quickly and irretrievably. This is called a "normal accident," meaning that the system will inevitably produce such accidents. The opposite is a loosely coupled system, in which elements are involved in the same production sequence, but one does not cause the other (Perrow 1985). Such a system is robust. If networks are tightly coupled, they will exhibit dense, strong links among actors. For example, interactive complexity and tight coupling in nuclear weapons leads to "normal accidents," a situation that will be made worse by small, weak and unstable states (Sagan and Waltz 1995).

"Network" refers to both interorganizational structure and function. The relationship between actors may be financial, legal, social, or whatever.[13] (The actor need not be aware of a particular relationship for the link to exist.) The number of actors varies, but cannot be infinite:

[13] To cite but a few different types of relation: using information on choices for collaboration among scientists (Crane 1969), the people a patient called on for advice during an illness (Pescosolido 1991), the meetings jointly attended (Freeman 1992), the sequential emergence of marriage, economic, and patronage ties (Padgett and Ansell 1993), or the headquarters and branch locations of the Global 500 TNCs (Alderson and Beckfield 2004).

there is a practical limit to how many discrete actors can interact without some form of aggregation.

Network analysis may reveal properties of networks that are not visible through other methodologies, such as gaps and overlaps. Without forgetting that each individual relation is a demonstration of agency on the part of the actors in the dyad, a network map as a whole can be "the starting point from which strategic planning for social transformation has to begin" (Cox 1999). Knowing the structure of the prevailing social forces (which both enable and constrain action) allows actors more freedom of agency: knowing *where* to influence is vitally important to being able to exercise influence at all. Furthermore, social network analysis methods allow the dynamic mapping of networks over time.

For example, in his seminal work "The Strength of Weak Ties," Mark Granovetter illustrated the utility of indirect relationships over close friendships for the flow of help wanted information to job seekers: close friends had access to the same information, which made them less useful in a job search than mere acquaintances, who moved in different social circles and thus had access to different information (Granovetter 1973). Similarly, influence and direction from policy makers can significantly affect mobilization in the American electorate (Rosenstone and Hanson 1993), as people often participate in the political process based on the constraints and incentives encountered.

Different Types of Power Relations

In order to use SNA, there must be evidence of specific interactions and relations among actors. There are different methods of comparing networks: a relation measured over the same set of actors, a relation measured over the same set of actors over time, a relation measured on different sets of actors, a similar relation measured in different settings over different sets of

actors, and over different relations among different sets of actors (Faust and Skvoretz 2002). Because the purpose of this study is to test the hypotheses of different schools of thought in the field of international relations, it will use the third method, comparing the same relation over different sets of actors by mapping the different types of power being used in transnational interactions. This will allow the weighing of these different types comparably across multiple situations—a normalization of power terms, if you will. In the following section, the two power relations measured in this study, institutional and compulsory, are explained.

Network terms can be translated into international relations via the measures of power in global governance described by Michael Barnett and Raymond Duvall. They divide types of power into a matrix with two core dimensions: the kinds of social relations through which power works, and the specificity of the social relations through which power's effects are produced (Barnett and Duvall 2005).

The first kind of power, familiar to realists, is compulsory power that represents direct control of one actor over another. This can be measured in network terms in many ways: as a regulatory relationship with one party making and enforcing rules, as a contractual relationship with an exchange of goods or services for payment, or a conflictual relationship with one party using violence against another. Institutional power is more diffuse because actors exert control over others that are socially distant. Membership in an alliance, attendance at U.N. conferences and other types of affiliations are network relations that measure this type of power. Structural power represents the capacities of actors—in other words, what their capacity is depends on where they are in the network. Finally, productive power is the production of subjects through the diffuse social relations of discursive practices. To paraphrase, an actor's "self" is a creation of discourse, or negotiation with and against multiple others. This can be measured

longitudinally by process tracing that links diffusion of norms and ideas to actor constitution—that is, it is helpful to track the progress of an idea through the network, and then look for evidence that the actors' identities have changed as a result.

Networks could thus be demonstrated by treaties, executive agreements, and interorganization agreements, etc., to share resources and information. They could also be demonstrated by presence at decision-making meetings, and influential publications. The evidence of relationships can be quantified and directed. For example, in the case of contractors: the amount of the contract is interval data, and it flows from a source to a recipient (not the other way around). Such information is available in contemporary media reports. This dissertation maps two types of power relations, in hopes of discovering interesting information about the structural power relationship.

Each treaty accession, contract, and agreement is generally a painstakingly negotiated political activity; however, the goal here is not to look at the negotiations themselves but at the structure or international environment that together they create. Relations must be carefully chosen; not all relationships are equally meaningful and meaning depends on context. For this study, I will be using the following sources of network information: the non-proliferation treaties and international agreements, and contracts among nuclear energy suppliers. The first is an example of institutional power through the sharing of information, while the second is an instance of the compulsory power of financial contracts.

Network Theory

Network analysis is a fitting method for exploring the social structures that result from global interactions because it makes possible the measurement of interactions, rather than of actor attributes. This calls for quantifying relationships as much as possible. The form of the

network depends on both the method of joining (link to a hegemon or try to create a new alliance, for example) and on the nature of the link established (providing or receiving financial aid or security, for example). Therefore, I will be looking for evidence of network structures. This project is not primarily concerned with the process of framing; of how the situational framework is negotiated. It is primarily concerned with the structures that result from such framing, and will treat the frame as an independent variable.

Network theory is an ontological question, meaning it assumes there are relationships among actors; network analysis is an epistemological stance, meaning it is concerned with measuring the assumed relationship.

For example, John Braithwaite and Peter Drahos in *Global Business Regulation* (2000) examine the networks of webs of influence involved in global business regulation. They compare thirteen case studies of different industries. One of their most interesting conclusions is that the denser the network, the more effective that it is at securing compliance. Unfortunately, they do not use the graphical presentation techniques of social network analysis, and their analysis takes over seven hundred pages.

Furthermore, using the language and methods of network analysis allows the research to converse with other disciplines that deal with networks of interactions such as mathematics, physics, and biology. For example, it may be possible to re-create missing data about relationships in a network through Bayesian analysis. Recent research in biology used Bayesian network analysis to predict the number and location of links in a cellular network, which was then tested against what is known about that network from independent research. The study found that their network analysis was highly successful in predicting links from limited amounts of information (Sachs, et al 2005).

Networks could be produced by treaties, executive agreements, interorganization agreements, etc., to share resources and information. They could also be demonstrated by presence at decision-making meetings, and influential publications. Such information is available in the ReliefWeb archives, the IAEA and elsewhere in the U.N., the World Bank, from country databases and situational reports, from the national nuclear lab system, and in contemporary media reports.

Case Studies on Different Types of Security Networks

What does the network in each case study look like? To what extent do actors insist on doing their own thing (acting as isolates) without coordinating with others? Does this result in needs being met efficiently, or was there a lot of redundancy in some places and needs unmet in others? Do governments actually occupy similar structural positions in the network according to the theory (are they all nested within and relating to other actors in the same way), or do they play different roles (such as some are senders of aid and some were receivers)? Do other actors also play this nested role? If so, which ones? Are there unanticipated interaction effects, as one would expect in a complex system?

There are tradeoffs to using case studies to explore the effects of situational framing on security network creation. The advantages of structuring the project to ask general questions of certain aspects of cases include being able to provide knowledge that can be generalized and used to build theory (George and Bennett 2005). In focusing the project this way, however, both the richness of historical detail found in single case studies, and the certainty of large-n studies are pushed into projects for the future.

Evidence of framing was taken from media reports, speeches, and similar documents in major world media outlets on the web and in print. Sources will include web sites such as the

BBC News and the *Christian Science Monitor*, and major newspapers such as the *Times of India* and the *New York Times*. These sources will be scanned for indications of how different actors viewed the context, and how pervasive that view came to be. The narrative generated by the framing will thus serve as a check on the data generated by the relationship mapping. This narrative will have a bias toward the newsworthy,[14] which should be offset by the bias in the network relationship data sources.

Network Analysis

Network analysis also allows exploration of both the big picture, as well as local conditions. "Zoom in" features can be made apparent through the technique of blockmodeling, which groups actors into structurally similar roles, based on their patterns of links to other actors. Blockmodeling can map the way structurally similar roles in different networks relate to other roles (White, et al 1976). I may find that structurally similar positions are held by actors that were previously defined as being of different types.

Network analysis is therefore an excellent method to use because it allows the tracking of multiple relationships among different types of actor and between different levels of (subject content) analysis, without losing coherence. By making the interrelationships explicit and visible, lack of connection as well as duplication of effort can be seen with greater precision, thus allowing decision-makers to concentrate their efforts. A network analysis may reveal properties of networks that are not visible through other methodologies, such as the cutpoint (a node that connects components of a graph), the key actor that connects other actors. Knowing the

[14] Or whatever each disparate source deems worth covering—the difference in their motivations should be offset by each other: the *BBC* is a state-provided news source, the *Times of India* has a business orientation; the *New York Times* has a more breaking-news (and American) orientation than the *Christian Science Monitor*, which tends more to analysis.

structure (which both enables and constrains action) allows actors more freedom of agency: knowing where to influence is vitally important to being able to exercise influence at all.

Because network analysis depends largely on quantifying relationships, special effort will have to be made to supply the context in which the network is situated. Explanation of context and discovery of nuance is not part of network analysis *per se* and thus a comprehensive study requires triangulation with other methods. Cooperation does not happen in a vacuum, therefore historical background and circumstances are important and must be described. The qualitative aspect to this project will be researched through existing literature on humanitarian disaster response, nuclear proliferation, emerging infectious diseases, and on the geographic areas in question. The 2008 global financial crisis will be a useful test case, as it involves an issue area that has been the responsibility of governments in the past, is potentially deadly[15] to many people, could strike quickly, and would be the result of human agency—financial transactions.

SOURCES OF RELATIONSHIP INDICATORS

I will be looking at what the networks do in coordinating to accomplish something. The product of cooperation will vary according to the cases: in the tsunami case, the product will be the provision of humanitarian aid in an area; while in the nonproliferation case the product will be the interdiction of nuclear materials.

Information on nuclear nonproliferation network membership can begin with membership data from treaties such as the Non-Proliferation Treaty (NPT) and The Comprehensive Test Ban Treaty (CTBT), and other state actors such as the Nuclear Suppliers Group. There are also national programs such as the U.S. Nuclear Data Program. However, there are also businesses that construct, operate, and decommission nuclear power plants. These businesses' contract relationships with each other and with states will be constructed from

[15] Lack of money can be deadly in a society that requires payment in cash for food, housing, and medial care.

publicly-available information. Evidence of their relationship with each other and with states would include attempts at regulation, including self-regulation through industry associations.

For the tsunami case, I will look for evidence of shared information through jointly attended meetings, and of material resource flows. Presence at a meeting will be read as an indicator of shared information, and depending on specific context available in the reports, could serve as a directed indication of information flow. The online archives of ReliefWeb, which contains reports from academic institutions, governments, NGOs, the United Nations system and other intergovernmental organizations, the news media, and starts with the preliminary earthquake report from the U.S. Geological Survey. Of particular interest will be the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Situation Reports, which detail the activities and meetings of relief workers from different institutions. The U.N. Office of the Special Envoy for Tsunami Recovery provides fairly detailed information regarding transnational financial transfers to and from different types of institutions. The funds for tsunami recovery are being tracked in the Development Assistance Databases, and their data can be checked against information gathered by other United Nations agencies and the World Bank. Financial flows will be read as an indicator of a directed relationship.

For both case studies, effort was taken to derive all measures of relations from free and publicly available data sources. Not only is this important in terms of replication of results, but it demonstrates the possibility of doing global political research through data available to the general public rather than access either to elites or to classified information. If "global governance" is to have a normative component, it cannot rely solely on information that is tightly controlled, but must be democratically available if not also democratically produced.

Relations Measured for the Nuclear Nonproliferation Network

The Institutional Power Relation

For this investigation, I will be using treaty and agreement ties among states where the primary purpose of the agreement is the nonproliferation of nuclear weapons. A selection of organizations and treaties has been made in the interests of probing the plausibility of the argument for using network analysis to study global politics. The inventory provided by the United Nations, available at http://disarmament2.un.org/TreatyStatus.nsf will be considered the authoritative source for agreements among states, with background information from the Center for Nonproliferation Studies at the Monterey Institute for International Studies. This data is publicly available and free of cost, which is important both in terms of allowing other researchers to replicate results, but also as a means of demonstrating a source of network data on the subjects of other treaties and agreements. I recorded these interactions as undirected ties, because they did not have a beginning and end. They indicate the sharing of information and cooperation to coordinate activities. Furthermore, these ties were recorded as dichotomous, and not weighted in any way—either two actors cooperated by participating in the same organization, or they did not. These treaties and agreements are detailed in Table 1.

Table 1: Selected Treaties and International Agreements Concerning Nuclear Nonproliferation

Name	Organization Type	Purpose
Agency for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (OPANAL)	Regional international organization	To encourage the peaceful uses of atomic energy and prohibit nuclear weapons in South America
Antarctic Treaty	Regional regime	To encourage the peaceful uses of atomic energy and prohibit nuclear weapons on the continent of Antarctica
Comprehensive Test Ban Treaty (not yet in force)	Multilateral treaty	To prohibit nuclear (weapon) test explosions
Group of 6 (G-6)	International organization	To achieve nuclear disarmament
International Atomic Energy Agency (IAEA)	International organization	To promote peaceful uses of atomic energy
Nuclear Suppliers Group (NSG)	Nonproliferation export control regime	To establish guidelines for exports of nuclear materials, processing equipment for uranium enrichment, and technical information to countries of proliferation concern and regions of conflict and instability
Treaty of Bangkok	Regional treaty (nuclear-weapon-free-zone)	To encourage the peaceful uses of atomic energy and prohibit nuclear weapons in Southeast Asia
Treaty of Pelindaba (not yet in force)	Regional treaty (nuclear-weapon-free-zone)	To encourage the peaceful uses of atomic energy and prohibit nuclear weapons in Africa
Treaty of Rarotonga	Regional treaty (nuclear-weapon-free-zone)	To encourage the peaceful uses of atomic energy and prohibit nuclear weapons in the South Pacific
Nonproliferation of Nuclear Weapons Treaty (NPT)	Multilateral treaty	To encourage the peaceful uses of atomic energy and prohibit the spread of nuclear weapons globally

Zangger Committee (ZC)	Nonproliferation export control regime	To establish guidelines for the export control provisions of the Nonproliferation of Nuclear Weapons Treaty (NPT)
Proliferation Security Initiative	International Agreements	To interdict trafficking of weapons of mass destruction (WMD), their delivery systems, and related materials

The resulting network is a snapshot of all the treaties and agreements that are in force at this time. Since treaties are so difficult to negotiate, states rarely disengage from treaties, so in a very important sense, this network is also cumulative. The information on membership per treaty or organization was put into a two-mode state-by-treaty matrix, with a dichotomous tie/no tie relationship recorded. This network was then transformed into an affiliational state-by-state matrix (meaning that if states were participants in the same treaty, they were recorded as having a tie to each other). The data are available in Appendix B.

The Compulsory Power Relation

An organization that has control over material resources such as nuclear plant, materials and expertise is influenced by an organization that is requesting the use or ownership of the resources. Perhaps even more important to international life than *pacta sunt servanda* ("treaties must be obeyed") is the principle that contracts must be enforced. After all, there are far more contracts negotiated, signed, and enforced than treaties. The tacit knowledge gained from civilian nuclear activities (Montgomery 2005) may encourage the proliferation of nuclear weapons to states (Fuhrmann 2009), and may also enable the acquisition of WMD by terror groups.

For the purpose of this investigation, it was also important to count only signed contracts, and not pledges or agreements on future cooperation. However, the data sources for contracts are less comprehensive; as a starting point, I have used information culled from the Business

Source Premier database maintained by EBSCO Publishing, a division of EBSCO Industries, Inc. This data source, while not free, is available through most public and college libraries in the United States, making it possible for other researchers to replicate and verify. The search terms were "nuclear power" and "contracts" and the search was limited by time period (between 1989 and 2009), and by the availability of full-text articles. The following types of contracts were recorded as ties: construction, supply, reprocessing, enrichment, decommissioning, decontamination, operation (including software), and transportation of spent fuel or waste.

Actors were coded as their contemporary names. Due to the high rates of "birth" or foundation, "death" or dissolution, and merging, a table explaining the "genealogy" of selected companies is located in Appendix C, along with the data for this relation.

Relations Measured for the Indian Ocean Tsunami Response Network

For this case study, I will be using the following sources of network information: the spreadsheets compiled by the Financial Tracking Service (FTS), the global online humanitarian aid database; and the situation reports filed by the U.N.'s Office for the Coordination of Humanitarian Affairs (OCHA). The first is an instance of the compulsory power of financial contracts, while the second is an example of institutional power through the sharing of information. More information on the coding decisions is available in the appendices for each relation.

The Compulsory Power Relation

The Financial Tracking Service (FTS) is a global, real-time database which records all reported international humanitarian aid (including that for NGOs and the Red Cross/Red Crescent Movement, bilateral aid, in-kind aid, and private donations). FTS features a special focus on consolidated and flash appeals, because they cover the major humanitarian crises and

because their funding requirements are well defined—which allows FTS to indicate to what extent populations in crisis receive humanitarian aid in proportion to needs. FTS is managed by OCHA. All FTS data are provided by donors or recipient organizations. Having control over material resources such as money and in-kind aid gives an organization influence over an organization that is requesting the use of the resources—in other words, it gives them a say in how the money is spent. For this purpose, it was also important to count only commitments and contributions, and not pledges.

The raw data for the compulsory power relation is OCHA's "Table A: List of all humanitarian pledges, commitments & contributions in 2005," compilation as of 11 July 2006, showing donors, channels through which aid flowed, final destination of aid, description of project, and value in dollars. Humanitarian aid is defined as "an intervention to help people who are victims of a natural disaster or conflict meet their basic needs and rights" (http://fts.unocha.org). Because FTS is mandated to track all humanitarian aid, it was necessary for FTS' stakeholders to develop a definition of humanitarian aid for statistical purposes, which serves as the criterion for posting funding information on FTS. This is free and publicly available on the Internet data, which makes it possible for others to research and replicate results.

Again, it is important to note that these data were crowd-sourced, compiled by OCHA through organization self-reporting; while the information in OCHA Table A can be considered complete for the purposes of analyzing global networks of aid flows, using formal analysis techniques, there is no way to completely capture all of the humanitarian aid that was given in response to the tsunami, much of which was given by individuals in the region and never recorded. Furthermore, some recorders chose not to follow the database's standards. China, in

particular, failed to record a monetary value for many of its contributions, thus resulting in an undercount.

I had to make changes to OCHA Table A: the uncommitted pledges column was deleted; as were in-kind donations without dollar values; all descriptive information except destination was deleted (if destination was not given, the entry was added to the "Region" category); an "allocation of unearmarked funds" from an organization was listed as simply coming from that organization, and "bilateral" channels were listed as state-to-state.

I added two columns of attribute data to OCHA Table A: Type of Donor and Type of Channel, created with information from ReliefWeb. These columns listed the organization type as an attribute: international organization (IGO), nongovernmental organization (NGO), etc. The following attribute coding decisions were made: the International Federation of Red Cross/Red Crescent Societies (IFRC) is listed as an "IGO" because ReliefWeb categorizes it as "U.N. & international organizations", and all EU agencies are listed as "state" for the same reason. Channels that were listed as multiple countries or vague descriptors such as "U.N. Agencies, NGOs and Red Cross" and any acronyms not found in ReliefWeb or through Google were coded as "Region" for having been spent there; and their organization type was coded as “unspecified.” Other organization types were NGO, state, and company. Finally, in order to create digraphs that showed large flows of resource (and were understandable), all records from private individuals were simply aggregated and coded as “private,” as the goal of this study is to map transactions that crossed international borders. What is of interest here is the attribute character of the donors, not their individual identity.

Again, the raw data were three-mode, with donor individuals and organizations listed separately from the organizations that served as aid channels and from the ultimate destination of

the aid. In order to make sense of the aid flow, donors, channels, and destinations were re-coded into two modes: sender or receiver of aid, in essence deleting the destination column, to create a dyadic two-mode network, but without double-counting the channels. This is unfortunate, because both the lost information and a visual representation of the destination data would have been useful theoretically. This network was then transformed into a directed bipartite graph using iterative metric multidimensional scaling based on similarities. The data are available in Appendix D.

The Institutional Power Relation

The OCHA situation reports record the activities of the OCHA staff, the U.N. system, and their interactions with states, IGOs, and other civil society actors. This data source is also free and publicly available on the Internet. These interactions were recorded as undirected ties, because they did not have a beginning and end. They indicate the sharing of information and cooperation to coordinate activities that did not have the element of coercion—actors were free to do as they wished if they disagreed with the group. Furthermore, these ties were recorded as dichotomous, and not weighted in any way—either two actors cooperated, or they did not. It was assumed that if actors were recorded by OCHA in the same passage (usually a paragraph, but sometimes a table), then it was because they were working on the same project and were aware of each other's efforts.

Information for this relation was taken from the thirty-eight OCHA Situation Reports written between 26 December 2004 and 29 April 2005. Coding decisions were based on mining paragraphs for relationships. For example, see this passage from Situation Report 25, dated 8 Feb 2005:

> Planning and/or construction of temporary and semi-permanent schools is underway. The identification of suitable sites for semi-permanent school shelters

> is causing problems in densely populated areas, such as Ampara. Proposals for temporary school buildings in Paddiruppu and Batticaloa education zones (Batticaloa district) have been approved and work will start immediately. A proposal from Kalkudah for construction of semi-permanent buildings is being considered. In Jaffna district, UNICEF has agreed to undertake the reconstruction of 2 schools; GTZ will be responsible for 6 schools and the Swiss Development Cooperation (SDC) will be responsible for 4 schools. UNICEF will support the construction of 46 temporary modular classrooms in Maruthankerny in Jaffna district. These will accommodate up to 1,500 children.

In this passage about school construction, the Sri Lankan local authorities, UNICEF, GTZ, and the Swiss Development Corporation have all worked together to provide school buildings while not duplicating each other's work.

Intra-state cooperation between the various ministries and agencies was not recorded. If a passage mentioned cooperation between the ministries and agencies of a state with another actor, it was recorded as a relationship between the state and that actor. The reasoning is that the purpose of this study is to examine transnational cooperation, not domestic institutional cooperation.[16] Any meetings that were mentioned in the situation reports were also recorded as relationships. For example, this includes the regional workshop on rehabilitation of fisheries and aquaculture in coastal communities of tsunami affected countries in Asia, held from 28 February to 1 March 2005, in Bangkok, Thailand. These meetings account for several large "clusters" in the network of well-connected actors. However, it should be noted that many meetings were not mentioned in these situation reports, and that of the meetings mentioned, lists of participants were not always available. Also, several times the working partners were not named individually.

[16] This is a large assumption, but it was necessary to make the task of coding manageable. An idea for future research would be to take the original source data and machine code it using network data mining software in order to unpack the within-state relations and measure them alongside the transnational ones.

Finally, a word or two about the U.N. system is in order: the various U.N. agencies, including OCHA, were recorded simply as U.N. This may have made the U.N. seem more central than it already was, given the authorship of the situation reports. However, the purpose of this study is to trace transnational cooperative interactions, not intra-organizational cooperation within the U.N. system.[17] The exceptions to this rule were the autonomous agencies affiliated with the U.N.: the World Bank group, the U.N. Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the International Labor Organization (ILO), and the Food and Agriculture Organization (FAO). These agencies have become part of the U.N. system, but most have separate origins, and may have staff and budgets that are not within the U.N. The data are available in Appendix E.

HYPOTHESES

The need for testable hypotheses allows me to highlight the contrast in the two cases, and the extent to which much of the story in human security frames is lost by simplifying the models of investigation too much, and relying too heavily on state-centric lenses. Two themes for the development of testable hypotheses are therefore hierarchy and nonobvious relationships.

Hierarchy can be defined in several different ways, and these differences can lead to confusion when reading works in international relations using network analyses. Realism would define hierarchy as having states as the most important actors, at the top of a pyramidal power structure, with all others below. Intergovernmental organizations are the creatures of states in realist thought, while all other actors are bound to domestic civil society, even if they are transnational. Liberal institutionalism allows intergovernmental organizations to possess agency,

[17] This decision was made purely for ease in interpreting results given the research puzzle, and does not refer to either the U.N. as an institutional framework for state action, or to the constellation of NGOs that are affiliated (for a discussion of these different "United Nations," see Weiss, Forsythe, Coate, and Pease 2009). A suggestion for further research would be to disaggregate the U.N. system and code all agencies separately, to establish intra-system patterns of cooperation.

and thus to occupy the apex along with states, while constructivism should not privilege any actor *a priori*. However, if hierarchy is defined as centrality, then actors would need to have both the highest centrality scores, and to have them when the spread of centrality scores is large, to be considered hierarchically important.

Nonobvious relationships, like Darwin's clover and cats, refer to indirect relationships that may be many times removed from direct interaction between and among actors. All schools allow for these linkages, but carry through the expectations of state behavior and hierarchy through to nonstate behavior, as seen in the hypotheses below. Patterns of behavior that create clusters of similar actors would therefore indicate the presence of nonobvious relationships.

The different schools of thought in American International Relations—realism, liberal institutionalism, and constructivism—thus generate the following hypotheses on hierarchy and nonobvious relationships that will be tested by the case studies.

Hierarchy

H3 (realist): States will occupy the highest hierarchical positions available to the centrality measure used, regardless of frame.

> H3a: States will occupy the highest hierarchical positions, followed by intergovernmental organizations, with the lowest hierarchical positions occupied by all other actors.

H4 (liberal institutionalist): States and intergovernmental organizations will occupy the highest hierarchical positions available according to the measure of centrality used in traditional security frames; position will vary in human security frames.

H5 (constructivist): Actors occupying the highest hierarchical positions available according to the measure used will vary, regardless of frame.

Nonobvious Relationships

H6 (realist): Direct relationships between and among states (state-to-state interactions) will account for any patterns such as alliances or coalitions found in relationships.

> H6a: All other actors will only have indirect relationships with each other, as they will only interact through the states to which they belong.

H7 (liberal institutionalist): Both states and intergovernmental organizations will have direct relationships among each other, accounting for any patterns.

> H7a: All other actors will only have indirect relationships with each other, as they will only interact through the states or IGOs to which they belong.

H8 (constructivist): Any actor may have a direct relationship with any other actor.

CHAPTER FOUR

THE NETWORK RESPONSE TO NUCLEAR PROLIFERATION

The quest for nuclear weapons requires sacrifices of a nation or other group—thus far, only states have acquired them, but there have been disturbing attempts by other actors to buy or steal them. The insidious spread of nuclear materials and expertise is a widely acknowledged threat to international peace and security. And the dangers are present even for actors with the resources of states who might want to jump-start national pride and economic development, but fail to adequately develop what the IAEA calls a "nuclear security culture" (IAEA 2008), that addresses safety and security habits such as accountability and transparency.

President Obama called for total nuclear disarmament in his April 2009 Prague speech; but many observers believe that proliferation is inevitable (Editors, *World Policy Journal* 2009). A key question for policy makers then is can proliferation be managed, as one would manage a deadly disease? To switch metaphors, a pessimist would agree with O'Neil (2005) and insist it is better to learn how to prune than to try to slash and burn one's way through the forest. To that end, studies such as Newnham (2004) suggest that intentionally manipulating ties bears fruit for states.

Before one can ask if proliferation can be managed, it is important to understand what is meant by "proliferation," and what actors are involved. Proliferation should be understood as encompassing the acquisition of fission bombs delivered by missiles, improvised nuclear devices (IND), and radiological devices or "dirty bombs," conventional explosives that spread radiological material on detonation (U.S. Nuclear Regulatory Commission 2007). Proliferation therefore includes not just states, which are to date the only entities capable of creating nuclear weapons, but also terror groups such as al-Qaeda. Building a bomb is well within the

capabilities of terrorist groups, whereas enrichment is not (Frank 1967). What they need is highly enriched uranium (HEU) from the fuel cycle, which is available from both research reactors and medical use isotopes (Kahn 2008, Hansell 2009).

As Hansell points out about nuclear treaties, "it is not clear how the international agreements interact, thus gaps or overlaps are possible. Further, not enough has been done to implement the agreements domestically" (Hansell 2009). This chapter therefore seeks to make the interrelationships explicit and visible, because lack of connection as well as duplication of effort can be seen with greater precision, thus allowing decision-makers to concentrate their efforts. It begins with a background of state proliferation around the world and an explanation of why it is frightening, and then explores the conditions that allowed nonstate actors to participate in both proliferation and prevention. Following that, there is a network analysis of two different types of relationships among the actors cooperating to prevent proliferation, finding that the institutional power relation conforms to realist expectations about networks as previously defined in the hypotheses, while the compulsory power relation is more in accord with constructivist expectations as previously defined in the hypotheses. It ends with a suggestion for a further research agenda.

A Brief History of Global Nuclear Proliferation

Nuclear proliferation is a "dread risk" (Perrow 1985) which is improbable but horrifying to contemplate, because it could lead to the use of nuclear weapons. This visceral fear is familiar to anyone who has heard of the effects of the bombs used on Hiroshima and Nagasaki. These effects were described by Richard Rhodes at the end of his history *The Making of the Atomic Bomb*, detailing the impact of "Little Boy" on Hiroshima following the flash of white light:

> People exposed to within half a mile of the Little Boy fireball, that is, were seared to bundles of smoking black char in a fraction of a second as their internal organs boiled

> away...A human being left the memorial of his outline in unspalled granite on the steps of a bank...Farther away, in the suburbs, the flash induced dark, sunburn-like pigmentation sharply shadowed deep in human skin, streaking the shape of an exposed nose or ear or hand raised in gesture onto the faces and bodies of startled citizens; the mask of Hiroshima...The blast wave, rocketing several hundred yards from the hypocenter at 2 miles per second and then slowing to the speed of sound, 1,100 feet per second, threw up a vast cloud of smoke and dust...The peeled skin that hung from the faces and bodies of these severely injured survivors was skin that the thermal flash had instantly blistered and the blast wave had torn loose...The thermal flash started fires and very quickly the fires became a firestorm from which those who could ambulate ran away and those who sustained fractures or were pinned under houses could not...Of 76,000 buildings in Hiroshima 70,000 were damaged or destroyed, 48,000 totally (Rhodes 1986: 714-728).

But the story does not end there. Not only was the bomb itself incredibly destructive, it had effects that were new:

> Only gradually did the few surviving and overworked Japanese doctors realize that they were seeing radiation sickness...Direct gamma radiation from the bomb had damaged tissue throughout the bodies of the exposed. The destruction required cell division to manifest itself, but radiation temporarily suppresses cell division; hence the delayed onset of symptoms. The blood-forming tissues were damaged worst, particularly those that produce the white blood cells that fight infection. Large doses of radiation also stimulate the production of an anti-clotting factor. The outcome of these assaults was massive tissue death, massive hemorrhage and massive infection (Rhodes 1986: 731-732).

In the years since Hiroshima and Nagasaki, nuclear weapons have grown thousands of times more powerful, which is another reason aside from the possibility that they may be acquired by terrorist groups why the idea of their proliferation is terrifying.[18] It is because of this fear that nuclear weapons are the subject of the most powerful taboos in international relations (Tannenwald 2005).

[18] This is despite various attempts at de-mystifying atomic energy, such as the children's toy "Gilbert U-238 Atomic Energy Lab," available in 1951-1952 for $50.00. The kit boasted the possibility of conducting over 150 experiments with "four types of uranium ore, a beta-alpha source (Pb-210), a pure beta source (Ru-106), a gamma source (Zn-65?), a spinthariscope, a cloud chamber with its own short-lived alpha source (Po-210), an electroscope, a geiger counter, a manual, a comic book (Dagwood Splits the Atom) and a government manual "Prospecting for Uranium" (Oak Ridge Associated Universities 1999).

The story of global nuclear proliferation starts during World War II, when the Soviet Union gathered enough intelligence from the Manhattan Project to develop a nuclear weapon of its own (testing their first atomic bomb in 1949). It continued in 1947, when the British decided to build their own nuclear arsenal, rather than depending on the United States' aegis. During the late 1940s, there were suspected weapons programs in Canada and Yugoslavia, and 1950 saw China and North Korea begin development after the U.S. admitted it had thought of using them again during the Korean War. In 1952, both Israel and Sweden began nuclear programs. Egypt began a covert weapons program in 1954; France began a military program in 1956, after Soviet threats made during the Suez Crisis (PBS 2010).

The first decade of the atomic age saw a slow but steady increase in the number of states that either were or had plans to become nuclear weapons states. And coming years would see their numbers grow. These states were not limited in their ambitions by their economic development or lack thereof; indeed, the presence of a nuclear weapons program could be interpreted as both a shortcut to geostrategic power and to the development of both human and physical capital.

Nonproliferation efforts moved simultaneously. For example, in 1953 U.S. President Eisenhower's "Atoms for Peace" speech at the United Nations made several proposals aimed at harnessing the power of nuclear fission, among them the creation of an international organization to control and develop the use of atomic energy, while making it available globally. That proposal came to fruition when the International Atomic Energy Agency (IAEA) was set up in 1957 as an autonomous body under the U.N. In 1970 the IAEA took on the task of defining and inspecting safeguards, when the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

came into force. The nonproliferation regime now includes a multitude of treaties and agreements among states (listed in the previous chapter).

Currently, the following states have declared nuclear weapons: United States, Russia, Great Britain, France, India, Pakistan, and China. There is one *de facto* nuclear weapons state: Israel. And there is North Korea, which has tested two nuclear devices, and is thought to have produced enough plutonium for at least half a dozen nuclear bombs. According to Nikitin et al,

> The nonproliferation regime has not stopped all proliferation, but it has helped restrain nuclear ambitions and solidified an international norm of behavior strongly condemning proliferation. Many countries that could make nuclear weapons have not, but some have at one time or another taken significant steps towards acquiring a nuclear weapons capability (Nikitin et al 2010).

The nonproliferation regime is therefore an example of relatively robust global governance. Among the states that are known to have had nuclear weapons development programs are Japan and Germany (during World War II), Argentina, Brazil, South Africa, Iran, Iraq, Libya, North Korea, Taiwan, Sweden, and South Korea (Levite 2002, Arms Control Association 2011). The German and Japanese programs did not reach their goals before they were shut down by the end of World War II. Argentina, Brazil, South Korea, Sweden, Taiwan, and South Africa all decided to forswear their programs and join the NPT as non-nuclear-weapons states (of this group of states, South Africa was the only one to have built and destroyed actual warheads). However, the NPT's enforcement is not airtight: despite its membership as a non-nuclear-weapons state in the NPT, Libya had a clandestine nuclear weapons program that it was persuaded to give up in December 2003. The Libyan success at keeping their program a secret has intensified fears that both Iran and Syria have similar programs (BBC 2011).

NETWORKS IN NUCLEAR NONPROLIFERATION

The response to nuclear proliferation embodied in many treaties involving hundreds of states demonstrates global governance in microcosm—how a global problem is addressed in a decentralized world. States cooperate, exchanging information and expertise, in order to prevent the spread of nuclear weapons and the threat of nuclear terrorism. Despite the fact that this is the highest of high politics of military and security affairs, this network also involves actors that are more usually thought of in terms of the "low politics" of a human security political frame (MacFarlane and Khong 2006). The official nuclear "haves" attempt to halt nuclear proliferation—a case of traditional national security, where states have attempted to control knowledge that has both peaceful and deadly uses.

However, there are many steps in the nuclear fuel cycle that apply to both civilian energy programs and military weapons programs (BBC News "Indepth: Nuclear Fuel Cycle"). Uranium must be mined from concentrated ore that is available mainly in Australia, Canada, China, Kazakhstan, Namibia, Niger, Russia, and Uzbekistan. The ore must then be milled, chemically purified, and reconstituted into "yellow cake" powder, which is chemically treated before being heated to become uranium hexafluoride gas. The gas is then put through an enrichment process, usually using centrifuges, in which the uranium-238 isotope is drawn off, leaving the uranium-235 that can be used in fission. At this point, the cycles diverge: the uranium-235 can be used in either reactors to produce power, or in bombs to produce explosions. Furthermore, after the fuel in a reactor has been used, it can be reprocessed to create both reusable uranium and plutonium, which is used in plutonium bombs. The significance of this many steps is that states have only the most tenuous control over the entirety of the process: nonstate actors either do the actual work, as in mining, or can infiltrate the state's institutions as in the case of A.Q. Khan.

The A.Q. Khan proliferation ring in Pakistan demonstrated that it is no longer enough to rely on the difficulty of the process of enriching and weaponizing uranium (or reprocessing and weaponizing plutonium), nor on the idea that only states can (currently) command such resources to prevent proliferation. While both are more or less currently true (Lindley and Clemency 2009), it is also true that customers need not make the product from scratch, they need only buy or steal it in order to use it. Globalization has made this process easier and speedier than it was previously: technology makes it easier to establish contact between buyers and sellers, while innovations in shipping and transport make delivery simpler. And it has introduced new actors: it is no longer a question only of rogue states gaining access to these weapons through espionage or the weakness of state supervision and management; but also criminal groups and terrorists gaining access.[19] Nonstate actors in the nuclear nonproliferation network either provide information to others (as in the case of inter-governmental organizations such as the International Atomic Energy Agency, IAEA) or the actual materials and equipment required in the manufacturing process (as in the case of transnational corporations such as General Electric and Hitachi). These actors may be nominally controlled by states, but in actuality, policing them is difficult and enforcement is likely to happen after the fact, as has happened with illicit trade to Iran (Eligon and Broad 2009).

States in the nonproliferation network, by attempting to hold onto their *de jure* authority, may be denying the network as a whole the flexibility and transparency it needs to counter proliferation: "The relationships between the DPRK [North Korean] and Khan networks show

[19] This may be even easier in the future, as Russian company Rosatom proceeds with its planned fleet of floating nuclear power plants. From a piece on the nuclear renaissance in Russia: "Critics also fear that the floating power plants, each equipped with two 35-megawatt reactors, constitute a significant proliferation risk. The specialty reactors burn particularly highly-enriched uranium. 'How you do want to prevent terrorists from boarding the ships and simply weighing anchor?' asks Vladimir Kuznezov, a former nuclear inspector and current critic of Rosatom. 'We can't even stop Somali pirates.'"(Bethge et al 2009).

the shifting roles that ring members may play, with the DPRK acting on different occasions as a buyer, seller, and supplier to mutual partners" (Braun and Chyba 2004). Stopping or at least controlling proliferation is important; as Sagan explained, more nuclear states will be worse for the world. Novice nuclear states lack either adequate military or civilian political organizational controls, and therefore have a high risk of either deliberate or accidental nuclear war. Deterrence strategy took the U.S. and U.S.S.R. years to work out; many new nuclear states seem completely unaware of the depth of thinking necessary. Furthermore, deterrence may not work, because novice nuclear states' capability may not survive to make a second-strike (Sagan and Waltz 1995).

But today, the world sees the convergence of three interrelated trends. First is the global international political economy trend toward privatization at the expense of state authority known as the Washington Consensus (Williamson 1990, Crouch and Streeck 1997, Cerny 1997, Crouch 2004, Bremmer 2009). The second trend is a rise in the price of energy from traditional sources, and the consequent renewal of interest in nuclear energy—the "nuclear renaissance" (Lauvergeon 2009, Diyakov 2010). The plans for new nuclear power plants in the UK demonstrate these two trends: they are intended to be private industry, not state-controlled or even state-subsidized (Smedley 2008). The third and final trend is the existence of actors that are structurally similar to reputable companies in the nuclear fuel cycle in terms of the contracts they have with others, but that do not adhere to a code of conduct. The tacit knowledge gained from civilian nuclear activities (Montgomery 2008) is likely to encourage the proliferation of nuclear weapons to states (Fuhrmann 2009), and may also enable the acquisition of WMD by terror groups. These actors are weak links in the fuel cycle, and the most likely place for terrorists to deal, whether by attack or through the black market.

NONSTATE ACTORS IN NONPROLIFERATION NETWORKS

State behavior may be the beginning of the nuclear story, but it is not the end. For example, the World Association of Nuclear Operators (WANO) was formed following the Chernobyl accident, in order to create a "culture of openness" (http://www.wano.org.uk) between operators—thus ensuring best practices are developed and adhered to, and that nuclear power continues to be profitable. Nuclear power will not be profitable if the perceived threat to people's security is so great as to preclude its use. However, recent events in global finance have called into question the ability of many companies to strategically plan in such a way as to not poison the well from which they drink. When it comes to the bottom line, in other words, too many companies think only of the short term bottom line. This was too-vividly demonstrated by the failures of WANO member Tokyo Electric Power Company (TEPCO) at the Fukushima Daiichi plant both before and after the earthquake and tsunami of March 11, 2011 (Onishi and Fackler 2011, Norris 2011).

Not everyone is as willing to provide public goods as Warren Buffet apparently is. Peter Singer wrote in the *New York Times* that Buffet had pledged $50 million to assist in the establishment of the International Atomic Energy Agency's "fuel bank," which would supply nuclear-reactor fuel to countries that meet their nuclear-nonproliferation commitments. The theory behind the fuel bank is that it will dissuade countries from building their own facilities for producing nuclear fuel, which would make it easier to reroute it to weapons production. "It is, Buffett said, 'an investment in a safer world.' Though it is something that governments could and should be doing, no government had taken the first step" (Singer 2006).

Authors such as Eilstrup-Sangiovanni (2005) have noted that states are increasingly cooperating in network forms as a response to criminal or "dark" networks. However, anecdotal

evidence suggests that networks composed merely of states will not be enough to prevent proliferation—they are not flexible or innovative enough. Moreover, they do not target the weak points of state proliferation networks, because their solutions are one-size-fits-all and not based on network topography (Montgomery 2008).

States will always be playing catch-up to other, networked, actors that are capable of penetrating or co-opting the state (Naím 2005). In order to gain the upper hand, they must coordinate their efforts with other actors with the same goals. This would mean working with other actors, and not just in a hierarchical relationship, such as that existing between states and the businesses involved in building and/or exporting nuclear-industry components, or IGOs such as the IAEA. It would also mean collaborating formally or informally with NGO watchdog groups such as the Federation of American Scientists, and even individuals such as Mark Hibbs, formerly a reporter for *Nucleonics Week and Nuclear Fuel* (Langewiesche 2006). Both Naím and Langewiesche point out the importance of including nonstate actors in networks: they do not face the same constraints as states, so their efforts can be complementary to those of states.[20]

Nonstate actors in the nuclear nonproliferation network either provide information, as do the groups and individuals indicated above, or the actual materials required in the manufacturing process; as do transnational corporations such as General Electric and Toshiba. As Apasenko writes, "the term 'nuclear security' needs to be treated more broadly, with the understanding that it includes real security as it relates to the production and utilization of nuclear components both in the military and in the civilian sectors, as well as security in general" (Apasenko 2009). Mowatt-Larssen writes: "Developing a collective security consciousness demands an

[20] For example, NGOs can obtain evidence without a warrant by different methods such as deception. Such information is not always (or immediately) made public.

acknowledgement that there is no such thing as nuclear security, and thus, a fatal lapse of security at any site in any country would affect everyone" (Mowatt-Larssen 2009).

Seven brief examples, in order of increasing importance, will serve to demonstrate the issue.

- A French nuclear physicist at CERN (the European Organization for Nuclear Research) has been arrested on suspicion of links to al-Qaeda (BBC 2009d, BBC 2009e).
- There are credible reports that European nuclear waste has been dumped off the coast of Italy by organized crime groups, possibly the Calabrian mafia (BBC 2009d).
- In the United States, Florida Power & Light was fined by the Nuclear Regulatory Commission when their security subcontractor Wackenhut failed to report or equip employees as required at the Turkey Point plant (U.S. Nuclear Regulatory Commission 2008), an example of enforcement-after-the-fact as a result of subcontracting essential services.
- The West Valley Nuclear Services Company's website (www.wvnsco.com) has been vandalized. (WVNS was a subsidiary of Washington Group International, which is now part of URS (formerly United Research Services) and known as URS Washington.) In terms of information technology, this is not unlike defacing a billboard. However, given the Stuxnet attack on Iran's nuclear program, such lax information technology security is alarming (Clayton 2010).
- In *Uranium: war, energy, and the rock that shaped the world,* Tom Zoellner details the ludicrously poor security at uranium mining sites such as Shinkolobwe in the Democratic Republic of the Congo, source of much smuggled uranium (Zoellner 2009).

- Prosecutors in New York have indicted an executive from the Limmt Economic and Trade Company, a Chinese company, for selling tungsten, high-strength steels and exotic metals to the Defense Industries Organization, a subsidiary of the Iranian military, from 2006 to 2008 (Eligon and Broad 2009).
- In 2007, South Africa's Pelindaba nuclear research site was attacked by four armed intruders. They penetrated several layers of security in a facility "that contains an estimated 25 bombs' worth of weapons-grade nuclear material," shooting and wounding one worker (Zenko 2007).

The United Nations Security Council's Resolution 1540 of 2004,[21] with its attendant committee and follow-up procedures, is a good start at making sure states are held accountable for the business conducted within their borders (Nuclear Threat Initiative 2009). But the ideal concept of sovereignty is only absolute in a perfect world; in this one, states will never be able to police everything, all the time. Reacting quickly and appropriately after the fact is not enough—prevention is key.

NETWORK MEASUREMENTS

For this case study, I analyzed two relations among actors involved in global nonproliferation efforts: a compulsory power relation and an institutional power relation. Mapping these two relations should allow the discovery of relations of structural power. The institutional power network consisted of 196 distinct actors related by twelve treaties or agreements. These actors were all states as recognized by the United Nations, with the exception of Taiwan (Republic of China). The compulsory power network consisted of 575 records of financial transactions among 454 distinct actors. These actors were states, companies, state-

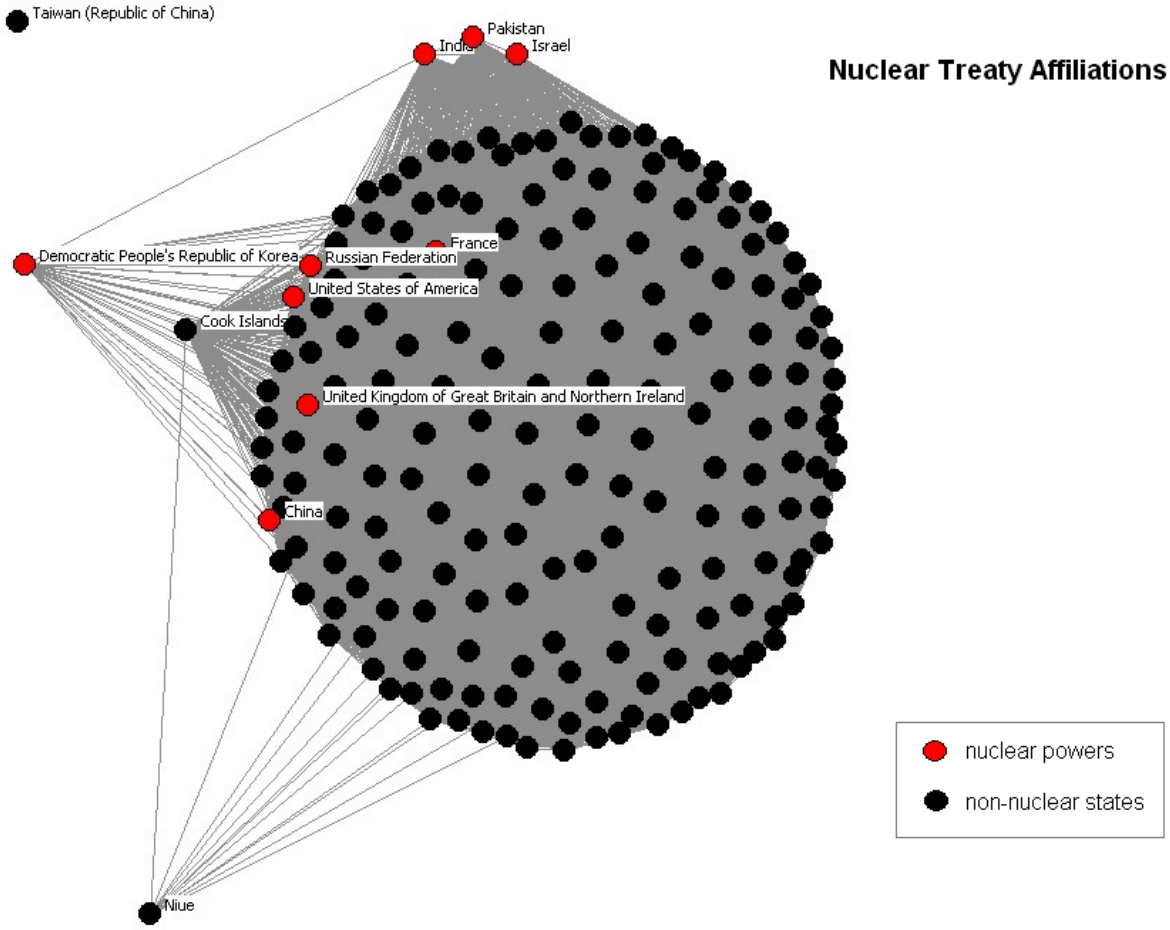
[21] The provisions of 1540 (2004) specify that all states must prevent non-state actors from acquiring, using or transferring nuclear, chemical or biological weapons and their delivery systems, and must establish domestic laws and appropriate controls over related materials.

owned corporations, joint action agencies (joint-action agencies are owned by their members, which are electricity cooperatives), partnerships, joint ventures, academic institutions, nongovernmental organizations (NGOs), intergovernmental organizations (IGOs), and unknown. Actors were coded as state-owned if they were more than 50% owned by a state. All calculations were performed with Ucinet 6 and all images were created using Netdraw (Borgatti et al 2002).

Institutional Power Network

The institutional power network is a two-mode rectangular matrix (actor-by-treaty). Because a two-mode network would not be directly comparable to the other networks in this study, it was transformed (using Data > Affiliations in Ucinet) into a one-mode square matrix (actor-by-actor), where treaty participation is counted as a relationship among all parties to the treaty. The network created by affiliation in treaties is depicted in Figure 2, with a spring embedding layout based on geodesic distances. A spring embedding layout uses iterative fitting starting from a random layout to locate the points in such a way as to put those with smallest path lengths to one another closest in the graph. This graph also uses node repulsion to separate objects enough to read them, and equal edge length to standardize the distances among adjacent objects.

Figure 2: Nuclear Treaty Affiliations: The Traditional Security Institutional Power Relation Network



A careful study of the graph will show several promising aspects to nonproliferation treaties: first, most states, even those that do not belong to the major treaties (NPT, IAEA, or CTBT), belong to at least one regional treaty that has as its goal nonproliferation. Second, most states belong to at least one of the major treaties. However, the pessimistic view must note several equally unpromising aspects: there are nuclear weapons states, in particular North Korea, India, Israel, and Pakistan, which do not belong to major treaties with their attendant strengthened enforcement; and there is a state, Taiwan, that is fully capable of developing nuclear weapons and is not party to any treaty at all.

For a valued network such as this (with the value of ties between actors determined by the number of treaties in which both participate), density is defined as the sum of the ties divided

by the number of possible ties. The density (matrix average) of the nuclear treaty network is 2.4210, with a standard deviation of 1.3299. According to Hanneman and Riddle's web text (2005) "A social structure in which individuals were highly clustered would display a pattern of high densities on the diagonal, and low densities elsewhere." This indicates that the speed at which information diffuses among the actors is relatively quick, and the extent to which actors have levels of social constraint is relatively high. In other words, the treaties taken together—aside from their enforcement powers—are likely to create a close-knit group that fosters powerful norms that constrain member behavior.

The geodesic distance of a network is the number of relations in the shortest possible walk from one actor to another; a walk is a sequence of actors and relations that begins and ends with actors (Hanneman and Riddle 2005). In other words, it measures how "reachable" the actors in a network are to each other. The average distance between reachable pairs is 1.027, and the distance-based cohesion of the graph is 0.976 out of a range from 0 to 1 (larger values indicate greater cohesiveness). This indicates that the network is cohesive. This result has implications for effectiveness at responding to a security threats: networks that are cohesive are likely to communicate well, and should therefore be more likely to share expertise and resources. Again, aside from any enforcement measures that the treaties may contain (such as inspections, etc.) the network they create is close-knit and can constrain members.

In a network graph, the degree centrality of the actors indicates the number of direct connections among them (Wasserman and Faust 1994), and the highest and lowest ten scores are given in Table 2.[22] The highest and lowest ten scores for closeness centrality, indicating the shortest paths to all other actors, is given in Table 3 (Wasserman and Faust 1994).

[22] Degree centrality is reported by Ucinet as a percentage of the maximum possible.

Table 2: Degree Centrality in the Traditional Security Institutional Power Relations Network

	Actor	Degree
1	Australia	99.48718
2	New Zealand	99.48718
3	Argentina	98.97436
4	Austria	98.97436
5	Belgium	98.97436
6	Brazil	98.97436
7	Bulgaria	98.97436
8	Chile	98.97436
9	Czech Republic	98.97436
10	Denmark	98.97436
188	Swaziland	96.41026
189	Timor-Leste	96.41026
190	Trinidad and Tobago	96.41026
191	Israel	80.51282
192	India	74.8718
193	Pakistan	73.84615
194	Cook Islands	72.30769
195	Democratic People's Republic of Korea	18.46154
196	Niue	6.153846
197	Taiwan (Republic of China)	0

Table 3: Closeness Centrality in the Traditional Security Institutional Power Relations Network

	Actor	Closeness
1	Australia	50
2	New Zealand	50
3	Argentina	49.87212
4	Austria	49.87212
5	Belgium	49.87212
6	Brazil	49.87212
7	Bulgaria	49.87212
8	Chile	49.87212
9	Czech Republic	49.87212
10	Denmark	49.87212
188	Swaziland	49.24242
189	Timor-Leste	49.24242
190	Trinidad and Tobago	49.24242
191	Israel	45.66745
192	India	44.52055
193	Pakistan	44.31818
194	Cook Islands	44.01806
195	Democratic People's Republic of Korea	35.58394
196	Niue	34.09091
197	Taiwan (Republic of China)	NA

Closeness centrality approaches emphasize the distance of an actor to all others in the network (the length of the path among two actors) by focusing on the distance from each actor to all others. [23] In closeness centrality, actors that are locally central (those that are connected to many others, but the others are not connected to the larger graph) do not get as high a score as they do in degree centrality. In this case, it turns out that the measures produce similar results: the same states are at the top and at the bottom of these tables, although the range between the top and bottom of the tables differs. This is cause for concern, as several of the states with the lowest scores are nuclear weapons states. This suggests that attempts to persuade them to change their behavior through the existing treaty structure will not be successful.

[23] Closeness centrality is reported by Ucinet on a scale of 0-100, with higher scores indicating more central actors.

Structural similarity can be determined using regular equivalence. “Actors that are regularly equivalent do not necessarily fall in the same network positions or locations with respect to other individual actors; rather, they have the same kinds of relationships with some members of other sets of actors” (Hanneman and Riddle 2005). In other words, the actors in the equivalence class or blockmodel (White et al 1976) share a similar relationship to the actors in the other classes, just as all children share the same child-parent relationship with their parents without necessarily being related to each other. The blockmodel results are contained in Table 4.

Table 4: Equivalence Classes in the Traditional Security Institutional Power Relations Network

Equivalence Class	Actor
1	Afghanistan, Andorra, Antigua and Barbuda, Bahamas, Bahrain, Barbados, Belgium, Niue
2	Argentina, Australia, Austria, Finland
3	Albania, Brazil, Tuvalu
4	Algeria, Bulgaria, Cook Islands, Nepal
5	Taiwan (Republic of China)
6	Armenia, Chile, Fiji, Lebanon
7	Angola, Azerbaijan, Bhutan, China, Kiribati
8	Bangladesh, Democratic People's Republic of Korea, Nauru
9	Belarus, Cuba, New Zealand, Pakistan
10	Belize, Benin, Bolivia, Bosnia and Herzegovina, Botswana, Brunei Darussalam, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Colombia, Comoros, Republic of the Congo, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Democratic Republic of the Congo, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Ethiopia, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Holy See, Honduras, Hungary, Iceland, India, Indonesia, Islamic Republic of Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Latvia, Lesotho, Liberia, Libyan Arab Jamahiriya, Liechtenstein, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Federated States of Micronesia, Moldova, Monaco, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Netherlands, Nicaragua, Niger, Nigeria, Norway, Oman, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Republic of Korea, Romania, Russian Federation, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Thailand, The former Yugoslav Republic of Macedonia, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania, United States of America, Uruguay, Uzbekistan, Vanuatu, Bolivarian Republic of Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe

The actors in the equivalence classes do not appear to have much in common other than their similar patterns of ties. Many nuclear weapons states are in separate blockmodels, which may indicate a higher probability of proliferation based on many different tie patterns, rather than just

one. Also, there are states in different blockmodels that have indigenous nuclear capabilities, either for research, power generation, or both. It would therefore be difficult to locate weak spots in the nonproliferation regime based on a blockmodeling of states, making it difficult to pinpoint prevention-strengthening efforts.

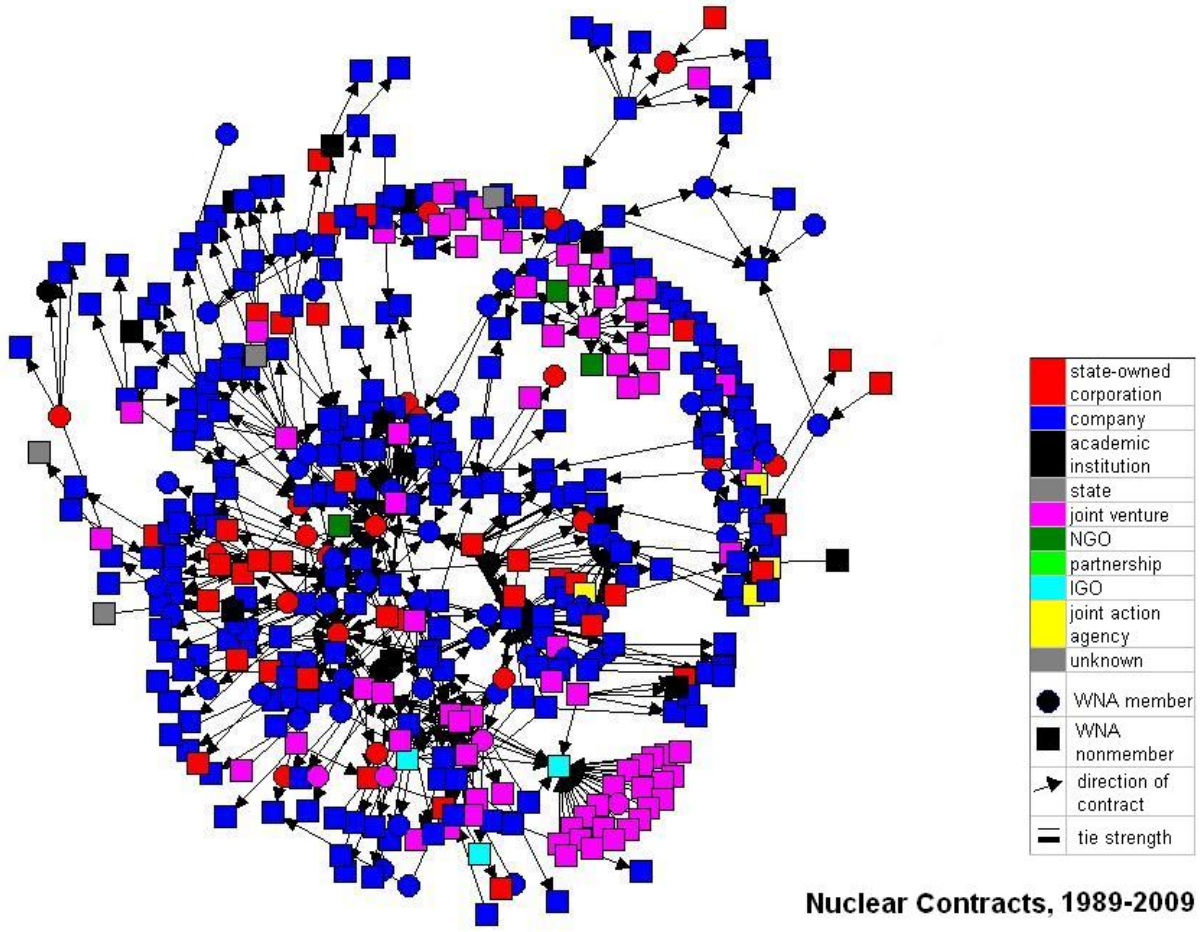
Problems with the data include the fact that not all treaties are equal, although this analysis has presented them as such. There are significant differences in enforcement, funding, and so on, that have not been accounted for. Refinement, perhaps by weighting the ties according to enforcement capability, would be a subject for future research. Also, there are other treaties that might be relevant to nonproliferation endeavors, such as the Convention on Nuclear Safety and the Convention on the Physical Protection of Nuclear Material. To get a more complete picture, these treaties should also be added to the dataset. Furthermore, adding treaty review conference participants would make the dataset more directly comparable to others, as there would be no artificial limit on actor type.

However, these findings demonstrate that a network analysis of nuclear nonproliferation networks is plausible, as it is capable of showing in quantified form what is already known from more qualitative studies. The advantage is that the results show the method is capable of reproducing existing knowledge. To find out what else it is capable of, I turn to a different relation, compulsory power.

Compulsory Power Network

The network created by contracts is depicted in Figure 3, again using a spring embedding layout with node repulsion and equal edge length. In this image, the organization types are also visible.

Figure 3: Nuclear Contracts, 1989-2009: the Traditional Security Compulsory Power Network



Organization types represented by color are states, companies, state-owned corporations, joint action agencies, partnerships, joint ventures, academic institutions, nongovernmental organizations (NGOs), intergovernmental organizations (IGOs), and unknown. The arrowheads indicate the direction of the contract, while the thickness of the tie indicates the number of contracts between those two actors. Finally, circles indicate that the actor is a member of the World Nuclear Association; squares indicate that the actor is not a member. The WNA is a global nuclear energy industry professional organization that has a commitment to nonproliferation in its Charter of Ethics. Actors can become members of the WNA only by a majority vote of the membership, making it unlikely that actors who do not demonstrate commitment to this principle will be accepted.

Again, density is here defined as the sum of the ties divided by the number of possible ties, with the value of ties between actors determined by the number of contracts in which both participate. For the compulsory power network, the average density was 1.0708, with a standard deviation of 0.3487. This is a lower density than the institutional power relation; not only should this be expected, but it is probably an over-estimation of density, as the dataset covers a twenty-year period in which not all ties were present at all times.

Again, the geodesic distance is the number of ties in the shortest path between each pair of nodes. For the network of contracts, the average distance was 1.000, while the distance-based cohesion was 1.000 (again, a range from 0 to 1, with larger values indicating greater cohesion). This would seem to indicate that the network is extremely cohesive, with most actors "next" to each other.

The degree centrality measure for this network appears to follow a power law distribution[24] (Barabási 2003), and is shown in Table 5. The lowest ten actors in degree centrality are not given because the lowest score of 0.221239 was shared by 287 actors. Similarly, the lowest score 0.221239 for closeness centrality is shared by 37 actors; however, in this case the graph of scores does not follow a power law. Closeness centrality is shown in Table 6.

[24]Power law distributions have a few actors with most of the links, and most actors with few links.

Table 5: Degree Centrality in the Traditional Security Compulsory Power Relations Network

	Actor	Type	Degree
1	Westinghouse Electric Co	company	8.40708
2	Chernobyl Shelter Project	IGO	6.637168
3	U.S. Department of Energy	state	6.637168
4	Framatome ANP	state-owned corporation	6.19469
5	Areva	state-owned corporation	5.309734
6	NNSA	state	4.20354
7	UK Atomic Energy Authority	state	3.539823
8	Russia	state	3.318584
9	Shaw Group Inc.	company	3.318584
10	Electricite de France	company	3.097345

Table 6: Closeness Centrality in the Traditional Security Compulsory Power Relations Network

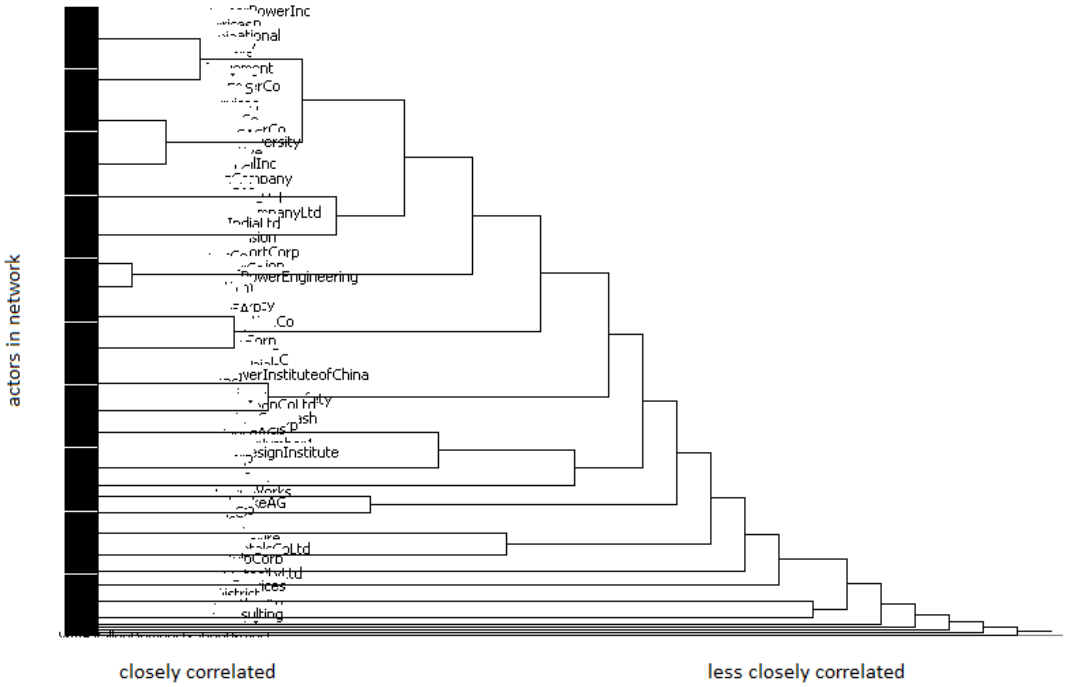
	Actor	Type	Closeness
1	Areva	state-owned corporation	0.974516
2	Framatome ANP	state-owned corporation	0.973739
3	Exelon Corp	company	0.973634
4	Westinghouse Electric Co	company	0.973446
5	U.S. Department of Energy	state	0.973278
6	Electricite de France	company	0.972273
7	Mitsubishi Heavy Industries Ltd	company	0.971562
8	Electrabel	company	0.971228
9	China Guangdong Nuclear Power Co	joint venture	0.97102
10	Tennessee Valley Authority	state	0.970957

This network shows a very different picture of degree and closeness centrality. Degree centrality (again, the number of direct connections between actors) shows a mixture of states and private corporations, with an IGO thrown in for good measure. Closeness centrality (the number of shortest paths to all other actors) shows a different group; the actors that overlap between the two groups are Areva, Framatome ANP, Westinghouse Electric Co, U.S. Department of Energy, and Electricite de France—only one state actor among them. The implication this has for policy is

clear: measures that do not have the support of the business community will be difficult to promulgate and enforce.

Another way to discover structural equivalence is through hierarchical clustering. The algorithm in Ucinet proceeds by initially placing each case in its own cluster. The two most similar cases are then combined into a new class. The similarity of this new class to all others is then computed, and the joining/recalculation process is repeated until all cases are aggregated into a single cluster. The "hierarchical" part of the method's name refers to the fact that once a case has been joined into a cluster, it is never re-classified, resulting in clusters of increasing size that always enclose smaller clusters (Hanneman and Riddle 2005). These hierarchical clusters show that being different organization types does not hamper certain types of similarity. For example, Areva is a vertically-integrated organization with contracts from suppliers and to customers at every stage of the fuel cycle from mining to plant operation. The other actors in Areva's "class" have similar patterns of ties, whether they are state-owned corporations like Areva or not. The result is too large to show with actor names included, but the dendrogram is shown in Figure 4.

Figure 4: Dendrogram in the Traditional Security Compulsory Power Relations Network



This structural equivalence measure indicates a useful result for policy makers. They could look at the other actors in the clusters containing known proliferators. Similar patterns of ties could be an indication that these actors are vulnerable to enabling proliferators themselves, whether knowingly, or through fraud such as the actions of an infiltrator, or through attack. Network analysis allows for more precise targeting of likely holes in the nonproliferation network. In either case, it would be prudent to undertake measures to strengthen security at those actors, and to forge even more network ties with them, as the more deeply embedded they are, the more likely they are to adhere to network norms.

DIRECTIONS FOR FUTURE RESEARCH

The next steps to take would be to extend the analysis to other actors, in order to get as complete a picture as possible. Information about structural position is likely to change with the addition of new actors. In a case study of the humanitarian response to the Indian Ocean

tsunami, it was discovered that not only did actors with different attributes play similar roles in the network, but that knowledge of attributes was insufficient to predict structural roles (Kamran 2009b). Information on nuclear nonproliferation network membership begins with membership data from treaties such as the Non-Proliferation Treaty (NPT) and other groups of state actors such as the Nuclear Suppliers Group. However, adding the many businesses (many of them Fortune Global 500 members), academic institutions, IGOs, and NGOs that are involved in the construction and operation of nuclear power plants, as well as production and transportation of nuclear materials, duplicates the tsunami finding in an entirely different security frame. The existing dataset of nuclear contracts could be used as a seed to start a snowball using other data sources such as *World Nuclear News* and the Mergent Horizon database of companies, their suppliers, and their customers. Evidence of their relationship with each other and with states would also include attempts at regulation.

Furthermore, think-tanks/institutes and activist/interest groups should also be taken into account, as they provide much of the information with which decisions are made by others. NGOs include multinational nuclear research institutions such as the European Organization for Nuclear Research (CERN), and the International Association of Lawyers Against Nuclear Arms (IALANA). Information about NGOs can also be found in the International Affairs Contact Network database maintained by the University of Pittsburgh (http://www.ucis.pitt.edu/iacnet/). As the case of the French physicist makes clear, such nonstate organizations are already being targeted by terror groups.

The analysis could also be extended to different levels of analysis to include national programs such as the U.S. Nuclear Data Program, and the problem of nonproliferation programs run by different subnational agencies such as those run by the U.S. Department of Energy versus

those run by the Department of Defense (GAO 2005), as well as the investigation of those programs individually, such as the bilateral program with Russia known as the Cooperative Threat Reduction (Nunn-Lugar) program or the Proliferation Security Initiative.

Future research should also take into account dynamics: evidence of different types of change in structural patterns should be sought, just as Holsti explored different types of change that international institutions such as state, sovereignty, territoriality, international law, diplomacy, trade and war have undergone (Holsti 2004). There are questions to be answered about changes in the nuclear treaty network; for instance, what was the structural impact of North Korea leaving the NPT? The speed of proliferation, and the rate at which a response is constructed, is also likely to have structural affects, which could be investigated with longitudinal network analysis programs such as SIENA (Snijders et al 2005) and SoNIA (Bender-deMoll 2006). Does longevity of tie make for a stronger or weaker tie? What is the impact of longevity on flexibility of ties? Do states proliferate if their neighbors in the network (not necessarily their geographic neighbors) do so? There is a correlation between ego and alter behavior in studies of individuals and smoking, obesity, and depression (Christakis and Fowler 2007, 2008, Fowler and Christakis 2008); is there such a correlation among proliferators and those that seek nuclear weapons? All of these questions have policy implications, from recommending that more authority and control be put back in the hands of the state, to developing new ways of holding nonstate actors accountable for their actions.

CONCLUSION

The institutional power (nuclear treaty) network is an excellent test of the network analysis method. If there had been unexpected patterns found in such a well-known network, the method would have to be considered suspect. Instead, the test demonstrates that the method is

not only appropriate, but that it can be a faster way than in-depth narrative or historical analysis to arrive at the same conclusion. Even more importantly, it is a method capable of handling far larger numbers of actors than can be held in the mind—the number of states is relatively tiny compared to the number of nonstate actors that must also be considered in global politics.

Expansion of inclusion in the institutional power network may help to explain why there has not been more proliferation over the years. Even as the size and scope of nonstate actors has increased exponentially, proliferation to states and nonstate actors has been steadily low. The explanation may be the multiple demand-side motives for nonproliferation (Sagan 1996, Liberman 2001, Hymans 2006) such as the needs of national identity, expense of production, and changes in both external threats and domestic regimes will change now that there are new types of actors. These new actors are more likely to bring motives such as profit. However, I hypothesize that the supply-side (Braun and Chyba 2004, Kroenig 2009, Gartzke and Kroenig 2009, Fuhrmann 2009) will change with the changing environment, as the structure that is the flexible and growing compulsory power network will make proliferation easier in both networks.

Based on these findings, the usual state-based way of thinking about nuclear security should be significantly revised. The privatization of security has led to many activities in both nuclear energy and research being contracted out to nonstate actors, which has led to a proliferation of actors in these fields, as well as the spread of fungible skills that can be applied to weaponry. States, with their lack of cooperation in traditional security for reasons of secrecy, have left the back door wide open. In the words of Frank C. Lanza, former chief executive officer (CEO) of L-3 Communications Holdings Inc., “the commercial world has permitted access by rogue nations to some very high technology” (Coy et al 2003, 41). Governments may have primary responsibility for nonproliferation efforts, but export controls need to be policed by

the private sector as well. Former CEO of Areva Anne Lauvergeon has made it very clear that companies have a clear responsibility to train employees, implement national and international standards, and exercise "special care" in the transfer of sensitive technologies (Lauvergeon 2009, 94).

While it is important that these actors have formed networks for the purpose of cooperating to prevent the misuse of nuclear weapons or materials, it is equally important that looking at maps of the networks reveals exploitable weaknesses. The institutional power relation reveals the fact that there are geographic locations such as Taiwan that are loosely policed by nuclear nonproliferation treaties, which, coupled with the knowledge of the location's internal politics, could be useful to groups looking for a place to conduct illicit nuclear activities. The compulsory power relation reveals the fact that there are actors structurally similar to each other, and that not all the actors in an equivalence class will belong to a self-policing organization such as the WNA. Terrorist groups looking for materials or expertise could "shop around" for the best fit with their needs: ideally a location that is not subject to treaty inspections, with access to companies that do not take security seriously.

Finally, these findings support the call for policy making to be opened up to multiple types of actors, who should also be responsible for enforcement. Companies, NGOs, IGOs, and academic institutions (and so on) are likely to be on the scene, or to have the information and resources needed to prevent proliferation. For example, companies performing due diligence should investigate or otherwise be aware of their counterparty's background and pedigree, and should alert relevant authorities when suspicions are raised.

CHAPTER FIVE

THE STRUCTURE OF THE TSUNAMI RESPONSE NETWORK

The scope and power of a natural disaster puts in perspective humanity's relative importance in the world and imposes the peace of silence. One such example of stillness after desolation occurred in the aftermath of the Indian Ocean tsunami of 26 December 2004. The global response to this regional disaster demonstrated cooperation in several different ways, from the marshaling of resources to the institutional collaboration to provide assistance to the afflicted. The political subject to be explored in this chapter is the shape and construction of a human security network in a case study of the tsunami disaster response network. The patterns of cooperation that arise to meet transnational problems in security will be mapped and explained.

Again, for the purposes of this investigation, "[t]wo agents cooperate when they engage in a joint venture for the outcome of which the actions of each are necessary, and where a necessary action by at least one of them is not under the immediate control of the other" (Gordenker et al 1995, 11). The concept of networks in international relations assumes that social structures such as those arising from cooperation matter more in explaining outcomes than do individual attributes, and are equally as important as material resources. It assumes that there is no central institution or idea that controls international relations (even in a specific issue area). It also assumes that according to the issue area, actor relationships will change. The unit of analysis will be the network as a whole; at the macro level (the system level of world politics), the network consists of the pattern of formal and informal interactions among states, intergovernmental organizations (IGOs), transnational and local nongovernmental organizations

(NGOs), transnational corporations (TNCs) as well as local corporations, and individual people[25].

The evolution of cooperation to respond to the South Asian tsunami began with an event, a tsunami in the Indian Ocean. The response network that was created was not started from scratch, however: there were communities of states, IGOs, and NGOs that already existed. To create the response network, not only did these pre-existing groups have to negotiate structure and authority amongst themselves, but they also had to incorporate many new groups which wanted to assist.

For the purpose of policy making in the future (as well as for theory-building in the field of international relations) we need to have more accurate pictures of what actually happens. As a reminder, Slaughter's theory of vertical and horizontal governmental networks suggests that these networks, while nested in larger policy networks, will (and should, for reasons of accountability and legitimacy) lead the way in any response: they should decide what to do and why, and then they should be the ones to do it (Slaughter 2004). Is this what actually happened? The concept of global governance suggests that other actors will also be important (and perhaps even equally or more important) in deciding why, and the existence of NGOs like Doctors Without Borders/Médecins Sans Frontières (MSF) suggests that the "doing" part, implementation, is also heavily dependent on other actors. Furthermore, if network structures are indeed complex, it suggests that actors with similar attributes may play different roles according to the frame.

[25]People are neither "transnational" nor "local" in that wherever they are is local, even if it is not their place of origin.

DISASTER RESPONSE IN THE PAST

The provision of emergency supplies to affected populations around the Indian Ocean was available almost immediately (within hours), reflecting a long-standing global moral commitment to react quickly and generously in the face of natural disasters. As people in the affected regions began calling, texting, and uploading images and movies, massive relief began. In a natural disaster, the acceptance of outside humanitarian action was virtually automatic, which is not the case in wars because aid can be seen to be benefiting the enemy rather than the common good.

Possibly the first recorded instance of a state's taking responsibility for the victims of a natural disaster is the Roman emperor Titus' reaction to the eruption of Vesuvius in 79 CE, when he decreed that the property of those who died without heirs would be dedicated to relief work rather than go to the imperial treasury, as was usual (Cooley and Cooley 2004). Humanitarianism can be traced from the major world religions as well as through Cicero, medieval philosopher St. Thomas Aquinas, father of international law Hugo Grotius, and liberal peace philosopher Immanuel Kant. Michael Barnett divides modern Western humanitarianism into three eras: "imperial humanitarianism" from the late 18th century to World War II, "neo-humanitarianism" from the end of World War II to the end of the Cold War, and "liberal humanitarianism" from the end of the Cold War to the present day (Barnett 2011). According to him, humanitarianism is a paternalistic empire with expansionist logic, in the sense that it has the following features: the long distance rule by one people over another, without legitimacy, and that power radiates downward in the empire's interests.

When the volcanic island Krakatau in the Sunda Strait between Java and Sumatra exploded on August 27, 1883, the world's response was markedly different. In the words of an eyewitness to the lava storms and the waves:

> It was while we were thus enveloped in darkness that the stones and cinders discharged by the mountain began to fall upon the ship. In a short time the canvas awning and the deck were covered with ashes and stones, to the depth of two feet, and all our available men were employed in removing the falling mass, which would otherwise have sunk the ship...While we were engaged in this struggle, and enveloped in the sheer blackness of a veritable hell, a new and terrible danger came upon us. This was the approach of the tidal wave caused by the final eruption, which occurred about 12.30 to 1 p.m. The wave reached us at 2 p.m. or thereabouts, and made the ship tumble like a sea-saw...When we reached Angier we found no trace—not a splinter of wood nor a fraction of stone— of the buildings of that once flourishing seaport (Worsfold 1893).

The tsunamis that resulted from Krakatoa's eruption killed more than 36,000 people (Winchester 2003).

However, Indonesia at that time was a possession of the Dutch government, which hindered an effective response by authorities in two ways. First, having endured colonization by both the Dutch and British East India trading companies as well as changes in sovereignty dependent on the changes in fortunes of various European empires, the people of the area were in a state of rebellion. Second, the “culture system” required villages in the Dutch East Indies to set aside 20% of their crops for taxes which provided fabulous profits for the Dutch but no public improvements or services of any kind for the villagers (Worsfold 1893, Winchester 2003). This system did not end until 1871, but years of under-supported infrastructure could not be easily rebuilt.

The contemporary round of globalization that began in the late nineteenth century, spurred by innovations such as the railroad and the telegraph, spread the details of the disaster to the world. But the global response was more to the spectacular sunsets caused by the pollutants

in the atmosphere than to the human suffering (Altick 1960). According to Winchester's account, the primary response of the other naval superpower of the day was to ensure that the international shipping lanes remained open (Winchester 2003). Such perceived callous disregard on the part of others fueled an already-angry brand of Islamic fundamentalism in Indonesia, especially the popularity of religious leaders such as the Sufi mystic Hajji Abdul Karim, who preached of the imminent arrival of the Mahdi. Winchester writes that t he Dutch, despite their large relief operations, were in uneasy control in Java and Sumatra, and that the eruption of Krakatoa may thus have sparked the Banten Peasants' Revolt in 1888, a prominent milestone on the way to Indonesian independence.

In contrast to that response, in the case of the 2004 tsunami we have seen that "competitive compassion" (Leach 2005) resulted in what many even saw as excess resources for the tsunami victims especially as compared to contemporaneous victims of other disasters.

THE INDIAN OCEAN TSUNAMI

On 26 December 2004, an earthquake that registered magnitude 9.0 (later adjusted to 9.3) on the Richter scale occurred just before 8 a.m. off the west coast of the Indonesian island of Sumatra. The epicenter was about 150 miles southeast of Banda Aceh. The earthquake occurred when the Indian plate was subducted under the Eurasian plate and was the second most powerful earthquake since 1900. The plates moved several hundred kilometers at a depth of about thirty kilometers. The vertical plate movement of about twenty meters displaced billions of tons of overlying ocean water. The resulting tsunami traveled at speeds up to 500 miles per hour. The tsunami hit Indonesia thirty minutes later and the coasts of Thailand, Sri Lanka, and India about thirty minutes after that.

While the knowledge necessary to predict tsunamis was available, the infrastructure and procedures to disseminate it were not. The U.S. tsunami warning center in Hawaii issued a local warning about fifty minutes after the earthquake tremors had stopped, and there were no early official warnings to South Asia. Most people on the beaches or nearby were enjoying a peaceful day after Christmas and were completely surprised by the waves tens of meters tall.

The earthquake and the resulting tsunamis spread unprecedented devastation across the Indian Ocean, affecting thirteen countries, some as far away as Africa. The waves stripped the land of vegetation and tossed ships about. The destruction to buildings, roads, and infrastructure was disastrous, and the tsunami killed more people than any other in history—final estimates ranged up to 280,000—and displaced more than one million. Ten countries in South Asia (Indonesia, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia, Maldives, the Seychelles, and Singapore) and three in east Africa (Somalia, Kenya, and Tanzania) suffered.

Viewers across the planet were transfixed by the images of waves swallowing islands and cities whole, creating scenes of apocalyptic destruction. On 26 and 27 December, the death toll was supposedly in the thousands because the scope of the impact was not immediately clear. As of 17 January 2005, the total death toll was estimated at 170,000. A year later, the total was revised upward to 225,000 (Geist, et al. 2006). Like Hiroshima after the first nuclear bomb was dropped, the devastation was so total that in many places there were no survivors left to report the damage.

Thousands of tourists, from the West and the region, were vacationing in the area with video cameras in tow. The video that they shot began to appear on international television news programs and on the Internet, allowing the scope of the disaster to become clear worldwide. In previous disasters of similar magnitude, such images would not have been available, as they

would have been contingent on the technology of television and satellites, and the presence of camera crews in the area. In effect, these tourists became their own reporters, cutting out the middlemen of journalism.

The responses by a constellation of relief organizations, national governments, militaries, and private individuals around the world illustrate the strengths and weaknesses of global governance. An overall response network (states, IGOs, and NGOs) was in place, but the creation of the tailored network for the tsunami required negotiating a structure among existing groups as well as procedures to incorporate others that joined later.

The initial offers of aid from Western countries were small in comparison to the magnitude of the crisis. For example on 27 December, the United States initially pledged $15 million to immediate disaster relief. Two days later this figure was increased to $35 million, but it was already clear how inadequate this sum was. On 28 December, U.N. Under-Secretary-General for Humanitarian Affairs Jan Egeland made headlines by asserting that industrialized countries had been "stingy" (Regan 2004). (Egeland later clarified his remarks, explaining that most countries define giving in terms of percentage of GDP, in which the U.S. lags, rather than total amount, in which the U.S. leads.)

With this statement and acting as the world organization's emergency relief coordinator, Egeland became the public face of the U.N. for the duration of the crisis. His comments were a bold start. By having the courage to say what others were thinking, he demonstrated clear moral leadership as well as constructivist framing; pushing countries into a certain kind of behavior through the power of an idea.

The Bush administration in particular took umbrage and was obliged to increase its pledge tenfold (to $350 million) as well as explain that the U.S. military had already created a

joint task force in Okinawa, which included the *U.S.S. Abraham Lincoln* carrier group and six C-130 cargo transport planes (Waldman and Hoge 2004). The Egeland comment also started a bidding war within the West to see who could pledge the most aid. In an interview with BBC News and a speech on the House floor, U.S. Congressman Jim Leach called it "competitive compassion." He noted that what gave the phenomenon a new dimension was that this time it was not only competition among governments but also among intergovernmental and nongovernmental organizations (Leach 2005). For example, by the middle of January 2005, the European Union had spent $30 million, had pledged $132 million in short-term aid, and $455 million for long-term reconstruction (BBC News 2005). This was in addition to the amounts that individual governments had spent and pledged.

Considering the lack of warning system and preplanning, the Indian government reacted remarkably quickly. It sent immediate aid to Sri Lanka, as well as mobilized its navy to help in rescue efforts in Indonesia, Thailand, and the Andaman and Nicobar Islands, where it also began the task of remapping the ocean floor to allow rescue and transport shipping to reach the region. New Delhi also refused offers of aid for itself, part of a demonstration of their power and as bid for a seat on the U.N. Security Council under discussion in the lead-up to the U.N.'s 60th anniversary in fall 2005 (Bagchi 2005, Denyer 2005). China also sent aid, with one expert stating that the actions of both governments were indicative of their worldviews: both "see themselves as civilizations, as great powers moving forward economically in ways that fit their sense of themselves" (Ford 2005). However, India's refusal to accept aid was also met with skepticism by NGO officials who in the past had experienced delays and duplication of effort in similar circumstances. Oxfam's humanitarian program manager in Delhi worried that the

insistence on self-reliance made the international aid givers feel both unwelcome and wary about being able to account for what aid was accepted (Kremmer 2004).

The Indonesian and Sri Lankan governments, both of which were embroiled in armed conflicts with separatist movements, admitted freely that they were overwhelmed by the magnitude of the disaster. In Sri Lanka, where a ceasefire had been in effect with the separatist Tamil Tiger movement, authorities on both sides demonstrated a striking degree of cooperation in the initial relief phase: dealing with dead bodies, sheltering survivors, and providing food and water. In Indonesia, the separatist Free Aceh Movement declared a unilateral ceasefire, which was (temporarily) observed by the government as well. The Indonesian government also opened Aceh to foreigners, including the airport, which as one of the few undamaged points of entry in the region became a key staging area for aid distribution. Oddly enough, the situation in Sri Lanka then deteriorated, with the civil war continuing into 2009, while the tsunami crisis in Indonesia led to a lasting ceasefire and a re-integration of the rebel movement into the nation's body politic.

The offer of debt relief was refused by the government of Thailand (Ford 2005), as it would only hurt their credit rating in the future in rebuilding the lucrative tourist industry. However, at an emergency summit convened in Jakarta by the U.N. on 6 January, the G-7 froze debt repayment. The summit also approved a U.N. call for a coastal warning system, similar to that already in place in the Pacific Ocean, to be implemented in the Indian Ocean (Reynolds 2005). (The system was partially operational by the first anniversary of the tsunami.)

Global and local civil society (Cardoso Commission 2004) responded with alacrity. Operational NGOs such as the International Federation of Red Cross/Red Crescent Societies (IFRC) along with national chapters, Oxfam, CARE, Médecins Sans Frontières, World Relief,

World Vision, and Habitat for Humanity International were just some of the transnational groups that responded immediately, sending teams to assess needs and damage. In fact, the IFRC and World Vision were the largest single recipients and dispensers of humanitarian aid (Kamran 2009a). The U.N. system—especially the World Food Programme (WFP) and UNICEF—was particularly active and well-placed to assess immediate needs and to react and rely on previous partnerships with local NGOs. For example, in Tamil Nadu, in southern India, Oxfam relied on the Women's Collective and the Association for Rural Women's Education and Liberation (Kremmer 2004).

The corporate world responded as well. Some of the reported examples included Mattel, whose foundation gave $250,000 to Save the Children. Citigroup allocated $3 million to the Red Cross, local relief organizations, and long-term rebuilding. Microsoft sent $220,000 to six Indian first-responder organizations; and by 4 January it had committed $2 million in cash to local and international relief organizations while its employees had contributed $700,000. Amazon.com became a fund-raising auxiliary for charities. Johnson & Johnson sent nine "disaster relief modules," which are big containers filled with kits to care for wounds, pain relievers, sutures and personal care products through AmeriCares. Concern about accountability and transparency led to increased monitoring of employer matching programs. Many other transnational companies, like IBM, responded through local offices and affiliates to calls from local officials within 24 hours for help from the companies' crisis response teams to create command centers; by early January IBM had allocated $1 million in cash and services to relief. According to one report, "Governments have been relying heavily on nongovernmental organizations and corporations to provide money, logistical help and expertise in the affected countries" (Stephenson and Strom 2005).

Individuals from around the world responded with overwhelming generosity. As the scale of the disaster grew, many transnational organizations reported that so many people were donating via the Internet that their servers could not handle the overload; individual donations would total over $3 billion. Neither the tsunami nor the response network respected borders, as individuals joined states, IGOs and NGOs in aggregating and channeling funds to recipients in the region (Kamran 2009a). It was possible to trace over $2 million back to the New York City area alone—likely the result of three factors: New Yorkers had the money, were likely to have personal ties to the region, and many live on islands (OCHA Table A 11 July 2006).

The agencies of the U.N. system did not remain idle either. For example, the WFP, the world's largest supplier of emergency food aid, reacted within two days in Sri Lanka. However, their response in Aceh was hampered because the civil war had prevented pre-positioning aid in Indonesia (Blenford 2004). UNICEF was particularly active because children were especially affected because of their helplessness and vulnerability after losing parents.

On 29 December, the United States announced that it was forming a "core group" to coordinate aid delivery with the governments of Japan, Australia, and India. This announcement was met with widespread dismay, as it was feared that the main effect would be duplication of effort and chaos. NGOs in particular pleaded with Washington to let the U.N. remain in the lead in coordinating aid delivery (Oxfam 2004). Through the U.N. Office for the Coordination of Humanitarian Affairs (OCHA), the world organization had been coordinating the relief effort across the twelve most affected countries. The idea was quietly dropped several days later.

OCHA's "Situation Reports" were posted daily and gathered country-by-country data with such useful information as a situation summary, requirements, including a breakdown of provision by sector, agency, and dollar amount, the U.N.'s response, and the national response.

Through its ReliefWeb Internet site, OCHA was able to inform the world both what survivors' immediate needs were, what was being done to meet those needs, and the help aid workers required, such as transportation and communications equipment. For instance, when it became apparent that the infrastructure was too damaged to allow aid workers to reach victims, the United States was contacted to donate what were most needed, helicopters and pilots. And the same lack of infrastructure hampered communications, prompting Ericsson to donate satellite telephones. The United Nations had proved its mettle; several days after it was announced, the U.S. "core group" was quietly disbanded.

NETWORK MEASUREMENTS

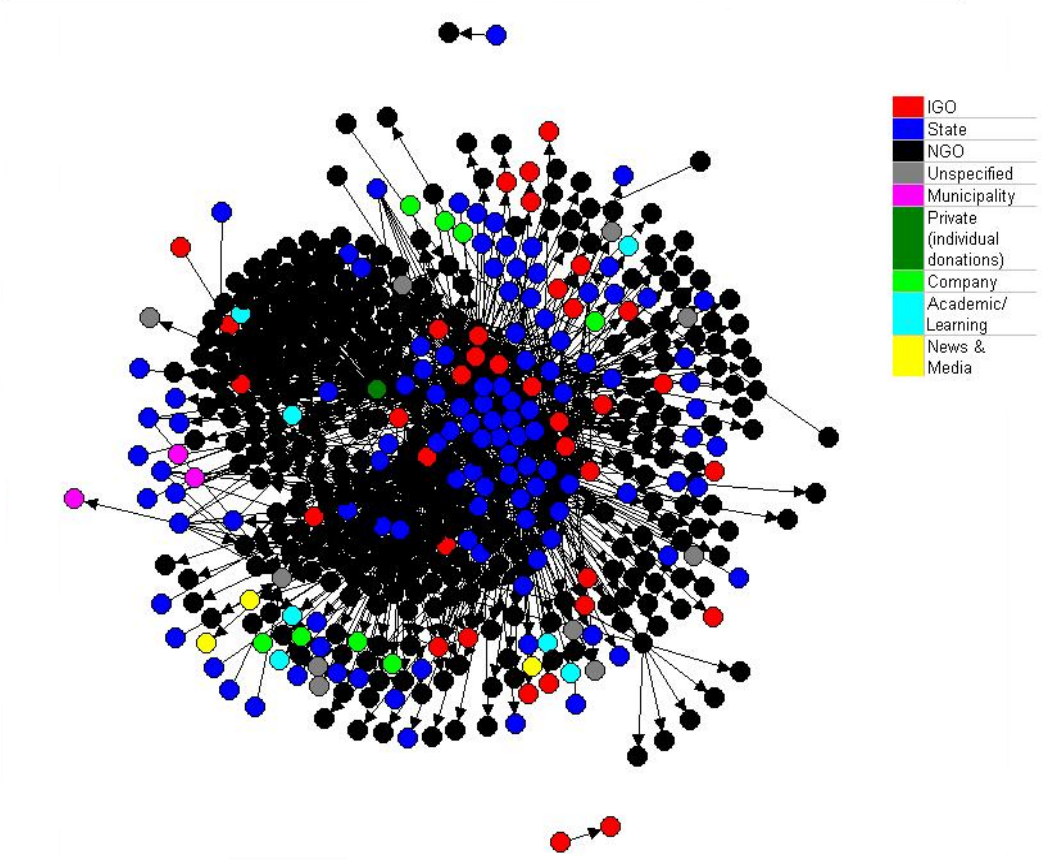
As in the previous case study, I examined both compulsory and institutional power relations in order to find structural power. The compulsory power network consisted of 2,107 records of financial transactions among 505 distinct actors. These actors were states, IGOs, NGOs, companies, academic institutions, municipalities, news media organizations, and private individuals, with a reserve category of "unspecified" for those that could not be traced via web search. The institutional power network consisted of 2,504 records of cooperative interactions among 234 distinct actors, in the following categories: state, IGO, NGO, academic institution, company, state-owned company, multiple (indicating an organization with multiple types of actors acting as one), and private individual. All calculations were performed with Ucinet 6 and all images were created using Netdraw (Borgatti et al 2002).

Compulsory Power Network

Manipulation of the layout for this network initially used spring embedding, distances plus node repulsion, and started from a Gower metric scaling layout in order to exaggerate the clustering. This gives a graph that suggests interesting things about the nature of global

cooperation. The length of the ties indicates the value; the shorter the length, the more money changed hands. The relationship between private individuals and NGOs is close and hierarchical; individuals are far more likely to aggregate their donations in NGOs. However, the picture is very different for cooperation between other actors.

Figure 5: Transnational Aid Flows: the Human Security Compulsory Power Relation Network

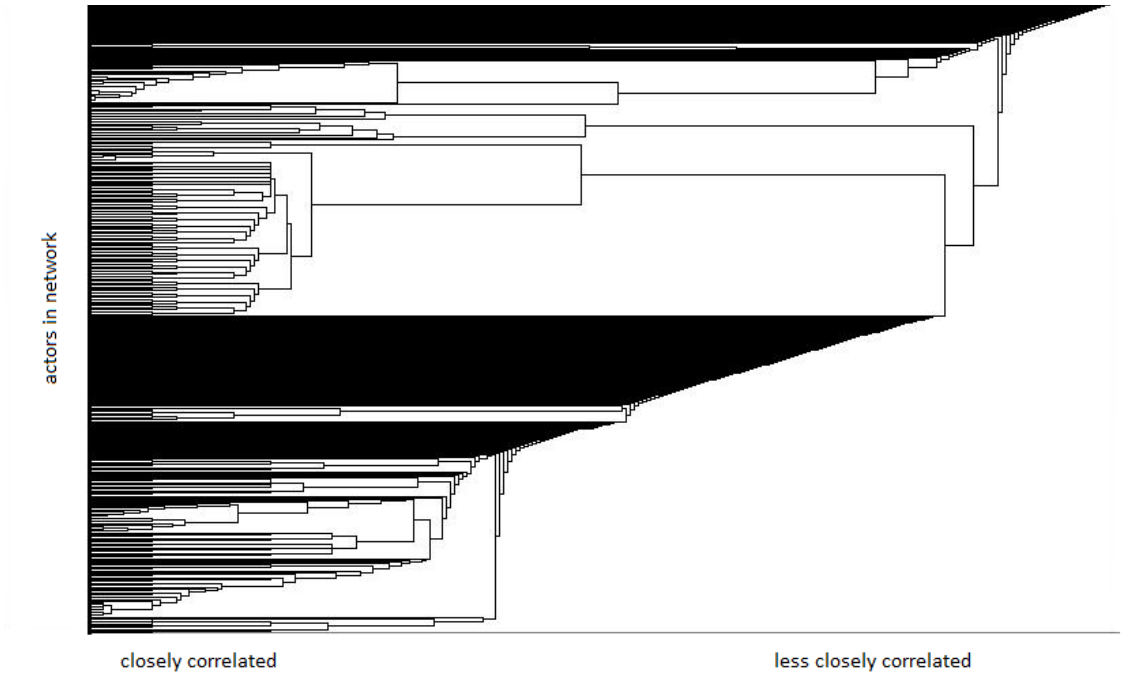


The network created by the flows of resources could be separated into its principle components: donors of funds, aggregators of funds, and channels for funds into the region. This image plots the transnational aid flows by type of actor. The actors, which are colored according to *a priori* differences in organizational type (black for NGOs, dark blue for states, etc.) are grouped according to structural similarity. That is, those that received money from one set of actors and gave money to another set of actors are thus approximately structurally

equivalent: they performed similar functions in the network, even though they are different types of organizations.

The most interesting point gained from the analysis of the dataset (from the international relations perspective) is found in the "structural equivalence" measure. Structural equivalence is the property of having the same ties to the same actors. There are five principal components in this network: 1. the private donors; 2. the IFRC; 3. World Vision; 4. a component with mostly NGOs, a few states and IGOs, and academic institutions; 5. a component with mostly states, and some IGOs and NGOs, companies, news and media organizations, municipalities, and unspecified institutions. Significantly, actor positions in the network did not depend on their attributes: different types of actors played similar roles, which is depicted in Figure 6.

Figure 6: Dendrogram of principal components in the Human Security Compulsory Power Relation Network



These components demonstrate that different types of organizations are performing similar functions in international relations in at least the circumstances of human security.

Actors in component #4 (the upper region of density on the dendrogram) seem to have been more of a destination for donor money as the organizations that spent in the region, while those in component #5 (the lower region of density) appear to have played a stronger role in aggregation.

These results seem to match the predictions that constructivists would make, such as the authoritative roles nonstate actors may play according to the particular ideational context, especially in light of the vast imbalance in the values of the donations. In this case, then, the clustering suggests that most of the resources were in the hands of nonstate actors, bolstering the constructivist argument about their importance, and suggesting that blockmodeling may find positions that are structurally similar. However, even most constructivists might not have predicted the spontaneous emergence of functionally differentiated clusters—nonobvious relationships among different actor types.

Density in a valued network is a measure indicating the total of all values divided by the number of ties possible in the network. When considering the entire range of monetary donations from OCHA's Table A, it emerged that even with comparatively small amounts at stake, organizations played multiple roles, in many instances aggregating donations from both private actors *and from states* before passing them on, either to a transnational NGO or an IGO. The density of the entire network (dichotomized) was 0.9346.

Closeness centrality, or the shortest paths to all other actors cannot be measured, because the graph is disconnected (Wasserman and Faust 1994, 200) meaning some actors are isolated from the rest. However, degree centrality, or the number of direct connections an actor has, can be measured. In a directed graph, the degree centrality of the actors can be given in in-degrees and out-degrees, indicating prestigious actors by the number of choices they received, or in-

degrees (Wasserman and Faust 1994, 170). Since the data are also valued, the degrees consisting of the sum of the values of their in-coming and out-going ties. However, degree centrality for valued data cannot be given as a normalized value for the purposes of comparison. For the compulsory relation network, the actors with the highest outdegrees are given in Table 7, and the actors with the highest indegrees are given in Table 8.

Table 7: Outdegree in the Human Security Compulsory Power Relation Network

Actor	Degree	Type of Actor
Private (individual donations)	41287.000	Private
United States of America	31309.000	State
United Kingdom	30713.000	State
European Commission Humanitarian Aid Office	30307.000	State

Table 8: Indegree in the Human Security Compulsory Power Relation Network

Actor	Degree	Type of Actor
International Federation of the Red Cross/Red Crescent	62388.000	NGO
International Organization for Migration	24894.000	IGO
Office for the Coordination of Humanitarian Affairs	20241.000	IGO
World Health Organization	18439.000	IGO

Private donations headed the list for outdegree. The list of highest indegree actors reflects the aggregating function that the IFRC plays internationally, similar to the way the American Red Cross aggregated private donations from people in the U.S (Kamran 2009a). Indegree measures number of ties sent, not the strength of those ties—the monetary value of the IFRC's indegrees was not as high as that for the American Red Cross.

That there is no coincidence between actors with high indegrees and actors with high outdegrees suggests that the network was highly differentiated by function: some actors were

receivers of funds, which were then funneled to others for spending. Furthermore, these functions were not a property of the type of actor. This result cannot be accounted for by either realism or liberal institutionalism. However, both can be accounted for by the constructivist school.

There are no cliques in a bipartite graph, as there are no nodes that are maximally connected, so other measures of finding cohesive subgroups had to be employed. The average distance between reachable pairs is 1.000, but the distance-based cohesion of the graph is 1.000, out of a range from 0 to 1 (larger values indicate greater cohesiveness).

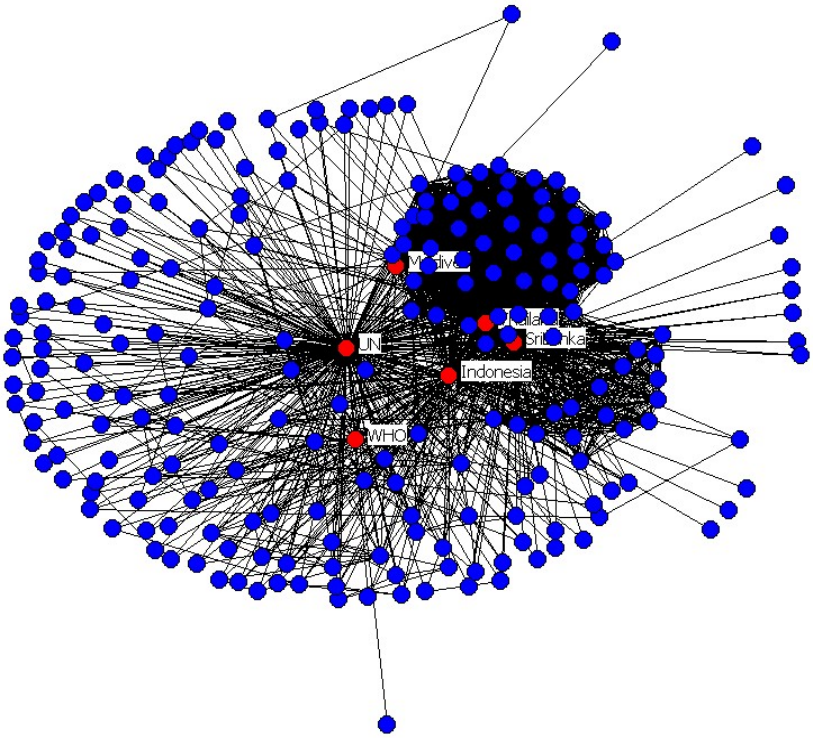
These measures indicate that the network is fairly cohesive. The measure of cohesiveness therefore likely means that the network was good at aggregating smaller sums, while the largest donations were spent without much coordination. This result has implications for effectiveness at responding to a security event: networks that are not cohesive are less likely to communicate well, and should therefore be more likely to duplicate efforts and waste resources. That the response to the tsunami was able to avoid this outcome has since been confirmed by evidence from post-action reviews (Telford et al 2006).

Institutional Relation Network

The disaster showed what the U.N. system of agencies could do in terms of filling the institutional gaps. Because the world organization had standing operating agreements with almost all of the governments, civil society actors, and other organized groups, it was able not only to fill the gap in knowledge about what had happened and what was needed where, but it was also able to incorporate new actors when they came on the scene: thousands of individuals spontaneously created relief groups whose action needed to be directed usefully (Global Surf

News 2005). In the network of institutional power relations, the U.N. is a cutpoint, while no member of the "core group" was, as demonstrated by Figure 7.

Figure 7: Cutpoints in the Human Security Institutional Power Relation Network



The cutpoints are the U.N., the World Health Organization (WHO), Maldives, Thailand, Sri Lanka, and Indonesia. It is likely that Washington's proposed "core group," consisting of the United States, Japan, India, and Australia, would have resulted in a very different network. The most central actors, for example, would have been the bilateral aid agencies of states rather than private donors, transnational NGOs, and transnational IGOs. And it is likely that the network would have had a different hierarchical structure, with the bilateral aid agencies at the center and all others on the periphery.

The average density of the network is 1.0056, with a standard deviation of 0.0748. This means that on average, each possible pair of actors shared attendance at roughly one meeting.

The measures of both degree and closeness centrality of the top ten actors in the network appear in Tables 9 and 10:

Table 9: Degree Centrality in the Human Security Institutional Power Relation Network

Name	Degree Centrality	Type of Actor
U.N.	93.562	IGO
Indonesia	55.365	State
Sri Lanka	52.490	State
Thailand	36.052	State
U.S.	35.193	State
World Bank	34.335	IGO
Asian Development Bank Australia (tie)	33.906	IGO State
India Japan (tie)	33.047	State State
IFRC	32.189	NGO
Maldives	29.614	State

Table 10: Closeness Centrality in the Human Security Institutional Power Relation Network

Name	Closeness Centrality	Type of Actor
U.N.	93.952	IGO
Indonesia	69.139	State
Sri Lanka	67.930	State
Thailand	60.995	State
U.S.	60.677	State
Australia World Bank (tie)	60.207	State IGO
Asian Development Bank	60.052	IGO
India	59.897	State
Japan	59.744	State
Maldives	58.690	State

There is a mix of actors for both measures of centrality, although the cast does undergo some changes in membership. In both cases, the countries most greatly affected by the tsunami are present, as well as the U.N., the U.S., Australia, Japan, and the financial branch of the international community (as represented by the World Bank and the Asian Development Bank)

are present. For degree centrality, it is interesting to note the key role of a transnational nongovernmental organization, the International Federation of the Red Cross/Red Crescent (IFRC) in coordinating humanitarian aid activities. However, for closeness centrality, the IFRC does not make it into the top ten. These measures indicate both the importance of the U.S. idea of a core group, as these countries' services were essential to the response; as well as why the idea was dismissed—the particular countries the U.S. would have included in the core group were essential, but not the most central to the response.

In contrast to the past, while criticism was leveled at poor management of relief funds (accompanied by fears that long-term support would dwindle), the basic goal of averting a second crisis was achieved. In particular, the U.N. and others moved to address the democratic deficits of disaster recovery by appointing an independent auditor. In February 2005 the auditor's task was taken on by the Tsunami Evaluation Coalition (TEC), a non-profit multi-agency learning and accountability initiative from across the humanitarian sector, including the U.N. system, donor nations, and transnational NGOs. The stated task was to ensure that the more than $6.7 billion that was pledged for humanitarian aid (Stamp 2005) actually reached the intended recipients. Corruption and leakage were often problems in such previous disasters as Hurricane Mitch in Central America or the earthquake in Bam, Iran (BBC News 2005). As of January 2007, TEC found that the funding was unusually transparent, generous, speedy, and from non-government sources (Telford et al 2006). However, much of the aid and accountability available for this unusual blockbuster natural disaster is absent in less visible emergencies of all types. Efforts to counter this include ReliefWeb, as well as private endeavors such as the crowd-sourced geospatial visualization platform Ushahidi (www.usahidi.com), which coordinates reports from individuals via text, email and social media.

CONCLUSION

This project makes clearer the existing relationships between actors than narrative analysis alone, thus suggesting areas in which improvements can be made. The project also shows that the structure of the network makes a difference in how effective the network is in meeting the threat it was created to resolve. The pattern of cooperation that emerged in this investigation indicates that this is an important area for study in the field of international relations. By using the techniques of social network analysis, it is possible not only to verify the hypothesis that nonstate actors are important in world politics, but also to find out more than narrative analysis or a dollar count will allow about just how important they are. The amount of money donated by each actor indicated how important nonstate actors are, but the description of the varying roles they played—aid aggregator and aid distributor—would not be apparent from a simple list of amounts contributed.[26] For example, just knowing that the single largest donor category was "private individuals" could not tell a researcher to whom that category's money was donated. Furthermore, the self-organization into aid aggregators and aid distributors is not predicted by any of the various schools of thought, which at most would have suggested that various actor types would cooperate to provide humanitarian aid, but *not* that they would spontaneously divide the job into gathering funds and resources on the one hand and distributing those funds and resources on the other. This ability to find nonobvious patterns is an important step in fleshing out a theory of international relations that is capable of dealing with more than one type of actor.

The findings and analysis of the compulsory relation confirm the hypothesis that nonstate actors can be as or more important than states in the right context. The actors with the largest

[26] Nor is it immediately obvious from the list of contributions and disbursements, which in this case is thousands of records long.

indegrees and outdegrees (number of donations) were more likely to be nonstate actors such as NGOs and IGOs than states. Analysis of the components showed that actors with different attributes played similar structural roles in the network, demonstrating that international politics is even more complex than most realize: it is not possible to tell an organization's position from attributes such as sovereignty or source of funding alone. Context is more important than the leading mainstream international relations theories of realism and liberal institutionalism[27] allow: framing the issue as one of human security allows the participation of a greater range of actors in more varied roles. Even more importantly, organizations of different types played structurally equivalent roles in the same network, meaning that the actor's attributes do not predict its role, even given a particular context.

The findings and analysis for the institutional power relation look more like what one would expect from the predictions of liberal institutionalism than of constructivism. An IGO, the U.N., was the most central actor, and states were vital to the coordination process. NGOs both local and transnational played a more peripheral role in this network than in the compulsory power relation. This bears out the liberal institutionalist hypothesis that IGOs play a major role in international relations precisely because their ability to marshal expertise is institutionalized (Goldstein and Keohane 1993).

The two networks of compulsory and institutional power are not exactly comparable; the former is valued and directed, while the latter is neither. However, comparison in relative terms is still useful, and shows us that while nonstate actors were important in both networks, they

[27] For example Gilpin's "The Richness of the Tradition of Political Realism" asserts the three assumptions the various strands of realist thought has in common are "the essentially conflictual nature of international affairs…the essence of social reality is the group …[and] the primacy in all political life of power and security in human motivation" (Gilpin 1986: 304-305). It is the first assumption that most needs questioning in terms of context: most interaction is not conflictual either domestically or globally; and *international* refers to nation-states but not to other types of groups. Similarly, Ruggie's definition of an international regime as encompassing mutual expectations of behavior among states (Ruggie 1975) refers to an agreement among *states* to cooperate in a particular way on a given issue.

were more important for funding than for coordination. In human security then, different types of actors are likely to occupy similar positions of structural power.

CHAPTER SIX

NETWORK STRATEGIES FOR GLOBAL GOVERNANCE

Swiss cheese is a structure whose taste remains unchanged but whose visual appearance changes by slicing in different directions—depending on the cut, the same holes appear different. At a higher level of detail, an MRI takes fine-grained pictures of such heterogeneous structures as the human brain. Tiny two-dimensional slices are assembled to provide an extremely accurate three-dimensional depiction of complex reality, but as with the cheese, any one slice provides only a partial picture that is accurate but can be misleading. Furthermore, what matters in any given situation are specific paths of connections—the terrain to be navigated. The concept of global governance provides a description of the complex, heterogeneous structures created by actors in world politics, which can be studied by examining slices at different geographical, temporal, and issue junctures.

For example, what was the structure of the network against trans-Atlantic human trafficking in 1865? What is it today? How do both structures (assuming they differ) compare to cooperation to prevent slavery in contemporary Asia? At present, social scientists have knives to slice cheese but are grasping for tools to take and aggregate MRI slides.

This chapter first reviews the use of social network analysis to map meaningful connections in global governance. It reviews the hypotheses about hierarchy and nonobvious relationships in terms of the two case studies: international responses after the Cold War to nuclear proliferation and to the Indian Ocean tsunami of December 2004. It then looks at a range of possible strategies at the micro level of individual actors and the macro level of networks as a whole of empirical examples of slices of security space. It ends with a discussion of the

elements of a theory of global governance—the most promising way to appreciate the partial and currently available slices of contemporary international relations.

USING NETWORK ANALYSIS TO STUDY GLOBAL GOVERNANCE

To review, the basic elements of network analysis are actors, which are the social units, and relations, which are the ties between or among actors that are channels for the flow of resources (ties can be affiliations, as in members of the same club). There are three basic assumptions underlying social network analysis. First, we are dealing with relationships or connections and not merely static units. It is therefore not a method suited to studying units in isolation. Second, network analysis assumes that social units are interdependent; their ties both enable and constrain actions. This also means that regular statistical methods have limited utility because actors are not independent and cannot be analyzed in isolation one from another. Third, network analysis assumes that there are system-wide relational properties, and that the sum of such patterns constitutes the system's structure. (SNA is explored in more detail in Appendix A.)

This chapter compares networks of actors involved in the governance of global security issues (for the purposes of demonstration, this paper looks at networks from different issue areas, but the concept applies to geographical and temporal slices as well). There are the two networks created from institutional power relations, and the two from compulsory power relations: one each from a case study of a human security threat—the Indian Ocean tsunami, and one each from a case study of a traditional security threat—the attempt to stem nuclear proliferation. From these mapping exercises, I extract principles of structural power.

An ecological approach looks at the entire system of interactions, both among actors and between actors and environment. Global governance fits the definition of a complex system: multiple types of actors and processes, the structure of which is the result of past structure, actor

choices, and stochastic processes. The modeling of such complex systems in international relations has its roots in sociology. It is greatly facilitated by the use of quantitative social network analysis methods, used to map broad trends and patterns, which can then be used as a basis for comparison, for finding "communities" of similar actors, and for investigations into dynamics. To demonstrate this, examples from a range of global security governance issues will be explored.

However, using social network analysis to study global governance requires careful examination of both ontology and epistemology, as the definitions and conceptions of what is to be studied are affected by the choice of a formal mathematical approach. In contrast to both realism and liberal institutionalism, which look at the pattern of interactions among the members of only one or two types of organization, the ecological approach assumes that all the organizations that demonstrate agency, or choice, count as actors. These actors interact with each other and with their environment, which refers not just to the strictly material or ideal, but also to background trends such as globalization that do not exhibit agency. In this sense, it draws upon the heritage of English School theory (Bull 1977, Buzan 2004, Devlen et al. 2005, Hurrell 2007). This approach also means that the intellectual puzzles of researchers will change, as the questions become more oriented toward patterns of cooperation and cohesion, and less about the actions and motivations of individual actors, or of specific types of actors.

Slices of political space

A graphic representation of political space would show the multiple dimensions in which issues can be mapped. The dimensions to be mapped may vary, but as an example, security could be mapped by asking these questions: "Where does the threat come from?" "What is the target of the threat?" "How fast does the threat move?" and "What is the severity of the threat?"

These are spectra, or continuums, not dichotomous categories, and thus can be imagined as dimensional axes. Patterns of cooperation, or networks among actors, are different depending on where one looks on these dimensions.

An advantage of mapping along multiple dimensions is that no one position can be seen as a priori privileged. It also means that the space can be "questioned" by different lines of thought. For example, one could ask where the organizations that deal with the security of internally displaced persons (IDP) camps intersect with organizations that deal with human rights or more specifically women's rights. This could help provide security to those most likely to face unique threats to their security while in the camps, not just the threat that the camp itself provides security from.

Take slices of this space by imagining Swiss cheese or an MRI: one network may be a very misleading picture of the structure, but build up enough layers, and you start to get a 3-D object. Some of these networks may have overlapping memberships, or intersections. Capturing the complexity of the range of problems, actors, and partial solutions is a benefit of using global governance as an analytical perspective in understanding international responses to events like the tsunami. But we are still at the Swiss cheese-level of precision, groping for tools for a few MRI-level slides. What could get us closer?

As we have seen, network analysis is a promising methodology because it allows comparisons of the types of contours of structures and gaps that characterize international reactions to global problems. It provides a way to systematically study the structural properties of networks as well as the location and characteristics of actors within them; it uses mathematical representation in order to quantify empirical data and to model relations and structures and represent the results graphically. Network analysis allows the simultaneous consideration of

multiple relationships—a major insight for the analysis of international relations, even when considering states let alone the multiple types of actors and layers of relationships that characterize contemporary global governance.

The actors belong to different sets (because they are different types of organizations—states, NGOs, companies, etc.), but there are also connections among and between sets. On the basis of this theoretical framework, it should be possible to examine both clustering, or how closely connected actors are, and structural equivalence, or finding "communities" of actors with similar patterns of relations to the rest of the network.

THE HYPOTHESES AND THE CASE STUDIES

To review, the compulsory power network for the tsunami consisted of 2,107 records of financial transactions among 505 distinct actors from the Financial Tracking Service database. These actors were states, IGOs, NGOs, companies, academic institutions, municipalities, news media organizations, and private individuals, with a reserve category of "unspecified" for those that could not be traced via web search (Kamran 2009a). The institutional power network for the tsunami consisted of 2,504 records of cooperative interactions among 234 distinct actors culled from OCHA's situation reports, in the following categories: state, IGO, NGO, academic institution, company, state-owned company, multiple (indicating an organization with multiple types of actors acting as one), and private individual (Kamran 2009a).

The compulsory power network for nuclear nonproliferation consisted of 575 records of financial transactions among 454 distinct actors created from the Business Source Premier (now called Business Source Complete) database maintained by EBSCO. These actors were states, companies, state-owned corporations, joint action agencies (joint-action agencies are owned by their members, which are electricity cooperatives), partnerships, joint ventures, academic

institutions, nongovernmental organizations (NGOs), intergovernmental organizations (IGOs), and unknown. Actors were coded as state-owned if they were more than 50% owned by a state (Kamran 2009b). The institutional power network for nuclear nonproliferation consisted of 196 distinct actors related by twelve treaties or agreements. These actors were all states as recognized by the United Nations, with the exception of Taiwan, Republic of China (Kamran 2009b). This network can also be regarded as a test of the method: if a network analysis finds anything completely unexpected in a network that has been so well-traveled by scholars using other methods, we must suspect that the method is either inappropriate or has been misapplied.

As has been demonstrated by the case studies, there are distinct patterns to global politics. There is significant support for both H1 (the more traditional the situational frame, the more state-centric the relationships will be) and H2 (the more traditional the frame, the more hierarchical the structure). These patterns are influenced by the frame, which can to some extent determine the types of actor that can participate and what their network position will be. However, these patterns are not dichotomous, as would be the case if the networks created adhered strictly to ideal type: the overall network structure appears to depend on the type of power relationship under examination.

Hierarchy

Neither H3, the realist hypothesis of hierarchy, nor its subsidiary hypothesis H3a is supported by the evidence. States are not the most central actors in every frame, nor are nonstate actors central in the order defined by an a priori hierarchy of state, IGO, and civil society actors. States were solely the most central actors only when states were the only actors allowed in the network, as in the institutional power relation for the traditional security network. There is more support for H4, the liberal institutionalist hypothesis of hierarchy, but only on the institutional

power relation for the human security network. H5, the constructivist hypothesis of hierarchy, is the only hypothesis that is not invalidated: it holds true for both frames and both power relations.

Nonobvious Relationships

Both the hierarchical cluster analyses and structural equivalence classes indicate no support for either the realist or the liberal institutionalist hypotheses on nonobvious relationships. When actors are free to make (or not make) relationships, as they are in all frames and relations except the institutional power relation of the traditional security frame, there is no evidence that nonstate actors are limited to direct relations with states. Nor is there evidence that states, or states and IGOs, limit themselves to direct relations with each other and indirect relations with NGOs that are not their own creatures. Again, the only hypothesis that is not invalidated is H8, the constructivist hypothesis of nonobvious relationships.

NETWORK STRATEGIES

Networks in global politics are certainly applicable to the study of strategy—Nobel-laureate Thomas Schelling wrote that tactics to be used in indeterminate situations depend on relationships:

> The essence of these tactics is some voluntary but irreversible sacrifice of freedom of choice. They rest on the paradox that the power to constrain an adversary may depend on the power to bind oneself; that, in bargaining, weakness is often strength, freedom may be freedom to capitulate, and to burn bridges behind one may suffice to undo an opponent (Schelling 2002, 22).

There are two types of network strategies: those that can be used by actors within a network in order to improve their position vis-a-vis or attack other actors within that same network, and those that can be used to increase or decrease the efficiency of a network as a whole. These strategies are interdependent, as one might guess about a socially-constructed entity. Much of the network literature on terrorist networks and other "dark" networks is concerned with disruption of a network which is itself focused on rupturing security (Everton and Roberts 2011,

Carley 2006, Raab and Milward 2003). The idea here is to use network strategies to provide security, not damage it.[28]

Network-as-Structure: Micro-Level Strategies

Kahler identifies three types of structural power that can be exercised by actors in networks: bargaining, in which actors that connect the weakly connected have leverage (can act as brokers between others); social power in which nodes that are really well-connected have the best access to whatever is flowing through the network; and the power of exit, or the ability to leave the network altogether, thus ending cooperation (Kahler 2009). The first type relates to the existence of cutpoints in the network; those actors that are bottlenecks for resources can use their position to extract concessions. Social power is centrality in the network, while exit is the ability to become an isolate, a totally separate component of the graph, at will.

There are cutpoints in the human security "OCHA sitreps" network: the U.N., the WHO, Maldives, Thailand, Sri Lanka, and Indonesia. An interesting point raised by this case study is that the actors that constituted the network's cutpoints had policies for close institutionalized ties among each other. These individual policies interacted to create from the cutpoints a "backbone" along which the network could be quickly built.

Centrality is a power indicator, measuring how information and resources flow or fail to. "Closeness centrality" indicates the shortest paths to all other actors, while "degree centrality" the number of direct connections an actor has.

[28] In the following sections, all calculations were performed with Ucinet 6 (Borgatti, et al. 2002).

Table 11: Centrality Compared Across Security Networks

Frame	Relation	Closeness Centrality	Degree Centrality
Human Security	Compulsory power	(this measure is not applicable in a disconnected graph)	Private (individual donations) United States United Kingdom EC Humanitarian Aid Office IFRC International Organization for Migration U.N. OCHA World Health Organization
	Institutional power	U.N. Indonesia Sri Lanka Thailand U.S.	U.N. Indonesia Sri Lanka Thailand U.S.
Traditional Security	Compulsory power	Areva Framatome ANP Exelon Corp Westinghouse Electric Co U.S. Dept. of Energy	Westinghouse Electric Co Chernobyl Shelter Project U.S. Department of Energy Framatome ANP Areva
	Institutional power	Australia New Zealand Argentina Austria Belgium	Australia New Zealand Argentina Austria Belgium

Table 11 shows the actors in each network with the highest centrality scores. Degree centrality for "transnational aid flows" is divided into outdegree (on top) for aid donors and indegree (on bottom) for aid recipients. There can be important differences in which actors are most central according to the measure used, which is why it is recommended to look at more than one measure. One thing that becomes clear, however, is that nonstate actors can be as or more important to the structure and functioning of the network than state actors.

Finally, it is important to note that while all actors in these networks have the power of exit,[29] not all of the actors have the same power of entry in all of the networks. It makes little sense for central actors with control over resources and information not to be included in treaty networks. The existing system of nonproliferation treaties has worked very well for states. It should be taken as a model for issues requiring high levels of enforcement. However, the OCHA sitreps network should be taken as a model for incorporating other actors in networks, as issues requiring high levels of enforcement are likely to need cooperation among actors in addition to enforcement from states. While states have guns and other resources they cannot be everywhere or monitor every transaction, making it necessary that other actors in the network either enforce rules themselves or make infringements public so that they can be dealt with either by the network as a whole (i.e.: expulsion) or by more powerful actors.

Network-as-Actor: Macro-level Strategies

The first step in building a network theory of international relations is to embrace the idea that other actors, beyond the state, are more prevalent in world politics than realist and liberal institutionalist theories have previously suggested. Therefore, it is imperative that scholars and others be very clear about who makes decisions, on what authority, and in what relation to each other. Network structure will affect relations; we need more information on how it will do so.

The powers that networks themselves can exercise are scalability and adaptability. Scalability refers to the ability to grow rapidly at low cost without altering fundamental form, and adaptability refers to the ability to change form over the term of the organization's life cycle. Both are seen as crucial to the effectiveness of meeting the organization's goals (Kahler 2009).

[29] All actors have the power of exit, even if that means their own dissolution due to lack of incoming resources from other actors in the network.

Scalability can be measured by density and by cohesion. Density in a network is a measure indicating the total of all existing ties divided by the number of ties possible in the network (with the value of the ties being included in ordinal networks).

Table 12: Density Compared Across Networks

Frame	Relation	Density
Human Security	Compulsory power	0.9
	Institutional power	1.0
Traditional Security	Compulsory power	1.1
	Institutional power	2.4

As is clear from Table 12, density is higher in traditional security networks than in human security networks. This is likely a reflection of flexibility and ease of making/breaking ties in human security networks. However, it also indicates that the speed at which information diffuses among the actors is relatively quicker in the traditional security networks, and the extent to which actors in those networks have levels of social constraint is higher than in human security networks. Density is also higher in the compulsory power relations than in the institutional power relations of both human and traditional security networks, demonstrating that making ties in order to share information and expertise (as well as enforcement) generally involves more than bilateral ties—information diffusion is maximized when there are more actors in the network.

Cohesion measures sub-structures within networks, such as alliances or even cliques. Actors that are well-connected to one another can form a backbone to which new actors can attach—new actors need not be connected to each existing member of the network, they just have to be connected to some entity which is well-connected (a hub). The institutional power relation networks were more cohesive than the compulsory power networks, even though in the human security frame the organizations did not necessarily have ties prior to the event while in the traditional security frame the cohesion was the result of long and painstaking multilateral

treaty negotiation. This result has implications for effectiveness at responding to a security event: networks that are not cohesive are less likely to communicate well, and should therefore be more likely to duplicate efforts and waste resources.

Because the current study only deals with static "snapshots" of its networks, adaptability in these networks is not known. However, speculation on the ability of a network to adapt its form according to circumstances is prompted by the discussion on cutpoints above. Furthermore, actors in networks should be very careful in choosing to retain or discard rules for network formation that allow and encourage such flexibility, lest they choose policies that become path dependent over time (Pierson 2000). Flexibility of network structure may not be very important at any particular moment, but if it becomes important in the future, it is important not to adopt rules that prevent it—such as those that limit inclusion in the network based on actor type.

STRUCTURAL EQUIVALENCE AND INTERSECTIONALITY

Equivalence Classes

There are many measures that look at the similarity of roles in a network. Structural equivalence indicates that different actors share a jointly occupied position in the network. In the transnational aid flows network, there was an interesting breakdown of actors into large clusters of aggregators and channels. Aggregators collected aid from individuals and from other organizations and passed it on to channels, which delivered the aid, either themselves or through others in the region. In the OCHA sitreps network, the cutpoints, or the actors that were major hubs for information, were the U.N., WHO, Maldives, Thailand, Sri Lanka, and Indonesia.

The equivalence classes in the nuclear treaty network points out the danger that many nuclear weapons states are in separate classes. Also, there are states in these classes that have

indigenous nuclear capabilities, either for research, power generation, or both. Another way to discover structural equivalence is through hierarchical clustering. For the nuclear contracts network, these hierarchical clusters show that being different organization types does not hamper certain types of similarity. For example, Areva is a vertically-integrated organization with contracts from suppliers and to customers at every stage of the fuel cycle from mining to plant operation. The other actors in Areva's "class" have similar patterns of ties, whether they are state-owned corporations like Areva or not.

Intersectionality

The concept of intersectionality first surfaced in the humanities and social sciences in critical theory, and was best explained by Kimberle Crenshaw in a study on the effects of different types of violence on women of color. She found that the narratives that describe, explain, and circumscribe race and gender are coded—"blacks" are male in the mainstream narratives, while "females" are white. Intersectionality refers to the properties exhibited by actors that belong to racial and gender identity groups that are narratively treated as being mutually exclusive. This could have disastrous effects on policy choices, preventing women of color for reporting violence, for preventing violence, and from accessing services for domestic violence victims (Crenshaw 1991). In other words, actors belonging to multiple networks (as measured by their different relationships) can be expected to have different identities, to face different structural opportunities and constraints, and to pursue different interests—different from actors belonging only to one of the networks.[30]

[30] Feminists have recognized a "need for understanding complexities posed by intersections of different axes of differentiation." Intersectionality thus signifies "the complex, irreducible, varied, and variable effects which ensue when multiple axes of differentiation – economic, political, cultural, psychic, subjective and experiential – intersect in historically specific contexts. The concept emphasizes that different dimensions of social life cannot be separated out into discrete and pure strands" (Brah and Phoenix 2004). Actors at intersections do not experience identity as additive—black + female = black female—they experience identity in unique ways, often in opposition to the mainstream narrative.

Intersectionality is therefore a complex and fluid concept, difficult to operationalize, and even more difficult to quantify—unless we marry network analysis to mathematics: membership in a network is a dimension of identity (whether for individual or collective actors), and again, the networks themselves can be considered cells or subsets of a set or hypergraph. (The notation, which is from set theory in mathematics, is given in Appendix A.)

To find the intersection of the four networks discussed here, the software program ORA (Carley 2010) yielded some interesting results: Australia, Austria, Belgium, Canada, India, Denmark, Finland, France, Germany, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States were the members of this "community," appearing in all four networks. All are states; there are no nonstate actors in the group—so far, the results agree with Lentner (2004) that states are the most important actors in global politics. However, while realists might point out that this would be their expected result anyway, it is an important result because the intersection does not depend on *a priori* definitions of actors but on the relations in which these actors are active. As a result, it could change in the future—indeed, one could argue that within the United Nations family there are treaty-based non-proliferation organizations, so the United Nations should also be included in the intersection and that it was not is a mere artifact of coding.

Furthermore, the focus on multiple relations or layers means that the actors in the intersection are not just features in the network surface topography, but are prominent in the networks' geology. It comes as no surprise that the usual suspects—the highly developed states of Western Europe, North America, Australia, and Japan—are active in the provision of security in many frames and relations. However, the intersection also indicates that there are newcomers to this club such as India. There are also notable no-shows, such as China, Brazil, and Russia.

There are several possible uses for intersections. This would be useful for "profiling," or to ask a specific question of multiple networks (i.e., how many actors fit a specific profile). It could be used to find a core of actors in multiple networks. This would be useful in for example global economic governance in taking the economy's "temperature" in testing the network positions of companies in different industries, if one has reliable transaction data (Germain 2007, Setser 2008, Bernanke 2008). For example, the definition of "too big to fail" might be those high-volume actors with high centrality measures at the intersection of multiple networks as measured by relation type (Chan-Lau 2010). And it could be used to test for change over time by looking at the same network at multiple points in time (i.e., asking is there a stable group of core actors?).

TOWARDS A NETWORK THEORY OF GLOBAL GOVERNANCE

A network theory of global governance would use the multi-dimensional definition of global governance developed by Weiss and Thakur; define actor as an individual or organization capable of exercising agency by sending and receiving ties; and define network as a group of actors connected to each other by a specific relation.

The assumptions such a theory would have should include the following: first, there will be multiple actor types involved in governance, whose structural position is determined by their pattern of relationships, and not only material capabilities. Second, there will be multiple relationship types, which are relatively open to change by the actor's initiative. Ability to change will depend on frame, relationship type, and the existing network structure. Third, the entire network structure can change as a result of individual actors' changes—the accumulation of individual changes can "tip" or push it into a new frame.[31] Fourth, network structure impacts

[31] This may seem counterintuitive, but imagine a room with a dozen people, all silent except for one pair talking. As more people join the group of people talking, the composition of the group changes, and the structure of the network

the effectiveness of meeting the goals of the network (which are not necessarily the goals of the individual actors). And fifth, these assumptions all operate under conditions of anarchy.

On the basis of the security networks studied, we can draw some conclusions about structural power: actors can leverage expertise such as research and operational know-how as well as material capabilities into structural advantage. This applies to any actor, as non are privileged *a priori*. It also applies across networks. We can also see how existing structure would both enable and constrain future interactions, as duration or the shadow of the future would engender at least a limited amount of trust in other network participants. Such trust is necessary to building stable network "backbones" that can work together, scale up and down, and perhaps even model good governance for the rest of the network.

Of particular interest are the principles that apply to the community of actors found at the intersection:

1) Actors at the intersection of global security provision networks have the ability to play on many fields, with a wide range of other actors. The absence of some of the usual suspects and emerging powers shows that a state can be successful in global governance without being particularly prominent by conventional standards.

2) Actors at the intersection have more than the usual actor's ability to set the rules of the network's relationships: the conditions of entry and exit, and the terms of interaction. This is substantiated by noticing that usually the actors with high eigenvector centrality are the ones that have been identified in qualitative studies as being the institution-builders of international regimes.

(consisting of all the people in the room) goes from mostly unconnected to mostly connected. This is the result of individual choices to engage, but that has an effect at the level of structure.

Finally, a network theory of global governance would predict that frames can be altered, and are permeable depending on the measure of power used: they are open both to different actor types and more flexible as to conditions of entry and exit.

A Future Research Agenda

Global governance network research is obviously at an early stage, and capturing global governance data will be problematic until social scientists become more aware of the abundance of data inherent in the increasingly digitized records of movements and transactions by actors of every stripe. The possibilities of finding or recording digitized data, and using it to examine interaction patterns will grow. Meaningful global governance data is available if we have better theory to guide us. For instance, it would be useful to imagine a laser's sending a sheet of light through a cloud of smoke as it swirls in a current. Many slices will be required just to approach a three-dimensional model of the cloud, and we require the fourth dimension of time to show air currents. We cannot merely examine one network at one point in time—not only do we need lots of slices, but we need to see them in proper sequence. We require better pictures, or thick descriptions, of both constituent actors and processes.

Global governance has been a difficult concept to grasp because its manifestations sometimes seem inconsistent. Imploding states and the European Union are part of contemporary reality, which reflect James Rosenau's "fragmegration" (Rosenau 1997). Keeping in mind simultaneously what seem like inconsistencies is a perceptual problem and not an indicator that global governance cannot be understood or made to work better. Global governance happens without perfect global integration, but clearly there is room for improvement. Without adequate depictions of what is going on, policy prescriptions are elusive—hence, simultaneous calls for more robust multilateralism as well as for stronger states. If we look at sovereignty as an

anomaly—or a cancer metastasizing in various directions and preventing common solutions—we need tools for diagnosis and prognosis before we can apply the correct drugs or surgery. More robust and diverse international institutions could be part of the mix if there is sufficient agreement about their mission, structure, funding, and so on. *Ad hoc* networks will likely evolve around issues if that agreement is lacking.

The central problem of prediction in the social sciences revolves around three factors. First, the consequences of one's actions are not completely knowable. Second, even the consequences that can ultimately be traced back to a cause are not always knowable in advance. And third, neither one's actions nor the consequences of those actions are independent of the actions of others.

At this time, it is impossible to use global governance theory to predict global system change or system-wide conflict, but that does not distinguish it from other bodies of theory. To continue the medical analogy, it would be like trying to predict multiple organ failure. I suspect that as global governance theory develops and our understanding improves, we may be able to use this framework to foresee just these kinds of changes within the world system. Slices would show us structural positions, and slices over time could show dynamic patterns of change. For example, the structure could show which states are becoming weaker relative to other actors. Their situations could then be investigated more closely to uncover the possible reasons, which could be compared to actors with similar structural patterns elsewhere in the system. As one group of analysts writes, "Finding local fluidity and global stability…suggests that change moves through structurally equivalent actors" (Moody *et al.* 2005)

Better information could also be used to calculate probabilities; for instance that a structure exhibiting certain characteristics is likely to change in predictable ways. Network

statistical applications could be particularly useful, especially in modeling the cooperation between individual actors in the framework of dynamic or evolutionary game theory. Absolute predictability is impossible because all subsequent conditions are explained part by previous ones and part by chance. In spite of this randomness, global governance is about numerous actors' self-organizing through formal and informal means to meet worldwide challenges.

The response to the Indian Ocean tsunami of December 2004 was anomalous—unlike most appeals for humanitarian aid from the U.N., it was over-funded. A nice side effect for social scientists of the globalization about which we theorize is the amount of data that is now available to us for empirical study. Future research using SNA on the tsunami response should look at several things, such as extending the analysis to the "destination" category to further map the money trail; adding a relation for information-sharing in order to include organizations that gave manpower and expertise rather than goods or money; and adding the element of time in order to see and compare the dynamics of this network to others.

In particular, the records of donations for those other appeals should also be subjected to similar analyses: the networks should be mapped and differences noted. For example, does it make a difference for the network structure if the human security situational framework is the result of a natural disaster, a conflict, or a complex emergency? Complex emergencies are characterized by extensive violence and loss of life; massive displacements of people; widespread damage to societies and economies; the need for large-scale, multi-faceted humanitarian assistance; the hindrance or prevention of humanitarian assistance by political and military constraints; and significant security risks for humanitarian relief workers in some areas (OCHA 1999). Does humanitarianism make the distinction between acts of God and acts of man? In other words, what is the role of human agency in the context in which the response is

embedded? These networks should also be mapped against networks from the more traditional side of security, such as military alliances.

It would also be interesting to compare transnational networks with national and local disaster response networks. The findings here, which emphasize the role of the U.N. agencies, states, and large transnational charities as the "backbone" to which others connected, disagree with those from a study of the network of responders in the World Trade Center disaster, which found that emergent coordination, or organization without reference to existing relationships or lines of authority, was more likely (Dynes 2003). Are there economies of scale when responding to disasters? It would of interest to generate time series data from the raw data, allowing the study of network dynamics. For example, do these security networks exhibit phase transitions or explosive percolation (Achlioptas et al 2009) in their growth?

A drawback to social network analysis is that it relies ultimately on quantification and is a crude measure for dealing with unquantifiable nuance or the rich contextual detail of more qualitative studies. However, network analysis is suitable for getting "the big picture," or persistent patterns of behavior within the contemporary world order. Furthermore, using the language and methods of social network analysis allows researchers to enter into a genuine dialogue with other disciplines that deal with networks of interactions such as mathematics, physics, and biology. For example, it may be possible to re-create missing data about relationships in a network through Bayesian analysis. Research in biology used Bayesian network analysis to predict the number and location of links in a cellular network, which was then tested against what is known about that network from independent research. The study found that their network analysis was highly successful in predicting links from limited amounts of information (Sachs et al. 2005). It may also be possible to generate networks by inference

from known networks (Hinton 2007). With more complete information, additional methods such as game theory could be useful in developing predictive theory, such as determining an actor's options and probable course of behavior, given a particular network structure.

Finally, there is a real need to expand the ability to manipulate multimode data. For example, having additional modes available for the transnational aid flows network would allow the extension of the analysis to consider the source of the private individual donations and the destinations of the funds within the affected region. It is quite likely that social scientists investigating other phenomena such as complex emergencies will also encounter multiple modes of data: wars and their combatants and suppliers, disasters and their internally displaced people and refugees, states, NGOs, IGOs, and so on. Measures of multimode network data should be developed and incorporated into network analysis software.

CONCLUSION

Social network analysis allows us to capture an Olympian view of global relationships in a comprehensive way. Global governance can be imagined as a cloud of actors interacting—or not—on every conceivable global issue. In depicting the entire network, it is like taking a slice through the cloud, like an MRI takes a picture of a slice of the human body. These slices can then be compared, or put in sequence. Comparing other security networks using the same power relations gives much more insight into their functioning.

Mapping multiple dimensions allows even small or peripheral actors to know where they stand in the international system. It may mitigate the "mirror imaging" risk of assuming others will think of and react to events in the same way as the analyst (Bremmer and Keat 2009, 175) by allowing others to see the constraints to which an actor is responding. And it may allow a

"sum over all tendencies" type of predictive approach in which extremes are possible, but usually cancel each other out, as in quantum electrodynamics (Feynmann 1985).

Networks in global security governance can set standards, mobilize actors and lower the collective action costs for organizing large and disparate groups, provided they share a sense of urgency and a similar commitment to process (Hamilton 2010). As we have seen, more traditional frames of security call forth dense networks that are ideally suited to enforcement measures, while the networks made in human security frames are structurally flexible with easier conditions of entry and exit. Effective global governance networks in the future will likely require the ability to morph from one category to another as needed.

Many observers attribute a normative aspect to global governance: i.e., it should be this, it should achieve that. I would argue that it is early days yet, and scholars do not know enough about what is happening to recommend to particular directions in which policy makers may want to move. For example, should global institutions be more democratic or more efficient? And how should they be designed—around the relationship or around the type of actor? Furthermore, how "institutional" should they be? In networks, it is possible to build capacity without building bureaucracy.

Network analysis allows vastly different fields to communicate with each other. For example, a recent Letter in the journal *Nature* reported that structure might explain sequence for gene regulatory networks in embryonic biology: "The architecture of the network circuitry controlling the dynamic process of endoderm specification then explains, at the system level, a sequence of developmental logic operations, which generate the biological process" (Peter and Davidson 2011). This means that having genes in particular places in the network affects how they interact, and thus impacts the developmental sequence of an embryo. Does structure

explain sequence in global governance? For example, could an ideal structure be designed for post-conflict societies; one that included attention to issues such as the rule of law, a functioning justice system, and developmental economic aid?

The purpose of using SNA as outlined in this study to model global governance is to create a road map so we as policy makers can decide where we want to go. It has the advantage of being both more comprehensive and a less disruptive method for mapping global governance structures than that chosen by Julian Assange, whose WikiLeaks project maps by provoking reactions among the governors (Assange 2006). However, the lack of legitimacy in the global system that prompted WikiLeaks is something that others have also warned against:

> Global governance is not slated to approach "world government" because of widespread sovereignty concerns, divergent interests, and deep-seated worries about the effectiveness of current institutions. However, enhanced and more effective cooperation among a growing assortment of international, regional, and national in addition to nonstate actors is possible, achievable, and needed, particularly to grapple with the growing interconnectedness of future challenges...[L]egitimacy—bringing multilateral institutions more in line with current power realities—has to be an objective of reform as much as dealing more effectively with "hubs" of risks for the future (NIC 2010, 39).

A not inconsiderable side benefit of using the network analysis method, supplemented with other methods, is that one can gain a fairly complete overview of global governance using existing, easily accessed, publicly (and sometimes freely) available data. These data have possibly revolutionary implications for the study of global politics. Previously, a comprehensive overview was obtainable if one was or had access to a member of a ruling elite, such as high government officials, or the view from the World Economic Forum at Davos. In contrast, I conducted the bulk of the research for this dissertation not in any particular location, but in cyberspace. This means that research on global patterns can be undertaken by anyone, anywhere, and that the types of questions will change to include those that concern "subaltern"

issues such as the structural location of the economically dispossessed, as well as those concerning the contexts of gender, ethnicity, and culture (Spivak 1988).

The study of structure, or the paths and processes of interactions, is essential to the study of agency, which is why as IR analysts we should move from being slicers of cheese to MRI technicians. University of Chicago historian and philosopher of theory development William Sewell theorized that dynamic structures are produced, reproduced, and transformed by human agency (Sewell 1992). His approach works equally well in history, sociology, and political science. In this vein, I seek to describe, explain, and predict politics at the global level in ways that are comprehensible to others. There is power latent in cooperation that can be revealed by mass defiance, and channeled by organizational structure (Piven and Cloward 1977). Furthermore, the great potential for such an exercise of power by non-elites lies in disrupting the relationships through which cooperation works—not by attacking individual actors. Our task as political scientists then is to create a model of global governance that can identify the most important processes by which human beings can exercise their agency, regaining control over themselves and the globe's destiny.

APPENDIX A

NETWORK ANALYSIS

The following section is meant as a basic introduction to the elements of social network analysis (SNA) using comparative security networks for those who are totally unfamiliar with SNA. For a more thorough introduction, please see the article "Social network analysis: A methodological introduction," by Carter Butts (2008), or the texts by Scott (1991), Wasserman and Faust (1994), or Knoke and Yang (2008). Unless otherwise noted, the source for all equations and their explanation is Knoke and Yang (2008).

What is network analysis, and why should it be a method in the toolbox of international relations? Network analysis is a way to systematically study the structural properties of networks and the locational properties of actors within those networks. It uses mathematical representation in order to quantify systematic empirical data and model relations/structure, and to represent the results graphically/visually. When the objects under the microscope are capable of demonstrating agency, network analysis is referred to as "social network analysis," or SNA.

Network analysis has a long history in sociology, with roots in Georg Simmel's work in the 19th century, and was revived as a methodology in the early 20th century by Jacob Moreno and his colleague Helen Jennings (Freeman 2004). (In physics and other physical sciences, it has more recently been referred to as "network science" (Barabási 2003).) It has been known to political science at least since the 1950s (Kochen 1989), and to international relations since the late 1960s (Brams 1969). However, for some reason it has never been used as widely as other quantitative methods such as statistics or regression analysis. This is regrettable, because network analysis is a method that treats actors as inherently interdependent while the other methods assume independence, and politics cannot happen without interaction.

Network analysis is motivated by a structural intuition based on ties linking social actors, it is grounded in systematic empirical data, it draws heavily on graphic imagery, and it relies on the use of mathematical and/or computational models (Freeman 2004). These requirements differentiate it from other treatments, such as those that use the term "network" as a metaphor. The basic elements of network analysis are actors, which are the social units; relations, which are the ties between or among actors (which can be affiliational) that are channels for the flow of resources or information; and attributes, which are measures taken on actors. The actors can be depicted as the rows and columns of a matrix, with the cells of the matrix depicting the relationship. The relationship can be binary (such as yes/no, on/off, married/not married), directed (such as "seeks advice from," "is parent of," and trade flows), or valued (such as the amount of the trade flow).

The cardinal assumptions of network analysis are first, that you are dealing with relations—with some kind of connection. Therefore, it is not a method suited to studying units in isolation, and is not a metaphor for examining actors in a category. Second, that the social units are interdependent; their ties both enable and constrain actions. Again, the use of regular statistical methods is inappropriate, because the actors are not assumed to be independent. And third, it assumes that you are looking for system-level relational properties. This constitutes structure, or an "enduring patterns of relations."[32] Two types of networks can be studied: an ego network consisting of an ego and all its alters (such as a parent and all children) and a complete network consisting of all the actors bounded by a particular relation (such as all parents and their children). The measures in this dissertation are for complete networks.

[32] Stan Wasserman, ICPSR workshop, 2005-06

Data visualization is important to understanding data. It is possible to ascertain the broad outlines of even very large datasets through the proper visualization techniques (Bender-deMoll and McFarland 2006). Edward R. Tufte made the point most forcefully:

> "At their best, graphics are instruments for reasoning about quantitative information. Often the most effective way to describe, explore, and summarize a set of numbers—even a very large set—is to look at pictures of those numbers. Furthermore, of all methods for analyzing and communicating statistical information, well-designed data graphics are usually the simplest and at the same time the most powerful" (Tufte 2007: 9).

This reason will only become more important as massive amounts of data about interactions become available, both those that are passively "collected" by sensors (Lazer et al 2009), and those that are generated by humans, such as the datasets made available by WikiLeaks and the Amn Dawla Leaks page on Facebook (http://213.251.145.96/ 2011, http://www.facebook.com/AmnDawlaLeaks?_fb_noscript=1, 2011).

There are two big questions asked in any network analysis: which are the most important actors in a network? And, are there subgroups of similar actors? The first question is answered by two main categories of measurements: density and centrality. There are many different measures of centrality, including closeness, degree, and eigenvector. The second question is answered by the third main category of measurement: cohesion. Cohesion is measured by various community-finding measures, such as those that look for cliques or structural equivalence.

In the following network equations, N is the set of actors represented by nodes, and $\mathcal{L}$ is a set of lines representing relational ties between pairs of actors. There are g nodes in N, and L lines in $\mathcal{L}$, while i refers to a row in the matrix and j to a column in the matrix; a particular cell would thus have the coordinates (i,j). Euclidean distance is denoted d, k refers to a node in the matrix, and x_{ij} is the value of a tie from actor i to actor j.

DENSITY

Density in a network is a measure indicating the total of all values divided by the number of ties possible in the network. Within and between block densities can be calculated for data that are grouped, so this preliminary measure is often used in blockmodeling (see below). For example, a researcher can partition data into different types of organizations, and examine the density of information exchange within and between types. *Degree* refers to the total number of relations that a particular actor has. Relations can be directed, indicating that there is a start point and an endpoint. Relations that are received are referred to as *indegrees*, while relations that are sent are referred to as *outdegrees*. The *geodesic distance* is the length of the shortest path between two actors (a dyad). This is differently calculated if the network is directed and/or valued: directed graphs will have twice as many possible paths as undirected graphs, while valued graphs must take into account the possible values of each path as well.

To find density, the following equation (Wasserman and Faust 1994: 101) is used:

$$\Delta = \frac{2L}{g\,(g-1)}$$

In words, this translates to "density equals the number of observed ties divided by the number of possible ties."

CENTRALITY

Centrality is a key measure of power, because it measures how information and resources flow (or fail to flow) by measuring the actor's prominence in the network. Centrality measures can be calculated for each actor individually, and as a distribution over the network as a whole. This appendix contains only the actor measures, as they are the measures calculated in the case studies.

Closeness centrality is the shortest path to all other actors, in other words, how near a node is to the other nodes in the network. It is the inverse of the sum of the geodesic distances between a particular actor and all the other actors.

$$C_C(N_i) = \frac{1}{\left[\sum_{j=1}^{g} d(N_i, N_j)\right]}$$

However, larger networks make larger scores possible, so that they cannot be usefully compared. To work around this, the measure for closeness centrality is "normalized," so that the score varies between 0 (completely isolated) and 1 (completely involved). The normalized measure is calculated by multiplying closeness centrality by the number of total actors in the network minus one.

$$C'_C(N_i) = (g-1)(C_C(N_i))$$

In words, the normalized equation translates to: "the standardized index of actor closeness centrality equals the maximum number of possible connections with the *g*-1 other actors multiplied by the inverse of the sum of the geodesic distances between actor *i* and the *g*-1 other actors." (Note: the geodesic distance is the length of the shortest path between two actors, and is differently calculated for directed and/or valued networks.)

Degree centrality is the number of direct connections an actor has. It can be given in in-degrees and out-degrees, indicating prestigious actors by the number of choices they received, or in-degrees; out-degrees are the number of ties sent, indicating actors by the number of choices that they could make and the number of ties established by them.

$$C_D(N_i) = \sum_{j=1}^{g} x_{ij}(i \neq j)$$

The measure for degree centrality is also normalized, so that the score varies between 0 (completely isolated) and 1 (completely involved).

$$C'_D(N_i) = \frac{C_D(N_i)}{g-1}$$

In words, this translates to: “the degree centrality of node i equals the total number of direct ties that node *i* has to the *g*-1 other j nodes (excluding *i*’s tie to itself and all diagonals) divided by maximum number of possible connections with the *g*-1 other actors.”

Betweenness centrality is the extent to which other actors lie on the geodesic path between pairs of actors in the network. It indicates control over network flows by showing where bottlenecks can happen, in fact, actors with high betweenness centrality are often *cutpoints*: removing these actors disconnects the network into separate graphs. It is calculated by dividing the sum of all dyads not including the actor for which the number of geodesic paths between any two other actors containing that actor divided by the number of geodesics between the two other actors by the maximum theoretical value assuming each dyad has only one geodesic path. The score varies between 0 (the actor is not on any geodesics) and 1 (the actor is on all geodesics).

$$C_B(N_i) = \sum_{j<k} \frac{g_{jk}[(N]_i)}{g_{jk}}$$

The normalized equation is:

$$C'_B(N_i) = \frac{C_B(N_i) \times 2}{(g-1)(g-2)}$$

In words, this translates as: “the standardized actor betweenness centrality equals the sum of all dyads not including node *i* for which the number of geodesic paths between *j* and *k* contain *i* divided by the number of geodesics between *j* and *k* divided by the maximum theoretical value assuming each pair has only one geodesic.”

Eigenvector centrality is a weighted measure of prestige, of the extent to which an actor receives ties sent by others in the network, and includes the number of prestigious actors that

choose the actor. It emphasizes inequalities in the actors' control over the resources in the network by identifying *hubs*, those actors adjacent to many peripheral actors, and *bridges*, those actors adjacent to a few central actors. An *eigenvalue* is the location of each actor in the matrix with respect to a particular dimension of analysis (the dimensions themselves are measured globally first, then more locally). An *eigenvector* is thus a collection of eigenvalues in n-space, collapsed down so that it can be represented in two-dimensional space (such as an arrow, with a beginning point and a direction). Eigenvector centrality is calculated via factor analysis (Wasserman and Faust 1994: 205-210).

COHESION

Cohesion measures sub-structures within the network, such as cliques. Cohesive subgroups are connected through many direct, reciprocated choice relations that enable them to share information, create solidarity, and act collectively. Many different measures have been developed to find cohesive subgroups, or communities.

Cohesive subgroups have four general properties: mutuality of ties, closeness or reachability of subgroup members, frequency of ties among members, and the relative frequency of ties among subgroup members compared to non-members (Wasserman and Faust 1994). For example, a clique is a maximal subgraph of three or more actors, all of which are directly connected to one another, with no other actor in the network having direct ties to *every* member of the clique.

Community-finding measures such as structural equivalence, clustering, multidimensional scaling, and blockmodeling. These measures have the added benefit of being uniquely depicted visually.

Structural equivalence indicates that different actors share a jointly occupied position. The pattern of ties to other actors is emphasized here; it is the similarity of ties that creates the shared position, not that the actors share the same ties (White et al 1976). In perfect structural equivalence, two actors have exactly identical patterns of ties sent to and received from all other actors in the network. This is rare, so a measure of relational similarity using Euclidean distance is used instead: the square root of the sum of two squared difference terms (non-directed graphs do not require both difference terms).

$$d_{ij} = \sqrt{\sum_{k=1}^{g} \left[(x_{ik} - x_{jk})^2 + (x_{ki} - x_{kj})^2 \right]}$$

In words, this translates as: "the Euclidean distance between actors *i* and *j* equals the square root of the sum of the difference between the value of *i* to *k* and the value of *j* to *k*, squared plus the difference between the value of *k* to *i* and the value of *k* to *j*, squared." For example, if actor A and actor B both have ties to actor C, they share a position. Actor A could have a tie to an actor that is similar to actor C, and that would still be regarded as structurally equivalent.

Hierarchical agglomerative cluster analysis partitions actors into subgroups of jointly occupied positions whose members are perfectly or approximately structurally equivalent. It is an iterative process that begins by treating each actor as a cluster, then by grouping similar clusters to create a dendrogram (tree diagram).

Multidimensional scaling (MDS) plots actors on a two or three-dimensional axis based on similarity (located closer together) or dissimilarity (located farther apart), using Euclidean distance. This is directly comparable to a map using miles as a unit of distance to separate cities. MDS computes a stress indicator measuring the discrepancies across all pairs between the observed matrix and the computed matrix by calculating the square root of the summed sum of a

nonmetric, monotonic function of the input values minus the Euclidean distance squared, divided by a scaling factor that constrains the stress values between 0.0 and 1.0. It is as if one imagined a matrix: sum all the possible values for a row by each column, and then do the same for each column—increasing by increments; you get the sum of all the summed values for each cell.

$$Stress = \sqrt{\frac{\Sigma\Sigma\left(f(x_{ij} - d_{ij})\right)^2}{Scale}}$$

In words, this equation translates as: "the stress indicator measuring the discrepancies across all pairs between the observed matrix and the computed matrix equals the square root of the summed sum of a nonmetric, monotonic function of the input values minus the Euclidean distance squared, divided by a scaling factor that constrains the stress values between 0.0 and 1.0." MDS is often used with a type of layout called spring-embedding, which is used to create a visually uncluttered image. In a spring-embedded image all the edges of the same stress are of equal length and there are as few crossing edges as possible.

Finally, blockmodeling is a matrix algebraic method for sorting network actors into jointly occupied, structurally equivalent positions by using density. The matrix having been partitioned into two or more discrete subgroups called *blocks*, permuted density and image matrices are calculated displaying the pattern of ties within and between the blocks. In a density matrix, cell values are the densities within and between blocks. An image matrix is obtained from the density matrix by recoding each cell to be either 0 or 1, based on theoretical and empirical grounds. Within and between block densities can be calculated for data that are grouped. For example, data can be partitioned into different types of organizations and examined for the density of information exchange within and between types—a key measure of diffusion of ideas.

INTERSECTIONS

In set theory (a separate branch of mathematics) the intersection of two sets *A* and *B* is the set that contains all elements of *A* that also belong to *B*, or equivalently, all elements of *B* that also belong to *A*, but no other elements.

$$A \bigcap B$$

Intersections can be found for multiple (more than two) sets, as seen in the equation below. The easiest way to visualize the intersection of sets is to think of a Venn diagram; the overlapping part is the intersection.

$$A \bigcap B \bigcap C$$

CUTPOINTS

Cutpoints are either actors or connections whose removal from the network will separate the network into completely unconnected components. If referring to an actor, the term sometimes used is "broker," if referring to a relationship/tie, the term sometimes used is "bridge."

APPENDIX B

THE TRADITIONAL SECURITY INSTITUTIONAL POWER NETWORK

This is the full matrix with labels for the traditional security institutional power network, consisting of 196 state actors affiliated by treaty. In the matrix, the value encoded represents the number of treaties of which the actors are both members. Columns are separated by commas.

Table 13: Nuclear Treaties Full Matrix

```
DL
N=196
FORMAT = FULLMATRIX DIAGONAL PRESENT
ROW LABELS:
"Afghanistan"
"Albania "
"Algeria"
"Andorra"
"Angola"
"Antigua and Barbuda"
"Argentina"
"Armenia"
"Australia"
"Austria"
"Azerbaijan"
"Bahamas"
"Bahrain"
"Bangladesh"
"Barbados"
"Belarus"
"Belgium"
"Belize"
"Benin"
"Bhutan"
"Bolivia"
"Bosnia and Herzegovina"
"Botswana"
"Brazil"
"Brunei Darussalam"
"Bulgaria"
"Burkina Faso"
"Burundi"
"Cambodia"
"Cameroon"
"Canada"
"Cape Verde"
"Central African Republic"
"Chad"
"Chile"
"China"
"Colombia"
"Comoros"
"Congo, Republic of the"
"Cook Islands"
```

"Costa Rica"
"Côte d'Ivoire"
"Croatia"
"Cuba"
"Cyprus"
"Czech Republic"
"Democratic People's Republic of Korea"
"Democratic Republic of the Congo"
"Denmark"
"Djibouti""Dominica"
"Dominican Republic"
"Ecuador"
"Egypt"
"El Salvador"
"Equatorial Guinea"
"Eritrea"
"Estonia"
"Ethiopia"
"Fiji"
"Finland"
"France"
"Gabon"
"Gambia"
"Georgia"
"Germany"
"Ghana"
"Greece"
"Grenada"
"Guatemala"
"Guinea"
"Guinea-Bissau"
"Guyana"
"Haiti"
"Holy See"
"Honduras"
"Hungary"
"Iceland"
"India"
"Indonesia"
"Iran, Islamic Republic of"
"Iraq"
"Ireland"
"Israel"
"Italy"
"Jamaica"
"Japan"
"Jordan"
"Kazakhstan"
"Kenya"
"Kiribati"
"Kuwait"
"Kyrgyzstan"
"Lao People's Democratic Republic"
"Latvia"
"Lebanon"
"Lesotho"
"Liberia"

"Libyan Arab Jamahiriya"
"Liechtenstein"
"Lithuania"
"Luxembourg"
"Madagascar"
"Malawi"
"Malaysia"
"Maldives"
"Mali"
"Malta"
"Marshall Islands"
"Mauritania"
"Mauritius""Mexico"
"Micronesia, Federated States of"
"Moldova"
"Monaco"
"Mongolia"
"Montenegro"
"Morocco"
"Mozambique"
"Myanmar"
"Namibia"
"Nauru"
"Nepal"
"Netherlands"
"New Zealand"
"Nicaragua"
"Niger"
"Nigeria"
"Niue"
"Norway"
"Oman"
"Pakistan"
"Palau"
"Panama"
"Papua New Guinea"
"Paraguay"
"Peru"
"Philippines"
"Poland"
"Portugal"
"Qatar"
"Republic of Korea"
"Romania"
"Russian Federation"
"Rwanda"
"Saint Kitts and Nevis"
"Saint Lucia"
"Saint Vincent and the Grenadines"
"Samoa""San Marino"
"Sao Tome and Principe"
"Saudi Arabia"
"Senegal"
"Serbia"
"Seychelles"
"Sierra Leone"
"Singapore"

"Slovakia"
"Slovenia"
"Solomon Islands"
"Somalia"
"South Africa"
"Spain"
"Sri Lanka"
"Sudan"
"Suriname"
"Swaziland"
"Sweden"
"Switzerland"
"Syrian Arab Republic"
"Tajikistan"
"Taiwan (Republic of China)"
"Thailand"
"The former Yugoslav Republic of Macedonia"
"Timor-Leste"
"Togo"
"Tonga"
"Trinidad and Tobago"
"Tunisia"
"Turkey"
"Turkmenistan"
"Tuvalu"
"Uganda"
"Ukraine"
"United Arab Emirates"
"United Kingdom of Great Britain and Northern Ireland"
"United Republic of Tanzania"
"United States of America"
"Uruguay"
"Uzbekistan"
"Vanuatu"
"Venezuela, Bolivarian Republic of"
"Viet Nam"
"Yemen"
"Zambia"
"Zimbabwe"
COLUMN LABELS:
"Afghanistan"
"Albania "
"Algeria"
"Andorra"
"Angola"
"Antigua and Barbuda"
"Argentina"
"Armenia"
"Australia"
"Austria"
"Azerbaijan"
"Bahamas"
"Bahrain"
"Bangladesh"
"Barbados"
"Belarus"
"Belgium"

"Belize"
"Benin"
"Bhutan"
"Bolivia"
"Bosnia and Herzegovina"
"Botswana"
"Brazil"
"Brunei Darussalam"
"Bulgaria"
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"Burundi"
"Cambodia"
"Cameroon"
"Canada"
"Cape Verde"
"Central African Republic"
"Chad"
"Chile"
"China"
"Colombia"
"Comoros"
"Congo, Republic of the"
"Cook Islands"
"Costa Rica"
"Côte d'Ivoire"
"Croatia"
"Cuba"
"Cyprus"
"Czech Republic"
"Democratic People's Republic of Korea"
"Democratic Republic of the Congo"
"Denmark"
"Djibouti"
"Dominica"
"Dominican Republic"
"Ecuador"
"Egypt"
"El Salvador"
"Equatorial Guinea"
"Eritrea"
"Estonia"
"Ethiopia"
"Fiji"
"Finland"
"France"
"Gabon"
"Gambia"
"Georgia"
"Germany"
"Ghana"
"Greece"
"Grenada"
"Guatemala"
"Guinea"
"Guinea-Bissau"
"Guyana"
"Haiti"

"Holy See"
"Honduras"
"Hungary"
"Iceland"
"India"
"Indonesia"
"Iran, Islamic Republic of"
"Iraq"
"Ireland"
"Israel"
"Italy"
"Jamaica"
"Japan"
"Jordan"
"Kazakhstan"
"Kenya"
"Kiribati"
"Kuwait"
"Kyrgyzstan"
"Lao People's Democratic Republic"
"Latvia"
"Lebanon"
"Lesotho"
"Liberia"
"Libyan Arab Jamahiriya"
"Liechtenstein"
"Lithuania"
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"Madagascar"
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"Maldives"
"Mali"
"Malta"
"Marshall Islands"
"Mauritania"
"Mauritius"
"Mexico"
"Micronesia, Federated States of"
"Moldova"
"Monaco"
"Mongolia"
"Montenegro"
"Morocco"
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"Niger"
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"Panama"
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"Peru"
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"Poland"
"Portugal"
"Qatar"
"Republic of Korea"
"Romania"
"Russian Federation"
"Rwanda"
"Saint Kitts and Nevis"
"Saint Lucia"
"Saint Vincent and the Grenadines"
"Samoa"
"San Marino"
"Sao Tome and Principe"
"Saudi Arabia"
"Senegal"
"Serbia"
"Seychelles"
"Sierra Leone"
"Singapore"
"Slovakia"
"Slovenia"
"Solomon Islands"
"Somalia"
"South Africa"
"Spain"
"Sri Lanka"
"Sudan"
"Suriname"
"Swaziland"
"Sweden"
"Switzerland"
"Syrian Arab Republic"
"Tajikistan"
"Taiwan (Republic of China)"
"Thailand"
"The former Yugoslav Republic of Macedonia"
"Timor-Leste"
"Togo"
"Tonga"
"Trinidad and Tobago"
"Tunisia"
"Turkey"
"Turkmenistan"
"Tuvalu"
"Uganda"
"Ukraine"
"United Arab Emirates"
"United Kingdom of Great Britain and Northern Ireland"
"United Republic of Tanzania"
"United States of America"

"Uruguay"
"Uzbekistan"
"Vanuatu"
"Venezuela, Bolivarian Republic of"
"Viet Nam"
"Yemen"
"Zambia"
"Zimbabwe"
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THE STRUCTURE OF TRANSNATIONAL SECURITY NETWORKS

by

ANNELIES ZERI KAMRAN

Volume II

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PART II

APPENDIX C

THE TRADITIONAL SECURITY COMPULSORY POWER NETWORK

This is the full matrix with labels for the traditional security compulsory power network, consisting of 453 actors who had business contracts with each other. In the matrix, the value encoded represents the number of contracts of which the actors are both members, with "?" representing no contract. Columns are separated by commas, rows are separated by paragraphs.

The matrix is followed by an attribute list which lists the actors by type, and a brief "genealogy" of companies. Subsidiaries were coded as WNA members if the company is on the membership list; former names of companies currently on the list are coded as WNA members. Companies were coded as state-owned corporation if the state owns more than 50%, and joint-action agencies are owned by their members, which are electricity cooperatives.

Table 14: Nuclear Contracts Full Matrix

DL
N=453
FORMAT = FULLMATRIX DIAGONAL PRESENT
ROW LABELS:
"23rdConstruction&InstallationCorp"
"ABBCombustionEngineeringNuclearPowerInc"
"ABBGroup"
"AEATechnology"
"AECLCandu"
"AMEC"
"ASLF"
"AVANTechIncorporated"
"AVK-SEG"
"AdvancedSciencesInc"
"AeroflexAltairCyberneticsCorp"
"AerosolLaboratoriesofTexasA&MUniversity"
"AkerKvaerner"
"AkerSolutions"
"AlfaLaval"
"Algeria"
"AlliantEnergy"
"Alstec"
"Alstom"
"AlternateEnergyHoldingsInternational"
"AmerGenEnergyCo"
"AmerenCorp"
"AmerenUE"
"AmericanEcologyCorp"
"AmericanElectricPower"
"Aquila"
"Areva"
"ArevaDongfang"
"ArevaFederalServicesInc"
"ArevaNP"

"ArizonaPublicService"
"Atkins"
"Atomenergoexport"
"Atomenergoproekt"
"Atomstroyexport"
"AtosOrigin"
"Australia"
"Austria"
"B&WCanada"
"BNFL"
"BNFLEnvironmentalServices"
"BNFLMagnoxGeneration"
"BNSNuclearServices"
"BWXTPantex"
"BWXTY-12LLC"
"Babcock&Wilcox"
"BabcockNoellNuclearGmbH"
"Babtie"
"Bahrain"
"BarsebackKraftAB"
"BattelleMemorialInstitute"
"BechtelBWXTIdahoLLC"
"BechtelCorp"
"BechtelHanfordInc"
"BechtelNationalInc"
"BechtelNevadaInc"
"BechtelPowerCorp"
"BelenePower"
"Belgium"
"Belgoprocess"
"BiggeCrane&RiggingCo"
"BiggePowerConstructors"
"BouyguesSA"
"BritishEnergy"
"BritishNuclearGroup"
"BrucePower"
"Bulgaria"
"BurnsandRoeEnterprises"
"C&DTechnologiesInc"
"CANBERRAEurisysSA"
"CBC-B2"
"CEZGroup"
"CH2MHillHanfordGroup"
"COGEMA"
"COMP2BR"
"CORYS-TESS"
"CPSEnergy"
"Cameco"
"Canada"
"CanatomInc"
"CatapultTechnologyLtd"
"Cegelec"
"CentralNuclearAlmaraz-Trillo"
"CeskeEnergetickeZavody"
"ChernobylShelterProject"
"China"

"ChinaGuangdongNuclearPowerCo"
"ChinaGuangdongNuclearPowerCo-NuclearPowerInstituteofChina"
"ChinaNationalNuclearCorp"
"ChinaNationalTechnicalImport&ExportCorp"
"ChinaNuclearPowerEngineeringCo"
"ChinaTechenergyCo"
"ClevelandElectricIlluminating"
"ComisionFederaldeElectricidad"
"CommonwealthEdisonCo"
"ConnecticutYankeeAtomicPowerCo"
"ConstellationEnergy"
"ControlledDemolitionGroup"
"Costain"
"Cuba"
"CurtissWrightElectroMechanicalCorp"
"DELTECAlliance"
"DEMCOInc"
"DHLGlobalForwarding"
"DHS"
"DTEEnergy"
"DTI"
"DZAtlantic"
"DaltonUtilities"
"DataSystems&Solutions"
"DataSystems&SolutionsSAS"
"Day&ZimmermanNPS"
"DecisionDynamicsTechnologyLtd"
"DelmarvaPower&Light"
"Denmark"
"DenverRadiumSite"
"DepartmentofTradeandIndustry"
"DeutscheAudco"
"Dominion"
"DominionEnergy"
"DongfangElectricCorp"
"DoosanHeavyIndustriesandConstructionCoLtd"
"DuPont"
"DukeEnergy"
"DukePower"
"DuratekInc"
"E-ONKernkraft"
"EG&GInc"
"EURATOM"
"EaglePicherCommercialPowerSolutions"
"EberlineServicesInc"
"EcolochemInternationalInc"
"Electrabel"
"ElectricPowerDevelopmentCoLtd"
"ElectricitedeFrance"
"Elektrizitats-GesellschaftLaufenburgAG"
"EletrobrasTermonuclearSA"
"EmersonProcessManagement"
"EmiratesNuclearEnergyCorp"
"Enel"
"EnerconServicesInc"
"EnergieBaden-WurttembergAG"

"EnergiewerkeNord"
"Energoatom"
"Energomontaz-Polnoc"
"Enertech"
"EngineSystemsInc"
"EntergyCorp"
"EntergyNuclear"
"EnvironmentalEnergyResourcesLtd"
"EquiposNuclearesSA"
"Eskom"
"EuropeanCommission"
"EuropeanUnion"
"EverestVIT"
"ExelonCorp"
"ExelonGeneration"
"ExelonNuclear"
"FBFCJapan"
"FPLGroup"
"FRAEC"
"Fernald"
"Finland"
"FirstEnergyNuclearOperatingCompany"
"FloridaPower&LightCo"
"FlowserveCorp"
"FluorCorp"
"FluorHanfordInc"
"FluorLimited"
"FluorNuclearRemediation"
"ForsmarksKraftgruppAB"
"FortumOyj"
"FramatomeANP"
"FramatomeANP-DE&S"
"France"
"FrenchInstituteforRadiologicalProtectionandNuclearSafety"
"GE-HitachiNuclearEnergy"
"GECAlsthom"
"GEEnergy"
"GEWater&ProcessTechnologies"
"GPUServiceInc"
"GSE"
"GUTOR"
"GeneralAtomics"
"GeneralElectric"
"GeneralPhysicsCorp"
"GeorgiaPower"
"Germany"
"Greece"
"HFControlsCorp"
"Hanford"
"HanjungandKoreaPowerEngineeringCo"
"HarbinPowerEquipmentCoLtd"
"Hatch-Acres"
"Hitachi"
"HoltecInternational"
"Hopkinsons"
"HurstTechnologiesCorp"

"Hydro-Quebec"
"ITTA-CPump"
"IVO"
"Iberdrola"
"Iceland"
"IdahoNationalEngineeringLab"
"India"
"Intercontrole"
"IntergraphCorp"
"Interserve"
"InvensysProcessSystems"
"IonBeamApplications"
"Iran"
"Ireland"
"Israel"
"Italy"
"Japan"
"JapanNuclearFuel"
"JapanSteelWorks"
"JohnsonControls-ProcordLtd"
"Jordan"
"JosephOatCorp"
"KEffectiveLLC"
"KHNP"
"KSB"
"KansaiElectricPowerCoInc"
"KazAtomProm"
"Kepco"
"KernkraftwerkBrunsbuttelGmbH"
"KernkraftwerkGosgenDanikenAG"
"KernkraftwerkLeibstadtAG"
"KnollsAtomicPowerLab"
"KraftdragarnaAB"
"Kuwait"
"Kvaerner"
"L-3MAPPS"
"Laing"
"Lemminkainen"
"LosAlamosNationalLab"
"LosAlamosTechnicalAssociates"
"LouisianaEnergyServices"
"Luch-TaskOrder1"
"Luxembourg"
"MACTECEngineeringandConsulting"
"MEAGPower"
"MHFLogisticalSolutionsInc"
"MOHT"
"MROSoftware"
"MagnoxNorth"
"MaineYankeeAtomicPowerCo"
"McCallum-Turner"
"Mirant"
"MitsubishiCorp"
"MitsubishiElectricCorp"
"MitsubishiHeavyIndustriesLtd"
"MitsuiBabcock"

"MowlemNuclear"
"MurmanskShippingCo"
"Murray&Roberts"
"Murray&RobertsSNC-LavalinNuclearPtyLtd"
"NACInternational"
"NFS-RPS"
"NNC"
"NNSA"
"NRCEnergyInc"
"NRGEnergy"
"NUKEMInc"
"NUKEMTechnologies"
"NationalAtomicEnergyCommission"
"NationalnaElektricheskaKompania"
"NebraskaPublicPowerDistrict"
"Netherlands"
"NewYorkPowerAuthority"
"Newberg-Perini"
"NiagaraMohawkPowerCorporation"
"NordostschweizerischeKraftwerkeAG"
"NorthCarolinaElectricMembershipCorp"
"NorthCarolinaMunicipalPowerAgencyNumber1"
"NorthKorea"
"NortheastUtilities"
"NorthernStatesPowerCo"
"NorthrupGrumman"
"Norway"
"NuStartEnergy"
"NuclearElectric"
"NuclearFuelIndustriesLtd"
"NuclearManagementCompanyLLC"
"NuclearNon-ProliferationCenter"
"NuclearPowerCorporationofIndiaLtd"
"NuclearPowerInternational"
"NuclearPowerQinshanJointVentureCompanyLtd"
"NuclearelectricaSA"
"NucleoelectricaArgentinaSA"
"NuklearnaElektrarnaKrsko"
"OKGAB"
"ORTEC"
"OakRidge"
"OglethorpePower"
"OntarioPowerGeneration"
"PBZ-C2"
"PCIEnergyServiceLLC"
"PEInternational"
"PPLCorp"
"PSEGNuclear"
"PTISystems"
"PaRNuclearInc"
"PacificGas&ElectricCompany"
"Pakistan"
"PaksNuclearPowerPlant"
"ParsonsInfrastructure"
"PeacockInc"
"PebbleBedModularReactorPtyLtd"

"PiedmontMunicipalPowerAgency"
"PipeCoatingFacility63544"
"Poland"
"PortlandGeneralElectricCo"
"Portugal"
"PrincetonUniversity"
"ProcessEnergyServices"
"ProgressEnergy"
"ProgressEnergyFlorida"
"ProjectPrometheus"
"ProjectServicesGroupLLC"
"Qatar"
"QinshanNuclearPower"
"ROSInc"
"RWENukemInc"
"RWEPowerAG"
"RinghalsAB"
"RockwellInternational"
"RockyFlats"
"Rolls-RoyceNuclearEngineeringServices"
"Rosatom"
"Rosenergoatom"
"RoyFWestonInc"
"Russia"
"RussianFoundationforEnvironmentalSafetyofPowerEngineering"
"RustConstructors"
"SAIC-PO14436"
"SGLCarbon"
"SGN"
"SGN-Eurisys"
"SGTLLC"
"SMStollerCorp"
"SNCLavalin"
"SacramentoMunicipalUtilityDistrict"
"SaludaRiverElectricCooperative"
"SanmenNuclearPowerCo"
"SaratovRegionalGovernment"
"Sargent&LundyLLC"
"SavannahRiver"
"Scientech"
"ScottWilson"
"Sebim"
"SecuritasSecurityServicesUSAInc"
"SercoAssurance"
"SeverskFossilFuelPlant"
"Sfarsteel"
"ShandongNuclearPowerCo"
"ShanghaiCraneandConveyorWorks"
"ShanghaiGaotaiRareandPreciousMetalsCoLtd"
"ShanghaiNuclearEngineeringResearchandDesignInstitute"
"ShawArevaMOXServicesLLC"
"ShawGroupInc"
"SheffieldForgemasters"
"Siemens"
"SiemensEnergy"
"SiemensKWU"

"SiemensPowerGeneration"
"SilexSystemsLtd"
"SirRobertMcAlpine"
"SkodaPlzen"
"SkodaPrahaAS"
"SlovakRepublic"
"Slovenia"
"SlovenskeElektrarne"
"SocieteaNationalaNuclearelectrica"
"SouthCarolinaElectric&Gas"
"SouthKorea"
"SouthTexasProjectNuclearOperatingCo"
"SouthernCaliforniaEdison"
"SouthernCompany"
"Spain"
"SpescomSoftwareInc"
"StateNuclearPowerTechnologyCo"
"StensandAB"
"Stone&WebsterConstructionInc"
"Strachan&Henshaw"
"StudsvikAB"
"StudsvikUK"
"SumitomoCorp"
"Sweden"
"Switzerland"
"T2-0186-RU"
"T2-0192-RU"
"T2-0194-RU"
"T2-0204-UA"
"T2-0244-RU"
"T2-2002-RU"
"TIC-UETreasureCoastJointVenture"
"TLGServicesInc"
"TVZ01"
"TXU"
"TaiwanPowerCompany"
"TaylorWoodrow"
"TeledyneBrownEngineeringInc"
"TennesseeValleyAuthority"
"TeollisuudenVoimaOy"
"TetratechInc"
"TheNorthernMachineBuildingEnterprise-Sevmash"
"ThermalEngineeringInternational"
"ThermoElectronCorp"
"ThermoFisherScientificInc"
"ThermtronProjects"
"ToledoEdison"
"ToshibaCorp"
"TransnuclearInc"
"UKAtomicEnergyAuthority"
"UKNuclearDecommissioningAuthority"
"URSWashingtonDivision"
"USARepositoryServices"
"USDepartmentofEnergy"
"USECInc"
"UddcombEngineeringAB"

"Uhde"
"Ukraine"
"UniStarNuclearEnergy"
"UnitedArabEmirates"
"UnitedCoRusal"
"UnitedKingdom"
"UnitedStates"
"UniversityofColumbia"
"UraMin"
"VTGroup"
"Vattenfall"
"VerityInc"
"VermontYankeeNuclearPowerPlantCorp"
"VinciGroupSA"
"VogtPowerInternational"
"VolianEnterprisesInc"
"WMG"
"WPI"
"WachsTechnicalServicesInc"
"WackenhutServicesInc"
"WashingtonGroupInternationalInc"
"WashingtonSavannahRiverCo"
"WasteIsolationPilotPlant"
"WestValleyDemonstrationProject"
"WestinghouseElectricBelgiumSA"
"WestinghouseElectricCo"
"WestinghouseSavannahRiverCo"
"WilliamLettisandAssociates"
"WolfCreekNuclearOperatingCorp"
"XcelEnergy"
"ZheleznogorskFossilFuelPlant"
COLUMN LABELS:
"23rdConstruction&InstallationCorp"
"ABBCombustionEngineeringNuclearPowerInc"
"ABBGroup"
"AEATechnology"
"AECLCandu"
"AMEC"
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"Atomenergoexport"
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"Atomstroyexport"
"AtosOrigin"
"Australia"
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"B&WCanada"
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"BNFLMagnoxGeneration"
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"BWXTPantex"
"BWXTY-12LLC"
"Babcock&Wilcox"
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"ChinaNationalTechnicalImport&ExportCorp"
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"ChinaTechenergyCo"
"ClevelandElectricIlluminating"
"ComisionFederaldeElectricidad"
"CommonwealthEdisonCo"
"ConnecticutYankeeAtomicPowerCo"
"ConstellationEnergy"
"ControlledDemolitionGroup"
"Costain"
"Cuba"
"CurtissWrightElectroMechanicalCorp"
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"DEMCOInc"
"DHLGlobalForwarding"
"DHS"
"DTEEnergy"
"DTI"
"DZAtlantic"
"DaltonUtilities"
"DataSystems&Solutions"
"DataSystems&SolutionsSAS"
"Day&ZimmermanNPS"
"DecisionDynamicsTechnologyLtd"
"DelmarvaPower&Light"
"Denmark"
"DenverRadiumSite"
"DepartmentofTradeandIndustry"
"DeutscheAudco"
"Dominion"
"DominionEnergy"
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"EG&GInc"
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"EnergiewerkeNord"
"Energoatom"
"Energomontaz-Polnoc"
"Enertech"
"EngineSystemsInc"
"EntergyCorp"
"EntergyNuclear"
"EnvironmentalEnergyResourcesLtd"
"EquiposNuclearesSA"
"Eskom"
"EuropeanCommission"
"EuropeanUnion"
"EverestVIT"
"ExelonCorp"
"ExelonGeneration"
"ExelonNuclear"
"FBFCJapan"
"FPLGroup"
"FRAEC"
"Fernald"
"Finland"
"FirstEnergyNuclearOperatingCompany"
"FloridaPower&LightCo"
"FlowserveCorp"
"FluorCorp"
"FluorHanfordInc"
"FluorLimited"
"FluorNuclearRemediation"
"ForsmarksKraftgruppAB"
"FortumOyj"
"FramatomeANP"
"FramatomeANP-DE&S"
"France"
"FrenchInstituteforRadiologicalProtectionandNuclearSafety"
"GE-HitachiNuclearEnergy"
"GECAlsthom"
"GEEnergy"
"GEWater&ProcessTechnologies"
"GPUServiceInc"
"GSE"
"GUTOR"
"GeneralAtomics"
"GeneralElectric"
"GeneralPhysicsCorp"
"GeorgiaPower"
"Germany"
"Greece"
"HFControlsCorp"
"Hanford"
"HanjungandKoreaPowerEngineeringCo"

"HarbinPowerEquipmentCoLtd"
"Hatch-Acres"
"Hitachi"
"HoltecInternational"
"Hopkinsons"
"HurstTechnologiesCorp"
"Hydro-Quebec"
"ITTA-CPump"
"IVO"
"Iberdrola"
"Iceland"
"IdahoNationalEngineeringLab"
"India"
"Intercontrole"
"IntergraphCorp"
"Interserve"
"InvensysProcessSystems"
"IonBeamApplications"
"Iran"
"Ireland"
"Israel"
"Italy"
"Japan"
"JapanNuclearFuel"
"JapanSteelWorks"
"JohnsonControls-ProcordLtd"
"Jordan"
"JosephOatCorp"
"KEffectiveLLC"
"KHNP"
"KSB"
"KansaiElectricPowerCoInc"
"KazAtomProm"
"Kepco"
"KernkraftwerkBrunsbuttelGmbH"
"KernkraftwerkGosgenDanikenAG"
"KernkraftwerkLeibstadtAG"
"KnollsAtomicPowerLab"
"KraftdragarnaAB"
"Kuwait"
"Kvaerner"
"L-3MAPPS"
"Laing"
"Lemminkainen"
"LosAlamosNationalLab"
"LosAlamosTechnicalAssociates"
"LouisianaEnergyServices"
"Luch-TaskOrder1"
"Luxembourg"
"MACTECEngineeringandConsulting"
"MEAGPower"
"MHFLogisticalSolutionsInc"
"MOHT"
"MROSoftware"
"MagnoxNorth"
"MaineYankeeAtomicPowerCo"

"McCallum-Turner"
"Mirant"
"MitsubishiCorp"
"MitsubishiElectricCorp"
"MitsubishiHeavyIndustriesLtd"
"MitsuiBabcock"
"MowlemNuclear"
"MurmanskShippingCo"
"Murray&Roberts"
"Murray&RobertsSNC-LavalinNuclearPtyLtd"
"NACInternational"
"NFS-RPS"
"NNC"
"NNSA"
"NRCEnergyInc"
"NRGEnergy"
"NUKEMInc"
"NUKEMTechnologies"
"NationalAtomicEnergyCommission"
"NationalnaElektricheskaKompania"
"NebraskaPublicPowerDistrict"
"Netherlands"
"NewYorkPowerAuthority"
"Newberg-Perini"
"NiagaraMohawkPowerCorporation"
"NordostschweizerischeKraftwerkeAG"
"NorthCarolinaElectricMembershipCorp"
"NorthCarolinaMunicipalPowerAgencyNumber1"
"NorthKorea"
"NortheastUtilities"
"NorthernStatesPowerCo"
"NorthrupGrumman"
"Norway"
"NuStartEnergy"
"NuclearElectric"
"NuclearFuelIndustriesLtd"
"NuclearManagementCompanyLLC"
"NuclearNon-ProliferationCenter"
"NuclearPowerCorporationofIndiaLtd"
"NuclearPowerInternational"
"NuclearPowerQinshanJointVentureCompanyLtd"
"NuclearelectricaSA"
"NucleoelectricaArgentinaSA"
"NuklearnaElektrarnaKrsko"
"OKGAB"
"ORTEC"
"OakRidge"
"OglethorpePower"
"OntarioPowerGeneration"
"PBZ-C2"
"PCIEnergyServiceLLC"
"PEInternational"
"PPLCorp"
"PSEGNuclear"
"PTISystems"
"PaRNuclearInc"

"PacificGas&ElectricCompany"
"Pakistan"
"PaksNuclearPowerPlant"
"ParsonsInfrastructure"
"PeacockInc"
"PebbleBedModularReactorPtyLtd"
"PiedmontMunicipalPowerAgency"
"PipeCoatingFacility63544"
"Poland"
"PortlandGeneralElectricCo"
"Portugal"
"PrincetonUniversity"
"ProcessEnergyServices"
"ProgressEnergy"
"ProgressEnergyFlorida"
"ProjectPrometheus"
"ProjectServicesGroupLLC"
"Qatar"
"QinshanNuclearPower"
"ROSInc"
"RWENukemInc"
"RWEPowerAG"
"RinghalsAB"
"RockwellInternational"
"RockyFlats"
"Rolls-RoyceNuclearEngineeringServices"
"Rosatom"
"Rosenergoatom"
"RoyFWestonInc"
"Russia"
"RussianFoundationforEnvironmentalSafetyofPowerEngineering"
"RustConstructors"
"SAIC-PO14436"
"SGLCarbon"
"SGN"
"SGN-Eurisys"
"SGTLLC"
"SMStollerCorp"
"SNCLavalin"
"SacramentoMunicipalUtilityDistrict"
"SaludaRiverElectricCooperative"
"SanmenNuclearPowerCo"
"SaratovRegionalGovernment"
"Sargent&LundyLLC"
"SavannahRiver"
"Scientech"
"ScottWilson"
"Sebim"
"SecuritasSecurityServicesUSAInc"
"SercoAssurance"
"SeverskFossilFuelPlant"
"Sfarsteel"
"ShandongNuclearPowerCo"
"ShanghaiCraneandConveyorWorks"
"ShanghaiGaotaiRareandPreciousMetalsCoLtd"
"ShanghaiNuclearEngineeringResearchandDesignInstitute"

"ShawArevaMOXServicesLLC"
"ShawGroupInc"
"SheffieldForgemasters"
"Siemens"
"SiemensEnergy"
"SiemensKWU"
"SiemensPowerGeneration"
"SilexSystemsLtd"
"SirRobertMcAlpine"
"SkodaPlzen"
"SkodaPrahaAS"
"SlovakRepublic"
"Slovenia"
"SlovenskeElektrarne"
"SocieteaNationalaNuclearelectrica"
"SouthCarolinaElectric&Gas"
"SouthKorea"
"SouthTexasProjectNuclearOperatingCo"
"SouthernCaliforniaEdison"
"SouthernCompany"
"Spain"
"SpescomSoftwareInc"
"StateNuclearPowerTechnologyCo"
"StensandAB"
"Stone&WebsterConstructionInc"
"Strachan&Henshaw"
"StudsvikAB"
"StudsvikUK"
"SumitomoCorp"
"Sweden"
"Switzerland"
"T2-0186-RU"
"T2-0192-RU"
"T2-0194-RU"
"T2-0204-UA"
"T2-0244-RU"
"T2-2002-RU"
"TIC-UETreasureCoastJointVenture"
"TLGServicesInc"
"TVZ01"
"TXU"
"TaiwanPowerCompany"
"TaylorWoodrow"
"TeledyneBrownEngineeringInc"
"TennesseeValleyAuthority"
"TeollisuudenVoimaOy"
"TetratechInc"
"TheNorthernMachineBuildingEnterprise-Sevmash"
"ThermalEngineeringInternational"
"ThermoElectronCorp"
"ThermoFisherScientificInc"
"ThermtronProjects"
"ToledoEdison"
"ToshibaCorp"
"TransnuclearInc"
"UKAtomicEnergyAuthority"

"UKNuclearDecommissioningAuthority"
"URSWashingtonDivision"
"USARepositoryServices"
"USDepartmentofEnergy"
"USECInc"
"UddcombEngineeringAB"
"Uhde"
"Ukraine"
"UniStarNuclearEnergy"
"UnitedArabEmirates"
"UnitedCoRusal"
"UnitedKingdom"
"UnitedStates"
"UniversityofColumbia"
"UraMin"
"VTGroup"
"Vattenfall"
"VerityInc"
"VermontYankeeNuclearPowerPlantCorp"
"VinciGroupSA"
"VogtPowerInternational"
"VolianEnterprisesInc"
"WMG"
"WPI"
"WachsTechnicalServicesInc"
"WackenhutServicesInc"
"WashingtonGroupInternationalInc"
"WashingtonSavannahRiverCo"
"WasteIsolationPilotPlant"
"WestValleyDemonstrationProject"
"WestinghouseElectricBelgiumSA"
"WestinghouseElectricCo"
"WestinghouseSavannahRiverCo"
"WilliamLettisandAssociates"
"WolfCreekNuclearOperatingCorp"
"XcelEnergy"
"ZheleznogorskFossilFuelPlant"
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Atomstroyexport	company	yes
AtosOrigin	company	no
Australia	state	no
Austria	state	no
AVANTechIncorporated	company	no
AVK-SEG	company	no
B&WCanada	company	no
Babcock&Wilcox	company	no
BabcockNoellNuclearGmbH	company	no
Babtie	company	no
Bahrain	state	no
BarsebackKraftAB	company	no
BattelleMemorialInstitute	NGO	no
BechtelBWXTIdahoLLC	company	no
BechtelCorp	company	no
BechtelHanfordInc	company	no
BechtelNationalInc	company	no
BechtelNevadaInc	company	no
BechtelPowerCorp	company	no
BelenePower	state-ownedcorp	no
Belgium	state	no
Belgoprocess	company	no
BiggeCrane&RiggingCo	company	no
BiggePowerConstructors	company	no
BNFL	state-ownedcorp	no
BNFLEnvironmentalServices	state-ownedcorp	no
BNFLMagnoxGeneration	state-ownedcorp	no
BNSNuclearServices	company	no
BouyguesSA	company	no
BritishEnergy	company	yes
BritishNuclearGroup	state-ownedcorp	no
BrucePower	partnership	yes
Bulgaria	state	no
BurnsandRoeEnterprises	company	no
BWXTPantex	company	no
BWXTY-12LLC	company	no
C&DTechnologiesInc	company	no
Cameco	company	yes
Canada	state	no
CanatomInc	company	no
CANBERRAEurisysSA	state-ownedcorp	no
CatapultTechnologyLtd	company	no
CBC-B2	state	no
Cegelec	company	no
CentralNuclearAlmaraz-Trillo	company	no
CeskeEnergetickeZavody	company	yes
CEZGroup	company	yes
CH2MHillHanfordGroup	company	yes
ChernobylShelterProject	IGO	no
China	state	no
ChinaGuangdongNuclearPowerCo	jointventure	yes
ChinaGuangdongNuclearPowerCo-NuclearPowerInstituteofChina	jointventure	yes
ChinaNationalNuclearCorp	state-ownedcorp	yes

ChinaNationalTechnicalImport&ExportCorp	state-ownedcorp	no
ChinaNuclearPowerEngineeringCo	state-ownedcorp	yes
ChinaTechenergyCo	jointventure	no
ClevelandElectricIlluminating	company	no
COGEMA	state-ownedcorp	yes
ComisionFederaldeElectricidad	state-ownedcorp	no
CommonwealthEdisonCo	company	no
COMP2BR	state	no
ConnecticutYankeeAtomicPowerCo	company	no
ConstellationEnergy	company	yes
ControlledDemolitionGroup	company	no
CORYS-TESS	company	no
Costain	company	no
CPSEnergy	company	no
Cuba	state	no
CurtissWrightElectroMechanicalCorp	company	no
DaltonUtilities	company	no
DataSystems&Solutions	company	no
DataSystems&SolutionsSAS	company	no
Day&ZimmermanNPS	company	no
DecisionDynamicsTechnologyLtd	company	no
DelmarvaPower&Light	company	no
DELTECAlliance	jointventure	no
DEMCOInc	company	no
Denmark	state	no
DenverRadiumSite	state	no
DepartmentofTradeandIndustry	state	no
DeutscheAudco	company	no
DHLGlobalForwarding	company	no
DHS	state	no
Dominion	company	no
DominionEnergy	company	no
DongfangElectricCorp	state-ownedcorp	no
DoosanHeavyIndustriesandConstructionCoLtd	company	no
DTEEnergy	company	no
DTI	company	no
DukeEnergy	company	yes
DukePower	company	yes
DuPont	company	no
DuratekInc	company	no
DZAtlantic	company	no
E-ONKernkraft	company	yes
EaglePicherCommercialPowerSolutions	company	no
EberlineServicesInc	company	no
EcolochemInternationalInc	company	no
EG&GInc	company	no
Electrabel	company	no
ElectricPowerDevelopmentCoLtd	company	yes
ElectricitedeFrance	company	yes
Elektrizitats-GesellschaftLaufenburgAG	company	no
EletrobrasTermonuclearSA	state-ownedcorp	yes
EmersonProcessManagement	company	no
EmiratesNuclearEnergyCorp	state-ownedcorp	no

Enel	company	no
EnerconServicesInc	company	no
EnergieBaden-WurttembergAG	company	yes
EnergiewerkeNord	state-ownedcorp	no
Energoatom	state-ownedcorp	yes
Energomontaz-Polnoc	company	no
Enertech	company	no
EngineSystemsInc	company	no
EntergyCorp	company	yes
EntergyNuclear	company	yes
EnvironmentalEnergyResourcesLtd	company	no
EquiposNuclearesSA	state-ownedcorp	no
Eskom	state-ownedcorp	yes
EURATOM	IGO	no
EuropeanCommission	IGO	no
EuropeanUnion	IGO	no
EverestVIT	company	no
ExelonCorp	company	yes
ExelonGeneration	company	yes
ExelonNuclear	company	yes
FBFCJapan	jointventure	no
Fernald	state	no
Finland	state	no
FirstEnergyNuclearOperatingCompany	company	yes
FloridaPower&LightCo	company	yes
FlowserveCorp	company	no
FluorCorp	company	no
FluorHanfordInc	company	no
FluorLimited	company	no
FluorNuclearRemediation	company	no
ForsmarksKraftgruppAB	company	no
FortumOyj	company	no
FPLGroup	company	yes
FRAEC	NGO	no
FramatomeANP	state-ownedcorp	yes
FramatomeANP-DE&S	state-ownedcorp	yes
France	state	no
FrenchInstituteforRadiologicalProtectionandNuclearSafety	state	no
GEEnergy	company	yes
GEWater&ProcessTechnologies	company	yes
GECAlsthom	company	no
GE-HitachiNuclearEnergy	jointventure	yes
GeneralAtomics	company	no
GeneralElectric	company	yes
GeneralPhysicsCorp	company	no
GeorgiaPower	company	no
Germany	state	no
GPUServiceInc	company	no
Greece	state	no
GSE	company	no
GUTOR	company	no
Hanford	state	no
HanjungandKoreaPowerEngineeringCo	company	no

HarbinPowerEquipmentCoLtd	company	no
Hatch-Acres	company	no
HFControlsCorp	company	no
Hitachi	company	yes
HoltecInternational	company	no
Hopkinsons	company	no
HurstTechnologiesCorp	company	no
Hydro-Quebec	state-ownedcorp	no
Iberdrola	company	yes
Iceland	state	no
IdahoNationalEngineeringLab	state	no
India	state	no
Intercontrole	state-ownedcorp	no
IntergraphCorp	company	no
Interserve	company	no
InvensysProcessSystems	company	no
IonBeamApplications	company	no
Iran	state	yes
Ireland	state	no
Israel	state	yes
Italy	state	no
ITTA-CPump	company	no
IVO	company	no
Japan	state	yes
JapanNuclearFuel	company	yes
JapanSteelWorks	company	no
JohnsonControls-ProcordLtd	company	no
Jordan	state	no
JosephOatCorp	company	no
KEffectiveLLC	company	no
KansaiElectricPowerCoInc	company	yes
KazAtomProm	state-ownedcorp	yes
Kepco	company	no
KernkraftwerkBrunsbuttelGmbH	company	no
KernkraftwerkGosgenDanikenAG	company	yes
KernkraftwerkLeibstadtAG	company	yes
KHNP	company	yes
KnollsAtomicPowerLab	state	no
KraftdragarnaAB	company	no
KSB	company	no
Kuwait	state	no
Kvaerner	company	no
L-3MAPPS	company	no
Laing	company	no
Lemminkainen	company	no
LosAlamosNationalLab	state	no
LosAlamosTechnicalAssociates	company	no
LouisianaEnergyServices	company	no
Luch-TaskOrder1	state	no
Luxembourg	state	no
MACTECEngineeringandConsulting	company	no
MagnoxNorth	company	no
MaineYankeeAtomicPowerCo	company	no

McCallum-Turner	company	no
MEAGPower	state-ownedcorp	no
MHFLogisticalSolutionsInc	company	no
Mirant	company	no
MitsubishiCorp	company	yes
MitsubishiElectricCorp	company	yes
MitsubishiHeavyIndustriesLtd	company	yes
MitsuiBabcock	company	no
MOHT	company	no
MowlemNuclear	company	no
MROSoftware	company	no
MurmanskShippingCo	company	no
Murray&Roberts	company	no
Murray&RobertsSNC-LavalinNuclearPtyLtd	jointventure	no
NACInternational	company	yes
NationalAtomicEnergyCommission	state	no
NationalnaElektricheskaKompania	state	no
NebraskaPublicPowerDistrict	state-ownedcorp	no
Netherlands	state	no
NewYorkPowerAuthority	state-ownedcorp	no
Newberg-Perini	company	no
NFS-RPS	company	no
NiagaraMohawkPowerCorporation	company	no
NNC	company	no
NNSA	state	no
NordostschweizerischeKraftwerkeAG	state-ownedcorp	no
NorthCarolinaElectricMembershipCorp	joint-actionagency	no
NorthCarolinaMunicipalPowerAgencyNumber1	state-ownedcorp	no
NorthKorea	state	no
NortheastUtilities	company	no
NorthernStatesPowerCo	company	no
NorthrupGrumman	company	no
Norway	state	no
NRCEnergyInc	company	no
NRGEnergy	company	no
NuclearElectric	state-ownedcorp	no
NuclearFuelIndustriesLtd	company	no
NuclearManagementCompanyLLC	company	no
NuclearNon-ProliferationCenter	NGO	no
NuclearPowerCorporationofIndiaLtd	state-ownedcorp	yes
NuclearPowerInternational	jointventure	no
NuclearPowerQinshanJointVentureCompanyLtd	jointventure	no
NuclearelectricaSA	state-ownedcorp	no
NucleoelectricaArgentinaSA	state-ownedcorp	no
NUKEMInc	company	yes
NUKEMTechnologies	company	yes
NuklearnaElektrarnaKrsko	company	no
NuStartEnergy	company	no
OakRidge	state	no
OglethorpePower	joint-actionagency	no
OKGAB	company	no
OntarioPowerGeneration	company	yes

ORTEC	company	no
PacificGas&ElectricCompany	company	no
Pakistan	state	yes
PaksNuclearPowerPlant	state-ownedcorp	no
PaRNuclearInc	company	no
ParsonsInfrastructure	company	no
PBZ-C2	state	no
PCIEnergyServiceLLC	company	no
PEInternational	company	no
PeacockInc	company	no
PebbleBedModularReactorPtyLtd	jointventure	yes
PiedmontMunicipalPowerAgency	joint-actionagency	no
PipeCoatingFacility63544	state	no
Poland	state	no
PortlandGeneralElectricCo	company	no
Portugal	state	no
PPLCorp	company	no
PrincetonUniversity	academic	no
ProcessEnergyServices	company	no
ProgressEnergy	company	yes
ProgressEnergyFlorida	company	yes
ProjectPrometheus	state	no
ProjectServicesGroupLLC	company	no
PSEGNuclear	company	no
PTISystems	company	no
Qatar	state	no
QinshanNuclearPower	state-ownedcorp	yes
RinghalsAB	company	no
RockwellInternational	company	no
RockyFlats	state	no
Rolls-RoyceNuclearEngineeringServices	company	yes
ROSInc	company	no
Rosatom	state	no
Rosenergoatom	state-ownedcorp	yes
RoyFWestonInc	company	no
Russia	state	no
RussianFoundationforEnvironmentalSafetyofPowerEngineering	state	no
SaratovRegionalGovernment	state	no
RustConstructors	company	no
RWENukemInc	company	no
RWEPowerAG	company	yes
SacramentoMunicipalUtilityDistrict	state-ownedcorp	no
SAIC-PO14436	company	no
SaludaRiverElectricCooperative	joint-actionagency	no
SanmenNuclearPowerCo	state-ownedcorp	no
Sargent&LundyLLC	company	no
SavannahRiver	state	no
Scientech	company	no
ScottWilson	company	no
Sebim	company	no
SecuritasSecurityServicesUSAInc	company	no
SercoAssurance	company	no

SeverskFossilFuelPlant	state	no
Sfarsteel	state-ownedcorp	no
SGLCarbon	company	no
SGN	state-ownedcorp	no
SGN-Eurisys	jointventure	no
SGTLLC	jointventure	no
ShandongNuclearPowerCo	state-ownedcorp	no
ShanghaiCraneandConveyorWorks	state-ownedcorp	no
ShanghaiGaotaiRareandPreciousMetalsCoLtd	company	no
ShanghaiNuclearEngineeringResearchandDesignInstitute	state-ownedcorp	yes
ShawArevaMOXServicesLLC	jointventure	no
SheffieldForgemasters	company	no
Siemens	company	no
SiemensEnergy	company	no
SiemensKWU	company	no
SiemensPowerGeneration	company	no
SilexSystemsLtd	company	yes
SirRobertMcAlpine	company	no
SkodaPlzen	company	no
SkodaPrahaAS	company	no
SlovakRepublic	state	no
Slovenia	state	no
SlovenskeElektrarne	state-ownedcorp	no
SMStollerCorp	company	no
SNCLavalin	company	no
SocieteaNationalaNuclearelectrica	state-ownedcorp	yes
SouthCarolinaElectric&Gas	company	no
SouthKorea	state	no
SouthTexasProjectNuclearOperatingCo	company	no
SouthernCaliforniaEdison	company	no
SouthernCompany	company	yes
Spain	state	no
SpescomSoftwareInc	company	no
StateNuclearPowerTechnologyCo	state-ownedcorp	no
StensandAB	company	no
Stone&WebsterConstructionInc	company	no
Strachan&Henshaw	company	no
StudsvikAB	company	no
StudsvikUK	company	no
SumitomoCorp	company	yes
Sweden	state	no
Switzerland	state	no
T2-0186-RU	state	no
T2-0192-RU	state	no
T2-0194-RU	state	no
T2-0204-UA	state	no
T2-0244-RU	state	no
T2-2002-RU	state	no
TaiwanPowerCompany	state-ownedcorp	yes
TaylorWoodrow	company	no
TeledyneBrownEngineeringInc	company	no
TennesseeValleyAuthority	state-ownedcorp	no
TeollisuudenVoimaOy	company	yes

TetratechInc	company	no
TheNorthernMachineBuildingEnterprise-Sevmash	state-ownedcorp	no
ShawGroupInc	company	yes
ThermalEngineeringInternational	company	no
ThermoElectronCorp	company	no
ThermoFisherScientificInc	company	no
ThermtronProjects	company	no
TIC-UETreasureCoastJointVenture	jointventure	no
TLGServicesInc	company	no
ToledoEdison	company	no
ToshibaCorp	company	yes
TransnuclearInc	state-ownedcorp	no
TVZ01	state	no
TXU	company	no
UddcombEngineeringAB	state-ownedcorp	no
Uhde	company	no
UKAtomicEnergyAuthority	state-ownedcorp	no
UKNuclearDecommissioningAuthority	state	no
Ukraine	state	no
UniStarNuclearEnergy	jointventure	no
UnitedArabEmirates	state	no
UnitedCoRusal	company	no
UnitedKingdom	state	no
UnitedStates	state	no
UniversityofColumbia	academic	no
UraMin	state-ownedcorp	no
URSWashingtonDivision	company	no
USDepartmentofEnergy	state	no
USARepositoryServices	company	no
USECInc	company	yes
Vattenfall	company	yes
VerityInc	company	no
VermontYankeeNuclearPowerPlantCorp	company	no
VinciGroupSA	company	no
VogtPowerInternational	company	no
VolianEnterprisesInc	company	no
VTGroup	company	no
WachsTechnicalServicesInc	company	no
WackenhutServicesInc	company	no
WashingtonGroupInternationalInc	company	no
WashingtonSavannahRiverCo	jointventure	no
WasteIsolationPilotPlant	state	no
WestValleyDemonstrationProject	state	no
WestinghouseElectricBelgiumSA	company	no
WestinghouseElectricCo	company	no
WestinghouseSavannahRiverCo	company	no
WilliamLettisandAssociates	company	no
WMG	company	no
WolfCreekNuclearOperatingCorp	company	no
WPI	unknown	no
XcelEnergy	company	no
ZheleznogorskFossilFuelPlant	state	no

Table D: Company “Genealogy”

Company	Subsidiary or joint venture of
23rdConstruction&InstallationCorp	China Nuclear Engineering & Construction Corporation (CNEC)
ABBCombustionEngineeringNuclearPowerInc	WestinghouseElectricCo
Alstec	now known as BNS Nuclear Services (part of Babcock)
Alstom Atomenergomash LLC	JSC Atomenergomash (51%) and Alstom (49%)
AmerenUE	AmerenCorp
ArevaDongfang	AREVA & Dongfang Electric Corporation
ArevaNP	AREVA (66%) and Siemens (34%)
ASLF	joint venture between Hatch Energy, Sargent & Lundy, and E.S. Fox Ltd
Atomenergoexport	now known as Atomstroyexport
Atomenergoproekt	Minatom (Russia)
Atomstroyexport	Minatom (Russia)
B&WCanada	Babcock & Wilcox
BechtelBWXTIdahoLLC	Bechtel Corp (lead partner)
BechtelHanfordInc	BechtelCorp
BechtelNationalInc	BechtelCorp
BechtelNevadaInc	BechtelCorp
BechtelPowerCorp	BechtelCorp
BelenePower	Nationalna Elektricheska Kompania (NEK) Bulgarian state-owned power utility
BiggePowerConstructors	BiggeCrane&RiggingCo
BNFL Engineering	BNFL (now known as VT Nuclear Services and part of the VT Group)
BNFLEnvironmentalServices	BNFL
BNFLMagnoxGeneration	BNFL
BrucePower	Cameco (31.6%), TransCanada Corp (31.6%), The Power Workers' Union and Society of Energy Professionals (5.2%), and BPC (OMERS) (31.6%)
BWXTPantex	a limited liability enterprise of BWX Technologies, Honeywell and Bechtel Corporation
CanatomInc	now known as SNC-Lavalin Nuclear (owned by SNC-Lavalin)
CANBERRA Eurisys SA	AREVA NC
Ceske Energeticke Zavody	ČEZ Group
ChinaGuangdongNuclearPowerCo	joint venture of the state-owned China Nuclear Industry Corporation, Guangdong provincial government, and China's Ministry of Power Industry
China Guangdong Nuclear Power Holding Company	China Guangdong Nuclear Power Group
ChinaNuclearPowerEngineeringCo	ChinaNationalNuclearCorp
ChinaTechenergyCo	joint venture co-funded by China Guangdong Nuclear Power Group (CGNPC) and Beijing Hollysys Co., Ltd
COGEMA	Areva
DataSystems&Solutions	Rolls-Royce plc (now known as Rolls-Royce Civil Nuclear)
DataSystems&SolutionsSAS	now known as Optimized Systems & Solutions LLC
DELTECAlliance	joint venture of RTS, Morson Projects, DGP International, and Capula
DominionEnergy	Dominion
DukePower	Duke Energy (former name of Duke Energy's electric utility business)
DuratekInc	now part of EnergySolutions

DZAtlantic	Day & Zimmerman
EletrobrasTermonuclearSA	company 52% owned by Brazil, rest is publicly traded
Eletronuclear (Eletrobrás Termonuclear SA)	Eletrobrás
EmiratesNuclearEnergyCorp	UAE state company
Enertech	Curtiss-Wright Flow Control
EntergyNuclear	EntergyCorp
EverestVIT	GeneralElectric
ExelonGeneration	ExelonCorp
ExelonNuclear	ExelonCorp
FBFCJapan	Framatome ANP 51%, and Fbfc International SA (Belgium)
FloridaPower&LightCo	FPLGroup
FluorHanfordInc	FluorCorp
FluorLimited	Fluor Corporation
FramatomeANP	AREVA (66%) and Siemens (34%), now called AREVA NP ("nuclear power")
FramatomeANP-DE&S	Framatome ANP (acquisition of Duke Engineering & Services)
GEEnergy	GeneralElectric
GEWater&ProcessTechnologies	GeneralElectric
GE-HitachiNuclearEnergy	GE Energy and Hitachi Ltd
General Atomics	General Dynamics
GeorgiaPower	SouthernCompany
GPUServiceInc	now part of FirstEnergy
HanjungandKoreaPowerEngineeringCo	Kepco
HF Controls	Doosan Heavy Industries
Hopkinsons	Weir Group
Intercontrole	Areva
JNFL	Japan Nuclear Fuel, consortium of ten electricity firms
LouisianaEnergyServices	Urenco Ltd
Magnox Electric	Reactor Site Management Company
MitsubishiElectricCorp	MitsubishiCorp
MitsubishiHeavyIndustriesLtd	MitsubishiCorp
MitsuiBabcock	now known as Doosan Babcock Energy (part of Doosan Heavy Industries)
Morrison Knudsen International	Washington Group International
MowlemNuclear	now part of Carillion
Murray&RobertsSNC-LavalinNuclearPtyLtd	Murray & Roberts and SNC-Lavalin Nuclear
NiagaraMohawkPowerCorporation	National Grid
NNC	now owned by AMEC
NNSA	United States National Nuclear Security Administration (NNSA) is part of the United States Department of Energy (DOE)
NordostschweizerischeKraftwerkeAG	Axpo
NorthernStatesPowerCo	Xcel Energy Inc
NuclearElectric	privatized as British Energy
NuclearPowerInternational	joint venture of Siemens and Framatome
OKGAB	E.ON Group
ORTEC	AMETEK Advanced Measurement Technology
PaRNuclearInc	WestinghouseElectricCo
PCIEnergyService LLC	WestinghouseElectricCo
PeacockInc	Kinecor
PebbleBedModularReactorPtyLtd	current investors are Eskom, the Industrial Development Corporation of South Africa and the Westinghouse Electric Company
Peco	ExelonCorp

ProgressEnergyFlorida	ProgressEnergy
ProjectPrometheus	NASA and DOE
Project Services	BritishNuclearGroup
PSEGNuclear	Public Service Enterprise Group (PSEG)
Reactor Site Management Company	Energy Solutions (formerly Nuclear Decommissioning Authority)
Rolls-RoyceNuclearEngineeringServices	Rolls-Royce Plc
Rosenergoatom	now Energoatom
RoyFWestonInc	now known as Weston Solutions Inc
RustConstructors	Washington Group International
RWENukemInc	now known as NUKEM
Sebim	The Weir Group PLC
Sfarsteel	now part of AREVA NP
SGN	COGEMA (now called AREVA NC "nuclear cycle")
SGTLLC	a joint venture between Washington Group International and AREVA NP SAS
ShandongNuclearPowerCo	a subsidiary of China Power Investment Corporation (CPI)
ShawArevaMOXServicesLLC	AREVA and The Shaw Group Inc
SiemensEnergy	Siemens
SiemensKWU	Siemens (Kraftwerk Union AG)
SiemensPowerGeneration	Siemens
SouthCarolinaElectric&Gas	subsidiary of SCANA Corporation
SouthernCaliforniaEdison	subsidiary of Edison International
SpescomSoftwareInc	now known as Enterprise Informatics Inc.
StensandAB	former subsidiary of Studsvik AB
Stone&WebsterConstructionInc	ShawGroupInc
Strachan&Henshaw	now part of Babcock International
StudsvikUK	StudsvikAB
TaylorWoodrow	now part of Vinci plc
Technicatome	now AREVA TA
TeledyneBrownEngineeringInc	Teledyne Technologies
ThermalEngineeringInternational	Babcock
ThermoElectronCorp	merged with Fisher Scientific, now called Thermo Fisher Scientific (soon to be Thermo-Fish, then just TheFish)
TLGServicesInc	Entergy
TransnuclearInc	part of AREVA
UddcombEngineeringAB	subsidiary of Framatome ANP SAS
Uhde	Thyssenkrupp Engineering (Pty) Ltd
Unicom	now Exelon
UniStar Nuclear	EDF (or AREVA NP, depending on reports!) and Constellation Energy
UraMin	Areva
USARepositoryServices	URS Corporation
VerityInc	Autonomy Corp
VogtPowerInternational	Babcock
WashingtonGroupInternationalInc	now known as URS Washington Division
WestinghouseElectricBelgiumSA	WestinghouseElectricCo
WestinghouseElectricCo	Toshiba (77%) (formerly BNFL)

APPENDIX D

THE HUMAN SECURITY COMPULSORY POWER NETWORK

This is the full matrix with labels for the human security compulsory power network, consisting of 505 actors who had financial transactions with each other. In the matrix, the value encoded represents the U.S. dollar value of the transaction rounded to the nearest thousand, with "?" representing no transaction. Columns are separated by commas, rows are separated by paragraphs.

The matrix is followed by an attribute list which lists the actors by type.

Table 16: Humanitarian Aid Full Matrix

DL
N=505
FORMAT = FULLMATRIX DIAGONAL PRESENT
ROW LABELS:
"African Union"
"IFRC"
"Albania"
"Albanian Red Cross"
"Algeria"
"UNDP"
"Algerian Red Crescent Society"
"American Red Cross"
"IOM"
"WFP"
"Andorra"
"Arab Association for Human Rights"
"AGPUNDO"
"OCHA"
"Argentina Red Cross"
"Australia Red Cross"
"Australia"
"CCF"
"IMC"
"NGOs"
"SC"
"UNFPA"
"UNHCR"
"UNICEF"
"UNJLC"
"WHO"
"WV"
"Austria"
"Sri Lanka"
"Austrian Red Cross"
"Azerbaijan"
"Bahamas Red Cross"
"Bangladesh Red Crescent"
"Barbados Red Cross"
"Belarus"
"Belgium Red Cross"

"Belgium"
"FAO"
"ILO"
"Indonesia"
"Ministry of Defense"
"Belgian Red Cross"
"Region"
"RKV"
"UN Agencies, NGOs and Red Cross"
"Belize Red Cross"
"Bolivia Red Cross"
"Bosnian Red Crescent Society"
"Botswana Red Cross"
"Brazil Red Cross"
"Brazil"
"Thailand"
"Bulgaria"
"Cambodia"
"Canada"
"ADRA Canada"
"CARE"
"CBM"
"CDP"
"CFHI"
"CRWRC"
"HPIC"
"IDRF"
"India"
"LWR (Canada)"
"Maldives"
"MCC"
"OXFAM"
"Canadian Red Cross"
"Indonesia Red Crescent"
"SCF/Canada"
"WVI (Canada)"
"CIDA/IHA"
"PCI"
"Canadian Red Cross Society"
"Chile Red Cross"
"China"
"Myanmar"
"UNEP"
"Chinese Red Cross"
"City of Munich (Germany)"
"UN-HABITAT"
"Colombia Red Cross"
"Cook Islands Red Cross"
"Croatia Red Cross"
"Curaçao Red Cross"
"Cyprus Red Cross"
"Cyprus"
"DW"
"JOIN"
"MDM"
"Private (individual donations)"

"Czech Rep. Red Cross"
"Czech Republic"
"Hrúz"
"UNV"
"Danish Red Cross"
"Denmark"
"ADRA Denmark"
"ADRA"
"Danchurchaid"
"Danish People's Aid"
"DBL"
"DDG"
"DEMA"
"DRC"
"IAS"
"RDROC"
"Disasters Emergency Committee (UK)"
"ACTIONAID"
"BRCS"
"CA"
"CAFOD"
"CONCERN"
"Help the Aged"
"MERLIN"
"TEARFUND"
"Ecuador Red Cross"
"El Salvador Red Cross"
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"Estonia"
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"EuropeAid"
"ECHAO"
"ACF-France"
"ACTED"
"AIFO"
"AMI-France"
"ATLAS"
"CAM"
"Care Germany"
"CARITAS"
"CISP"
"GAA (DWH)"
"HI"
"HI/France"
"ICMC"
"IRC"
"ISDR"
"NRC"
"OXFAM UK"
"Plan International UK"
"PSF (France)"
"PU"
"SC - UK"
"Solidarités"
"TdH - Italy"

"TdH (Switzerland)"
"THW"
"TGH"
"TSF"
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"Exactmobile (South Africa)"
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"Fiji"
"Finland Red Cross"
"Finland"
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"Finnchurchaid"
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"NGOs; Red Cross"
"UNESCO"
"France"
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"Adam's Peak"
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"French Red Cross"
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"Germany"
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"ASB"
"CARE INT"
"DEA"
"FI"
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"Help"
"Johanniter-Unfall-Hilfe"
"Kindernothilfe e.V."
"Nehemia Christenhilfsdienst e.V."
"Somalischer Verein e.V."
"WVI (Germany)"
"Greece Red Cross"
"Greece"
"European Perspective"
"Heart Doctors"
"HRT"
"VCGFR"
"Guyana Red Cross"
"Guyana"
"Hewlett Foundation"
"Honduras Red Cross"
"Hong Kong Red Cross"
"Hungary Red Cross"
"Hungary"

"Iceland Red Cross"
"Iceland"
"International Maritime Organization"
"UN"
"Iran Red Crescent"
"Iran"
"Ireland Red Cross"
"Ireland"
"GOAL /IRDO"
"GORTA"
"HFH"
"HOPE"
"IDLO"
"ISLTF"
"MCI"
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"Thai Tsunami Victim Identification Group"
"Trocaire"
"Unspecified"
"VSO"
"World Bank"
"Islamic Development Bank"
"IR"
"Israel"
"Italy Red Cross"
"Italy"
"INTERSOS"
"MFA"
"Jamaica Red Cross"
"Japan"
"UNIFEM"
"Japanese Red Cross"
"Jordanian Red Crescent"
"Kazakhstan"
"Korea (Republic of) Red Cross"
"Korea, Democratic People's Republic of"
"Malaysia"
"Korea, Republic of"
"Kuwait"
"Kuwait Red Crescent"
"Lao (People's Democratic Republic)"
"Latvia Red Cross"
"Latvia"
"Lebanese Red Cross"
"Liberia"
"Libya Red Crescent"
"Libya"
"Liechtenstein Red Cross"
"Liechtenstein"
"CARE Austria"
"Lithuania Red Cross"
"Lithuania"
"Luxembourg Red Cross"
"Luxembourg"
"Ibdesch Patenschaften"
"SOS Kinderdorf"

"Macedonia, FYR Red Cross"
"Madagascar"
"Malaysia Red Cross"
"Mali"
"Malta"
"SOS Malta"
"Mauritania"
"Mauritius Red Cross"
"Mauritius"
"Mercy Corps International"
"FCE"
"Mexico Red Cross"
"Mexico"
"Micronesia Red Cross"
"Micronesia, Federated States of"
"Moldova"
"Monaco Red Cross"
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"Morocco Red Crescent"
"Mozambique"
"Namibian Red Cross"
"Nepal"
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"UNAIDS"
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"Nigeria"
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"NCA"
"NTHO"
"Plan Norway"
"SCN"
"TRO"
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"Oxfam America"
"OXFAM Hong Kong"
"OXFAM/CAA"
"Palau Red Cross"
"Palau"
"Papua New Guinea Red Cross"
"Papua New Guinea"
"Paraguay Red Cross"
"Philippine Red Cross"
"Poland Red Cross"
"Poland"
"Portugal Red Cross"
"Portugal"
"AMI"

"Saúde em Português"
"AAH"
"ADH"
"AFSC"
"Aide et Action"
"AJWS"
"Americares"
"ARC"
"ASI"
"Asmae Soeur Emmanuelle"
"Baptist World Aid"
"BICE"
"CFSI"
"Collectif Asie Enfants Isolés"
"Comite Catholique contre la faim"
"CORDAID"
"CRS"
"CWS"
"Direct Relief International"
"DMC"
"DZI"
"Emmaüs International"
"Enfants et Développement"
"ERD"
"FH"
"Fondation de France"
"Frères des Hommes"
"Gifts in kind International"
"Give World"
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"H2H"
"HIVOS"
"IMA"
"INMED"
"International Aid"
"International Orthodox Christian Charities"
"IRA"
"IRD"
"IRT"
"JDC"
"JRS"
"Kerkinactie - Netherlands"
"La chaine de l'espoir"
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"National Peace Corps Association"
"NICCO"
"Northwest Medical"
"Operation USA"
"Partage"
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"Relief International"
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"Secours Islamique"
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"Somali Red Crescent Society"
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"Serbia and Montenegro"
"SERVICE plus GMBH"
"Singapore"
"Slovak Red Cross"
"Slovakia"
"Slovenia"
"FT"
"Slovenian Red Cross"
"South Africa"
"South African Red Cross"
"Spain"
"Autorités locales"
"Spanish Red Cross"
"Standard Chartered Bank"
"Sweden"
"CSA"
"Diakonia World Federation"
"IOGT-NTO"
"PMU-I"
"Swedish Red Cross"
"SMR"

"SRSA"
"Swiss Red Cross"
"Switzerland"
"FXB"
"SDC/SHA"
"SIG"
"Swiss Embassy"
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"Taiwan Red Cross"
"ESCAP"
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"Internews"
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"Red R"
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"VHAI"
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"United Nations Industrial Development Organization"
"UNIDO"
"USAID"
"United States of America"
"ACE"
"ACIL"
"AF"
"BMI"
"CARDI"
"CHFI"
"CLGI"
"DAI"
"EXNORA"
"Genesis Software"
"IBM"

"ICMA"
"IQC TBD"
"JHPIEGO"
"JHU"
"MRC"
"Nathan Associates"
"NMRU"
"Nurani Dunia"
"Peace and Conflict Institution"
"Sarvodaya Shramadana Movement"
"SFL"
"URI/SUCCESS LWA"
"USAID/ANE"
"USAID/OTI"
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"Vanuatu Red Cross"
"Venezuela Red Cross"
"Vitoria-Gasteiz, Municipality of (Spain)"
"World Vision Sri Lanka"
"WPD"
COLUMN LABELS:
"African Union"
"IFRC"
"Albania"
"Albanian Red Cross"
"Algeria"
"UNDP"
"Algerian Red Crescent Society"
"American Red Cross"
"IOM"
"WFP"
"Andorra"
"Arab Association for Human Rights"
"AGPUNDO"
"OCHA"
"Argentina Red Cross"
"Australia Red Cross"
"Australia"
"CCF"
"IMC"
"NGOs"
"SC"
"UNFPA"
"UNHCR"
"UNICEF"
"UNJLC"
"WHO"
"WV"
"Austria"
"Sri Lanka"
"Austrian Red Cross"
"Azerbaijan"
"Bahamas Red Cross"
"Bangladesh Red Crescent"
"Barbados Red Cross"

"Belarus"
"Belgium Red Cross"
"Belgium"
"FAO"
"ILO"
"Indonesia"
"Ministry of Defense"
"Belgian Red Cross"
"Region"
"RKV"
"UN Agencies, NGOs and Red Cross"
"Belize Red Cross"
"Bolivia Red Cross"
"Bosnian Red Crescent Society"
"Botswana Red Cross"
"Brazil Red Cross"
"Brazil"
"Thailand"
"Bulgaria"
"Cambodia"
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"Czech Republic"
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"Equatorial Guinea"
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"Ethiopian Red Cross"
"EuropeAid"
"ECHAO"
"ACF-France"
"ACTED"
"AIFO"
"AMI-France"
"ATLAS"
"CAM"
"Care Germany"
"CARITAS"
"CISP"
"GAA (DWH)"
"HI"
"HI/France"
"ICMC"
"IRC"
"ISDR"
"NRC"
"OXFAM UK"
"Plan International UK"
"PSF (France)"
"PU"
"SC - UK"

"Solidarités"
"TdH - Italy"
"TdH (Switzerland)"
"THW"
"TGH"
"TSF"
"ZOA Refugee Care"
"Exactmobile (South Africa)"
"Fiji Red Cross"
"Fiji"
"Finland Red Cross"
"Finland"
"FIDA International"
"Finnchurchaid"
"HT"
"NGOs; Red Cross"
"UNESCO"
"France"
"ACF"
"Adam's Peak"
"AIDER"
"Architectes de l'urgence"
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"Oeuvres hospitalières françaises de l'Ordre de Malte"
"PSF"
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"French Red Cross"
"German Red Cross"
"Germany"
"Arche Nova"
"ASB"
"CARE INT"
"DEA"
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"Help"
"Johanniter-Unfall-Hilfe"
"Kindernothilfe e.V."
"Nehemia Christenhilfsdienst e.V."
"Somalischer Verein e.V."
"WVI (Germany)"
"Greece Red Cross"
"Greece"
"European Perspective"
"Heart Doctors"
"HRT"
"VCGFR"
"Guyana Red Cross"
"Guyana"
"Hewlett Foundation"
"Honduras Red Cross"
"Hong Kong Red Cross"

"Hungary Red Cross"
"Hungary"
"Iceland Red Cross"
"Iceland"
"International Maritime Organization"
"UN"
"Iran Red Crescent"
"Iran"
"Ireland Red Cross"
"Ireland"
"GOAL /IRDO"
"GORTA"
"HFH"
"HOPE"
"IDLO"
"ISLTF"
"MCI"
"OXFAM Ireland"
"Thai Tsunami Victim Identification Group"
"Trocaire"
"Unspecified"
"VSO"
"World Bank"
"Islamic Development Bank"
"IR"
"Israel"
"Italy Red Cross"
"Italy"
"INTERSOS"
"MFA"
"Jamaica Red Cross"
"Japan"
"UNIFEM"
"Japanese Red Cross"
"Jordanian Red Crescent"
"Kazakhstan"
"Korea (Republic of) Red Cross"
"Korea, Democratic People's Republic of"
"Malaysia"
"Korea, Republic of"
"Kuwait"
"Kuwait Red Crescent"
"Lao (People's Democratic Republic)"
"Latvia Red Cross"
"Latvia"
"Lebanese Red Cross"
"Liberia"
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"Libya"
"Liechtenstein Red Cross"
"Liechtenstein"
"CARE Austria"
"Lithuania Red Cross"
"Lithuania"
"Luxembourg Red Cross"
"Luxembourg"

"Ibdesch Patenschaften"
"SOS Kinderdorf"
"Macedonia, FYR Red Cross"
"Madagascar"
"Malaysia Red Cross"
"Mali"
"Malta"
"SOS Malta"
"Mauritania"
"Mauritius Red Cross"
"Mauritius"
"Mercy Corps International"
"FCE"
"Mexico Red Cross"
"Mexico"
"Micronesia Red Cross"
"Micronesia, Federated States of"
"Moldova"
"Monaco Red Cross"
"Monaco"
"Morocco Red Crescent"
"Mozambique"
"Namibian Red Cross"
"Nepal"
"Netherlands Red Cross"
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"Nigeria"
"Norway Red Cross"
"Norway"
"Caritas Norway"
"FORUT"
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"NTHO"
"Plan Norway"
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"TRO"
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"OXFAM Hong Kong"
"OXFAM/CAA"
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"Palau"
"Papua New Guinea Red Cross"
"Papua New Guinea"
"Paraguay Red Cross"
"Philippine Red Cross"
"Poland Red Cross"
"Poland"
"Portugal Red Cross"

"Portugal"
"AMI"
"Saúde em Português"
"AAH"
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"Aide et Action"
"AJWS"
"Americares"
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"ASI"
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"Comite Catholique contre la faim"
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"Enfants et Développement"
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"FH"
"Fondation de France"
"Frères des Hommes"
"Gifts in kind International"
"Give World"
"Guilde du Raid"
"H2H"
"HIVOS"
"IMA"
"INMED"
"International Aid"
"International Orthodox Christian Charities"
"IRA"
"IRD"
"IRT"
"JDC"
"JRS"
"Kerkinactie - Netherlands"
"La chaine de l'espoir"
"LWR"
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"Operation USA"
"Partage"
"Project HOPE"
"Relief International"

"Salvation Army"
"SC - US"
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"Secours Islamique"
"Solidarité laique"
"SOS Villages d'enfants"
"Stichting Vluchteling"
"Swiss Solidarity"
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"WVI (Netherlands)"
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"Qatar Red Crescent"
"Qatar"
"ROLEX"
"Romania Red Cross"
"Romania"
"Russia Red Cross"
"Russian Federation"
"Samoa Red Cross"
"Saudi Arabia (Kingdom of)"
"India Red Cross"
"Maldive Red Cross"
"SLRC"
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"SRC"
"Thailand Red Cross"
"Senegal"
"Serbia and Montenegro"
"SERVICE plus GMBH"
"Singapore"
"Slovak Red Cross"
"Slovakia"
"Slovenia"
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"Slovenian Red Cross"
"South Africa"
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"Spain"
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"Spanish Red Cross"
"Standard Chartered Bank"
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"Swedish Red Cross"
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?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ?, ? 2288, ? 792 350 199 68
99, 3 988 210 197 56 150 200 173
350 254 25 13 579 99 440, 1, 1 750
25 411 1607, ?, ?, ?, ?, ?, ?
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ALNAP	Academic/Learning
AmericanRedCross	NGO
Americares	NGO
AMI	NGO
AMI-France	NGO
Andorra	State
ArabAssociationforHumanRights	NGO
AGPUNDO	NGO
ARC	NGO
ArcheNova	NGO
Architectesdel'urgence	NGO
ArgentinaRedCross	NGO
ASB	NGO
ASI	NGO
AsmaeSoeurEmmanuelle	NGO
ATAV	NGO
AtlasLogistique	NGO
ATLAS	NGO
AustraliaRedCross	NGO
Australia	State
Austria	State
AustrianRedCross	NGO
Autoritéslocales	Municipality
Azerbaijan	State
BahamasRedCross	NGO
BangladeshRedCrescent	NGO
BAPPENAS	State
BaptistWorldAid	NGO
BarbadosRedCross	NGO
BasicNeeds	Unspecified
Belarus	State
BelgiumRedCross	NGO
Belgium	State
BelizeRedCross	NGO
BICE	NGO
BMI	Unspecified
BoliviaRedCross	NGO
BosnianRedCrescent	NGO
BotswanaRedCross	NGO
BrazilRedCross	NGO
Brazil	State
BRCS	NGO
Bulgaria	State
CA	NGO
CAFOD	NGO
CAM	NGO
Cambodia	State
Canada	State

CIDA/IHA	State
CanadianRedCross	NGO
CARDI	NGO
CAREAustria	NGO
CAREGermany	NGO
CAREINT	NGO
CARE	NGO
CaritasNorway	NGO
CARITAS	NGO
CBM	NGO
CCF	NGO
CDP	NGO
CFHI	NGO
CFSI	NGO
CHFI	NGO
ChileRedCross	NGO
China	State
ChineseRedCross	NGO
CISP	NGO
CityofMunichGermany	Municipality
CLGI	State
CollectifAsieEnfantsIsolés	NGO
ColombiaRedCross	NGO
ComiteCatholiquecontrelafaim	NGO
COMSEC	IGO
CONCERN	NGO
CookIslandsRedCross	NGO
CORDAID	NGO
CroatiaRedCross	NGO
CRS	NGO
CRWRC	NGO
CSA	NGO
CuraçaoRedCross	NGO
CWS	NGO
CyprusRedCross	NGO
Cyprus	State
CzechRepublicRedCross	NGO
CzechRepublic	State
DAI	Company
Danchurchaid	NGO
DanishPeople'sAid	NGO
DanishRedCross	NGO
DBL	NGO
DDG	NGO
DEA	NGO
DEMA	State
Denmark	State
DiakoniaWorldFederation	NGO

DirectReliefInternational	NGO
DisastersEmergencyCommitteeUK	NGO
DMC	Academic/Learning
DMI	NGO
DRC	NGO
DSF	State
DW	NGO
DZI	NGO
EcuadorRedCross	NGO
EDM	NGO
ElSalvadorRedCross	NGO
EmmaüsInternational	NGO
EnfantsetDéveloppement	NGO
EquatorialGuinea	State
ERD	NGO
ERM	State
ESCAP	IGO
EstoniaRedCross	NGO
Estonia	State
EthiopianRedCross	NGO
EuropeAid	State
ECHAO	State
EuropeanPerspective	Academic/Learning
ExactmobileSouthAfrica	Company
EXNORA	NGO
FAO	IGO
FCE	NGO
FH	Academic/Learning
FI	Unspecified
FIDAInternational	NGO
FijiRedCross	NGO
Fiji	State
FinlandRedCross	NGO
Finland	State
Finnchurchaid	NGO
FondationdeFrance	NGO
FORUT	NGO
France	State
FrenchRedCross	NGO
FrèresdesHommes	NGO
FT	News & Media
FXB	NGO
GAA-DWH	NGO
GenesisSoftware	Company
GermanRedCross	NGO
Germany	State
GiftsinkindInternational	NGO
GiveWorld	NGO

GOAL/IRDO	NGO
GORTA	NGO
GreeceRedCross	NGO
Greece	State
GTZ	State
GuildeduRaid	NGO
GuyanaRedCross	NGO
Guyana	State
H2H	NGO
HeartDoctors	NGO
HelptheAged	NGO
Help	NGO
HelpAgeInternational	NGO
HewlettFoundation	NGO
HFH	NGO
HI	NGO
HI/France	NGO
HIVOS	NGO
HKI	NGO
HondurasRedCross	NGO
HongKongRedCross	NGO
HOPE	NGO
HPIC	NGO
HRT	NGO
Hrúz	NGO
HT	NGO
HungaryRedCross	NGO
Hungary	State
IAS	NGO
IbdeschPatenschaften	NGO
IBM	Company
IcelandRedCross	NGO
Iceland	State
ICMA	NGO
ICMC	NGO
ICRC	IGO
IDLO	IGO
IDRF	NGO
IFRC	IGO
IHI	NGO
ILO	IGO
IMA	NGO
IMC	NGO
IndiaRedCross	NGO
India	State
IndonesiaRedCrescent	NGO
Indonesia	State
INMED	NGO

InternationalAid	NGO
InternationalMaritimeOrganization	IGO
InternationalOrthodoxChristianCharities	NGO
Internews	News & Media
INTERSOS	NGO
IOGT-NTO	NGO
IOM	IGO
IQC-TBD	Unspecified
IR	NGO
IRA	NGO
IranRedCrescent	NGO
Iran	State
IRC	NGO
IRD	NGO
IrelandRedCross	NGO
Ireland	State
IRT	NGO
ISDR	IGO
IslamicDevelopmentBank	IGO
ISLTF	NGO
Israel	State
ItalyRedCross	NGO
Italy	State
JamaicaRedCross	NGO
Japan	State
JapaneseRedCross	NGO
JDC	NGO
JHPIEGO	NGO
JHU	Academic/Learning
Johanniter-Unfall-Hilfe	NGO
JOIN	Unspecified
JordanianRedCrescent	NGO
JRS	NGO
Kazakhstan	State
Kerkinactie-Netherlands	NGO
Kindernothilfee.V.	NGO
SouthKoreaRedCross	NGO
DemocraticPeople'sRepublicofKorea	State
RepublicofKorea	State
KuwaitRedCrescent	NGO
Kuwait	State
Lachainedel'espoir	NGO
LaoPeople'sDemocraticRepublic	State
LatviaRedCross	NGO
Latvia	State
LebaneseRedCross	NGO
Liberia	State
LibyaRedCrescent	NGO
Libya	State

LiechtensteinRedCross	NGO
Liechtenstein	State
LithuaniaRedCross	NGO
Lithuania	State
LuxembourgRedCross	NGO
Luxembourg	State
LWRCanada	NGO
LWR	NGO
MacedoniaFYRRedCross	NGO
Madagascar	State
MalaysiaRedCross	NGO
Malaysia	State
MaldiveRedCross	NGO
Maldives	State
Mali	State
Malta	State
MalteserOrden	NGO
MAP	NGO
Mauritania	State
MauritiusRedCross	NGO
Mauritius	State
MCC	NGO
MCI	NGO
MDM	NGO
MENTOR	Academic/Learning
MercyCorpsInternational	NGO
MERLIN	NGO
MexicoRedCross	NGO
Mexico	State
MFA	NGO
MicronesiaRedCross	NGO
MicronesiaFederatedStatesof	State
MinistryofDefense	State
Moldova	State
MonacoRedCross	NGO
Monaco	State
MoroccoRedCrescent	NGO
Mozambique	State
MRC	State
MSF	NGO
Myanmar	State
NamibianRedCross	NGO
NathanAssociates	Company
NationalPeaceCorpsAssociation	NGO
NCA	NGO
NehemiaChristenhilfsdienste.V.	NGO
Nepal	State
NetherlandsRedCross	NGO

Netherlands	State
NewZealandRedCross	NGO
NewZealand	State
NGOs	NGO
NGOs-RedCross	NGO
NICCO	NGO
Nigeria	State
NMRU	State
NorthwestMedical	NGO
NorwayRedCross	NGO
Norway	State
NRC	NGO
NTHO	NGO
NuraniDunia	NGO
OCHA	IGO
Oeuvreshospitalièresfrançaisesdel'OrdredeMalte	NGO
OICAidCommitteefortheChildVictimsofTsunami	IGO
OPECFund	IGO
OperationUSA	NGO
OxfamAmerica	NGO
OXFAMHongKong	NGO
OXFAMIreland	NGO
OXFAMUK	NGO
OXFAM	NGO
OXFAM/CAA	NGO
PalauRedCross	NGO
Palau	State
PapuaNewGuineaRedCross	NGO
PapuaNewGuinea	State
ParaguayRedCross	NGO
Partage	NGO
PCI	NGO
PeaceandConflictInstitution	Academic/Learning
PhilippineRedCross	NGO
PlanInternationalUK	NGO
PlanNorway	NGO
PMU-I	NGO
PolandRedCross	NGO
Poland	State
PortugalRedCross	NGO
Portugal	State
Private-individualdonations	Private-individualdonations
ProjectHOPE	NGO
PSFFrance	NGO
PSF	NGO
PU	NGO
QatarRedCrescent	NGO
Qatar	State

BelgianRedCross	NGO
CanadianRedCross	NGO
RDROC	Unspecified
RedCross	NGO
RedR	NGO
Region	Unspecified
ReliefInternational	NGO
RKV	NGO
ROLEX	Company
RomaniaRedCross	NGO
Romania	State
RussiaRedCross	NGO
RussianFederation	State
SalvationArmy	NGO
SamoaRedCross	NGO
SarvodayaShramadanaMovement	NGO
SaúdeemPortuguês	NGO
SaudiArabia	State
SavetheChildrenNetherlands	NGO
SavetheChildrenUK	NGO
SavetheChildrenUS	NGO
SavetheChildrenAlliance	NGO
SavetheChildrenFundCanada	NGO
SCN	IGO
SDC/SHA	State
SecourPopulaireFrancais	NGO
SecoursIslamique	NGO
Senegal	State
SerbiaandMontenegro	State
SERVICEplusGMBH	Company
SeychellesRedCross	NGO
SFL	NGO
SHO-NL	NGO
SIG	NGO
Singapore	State
SlovakRedCross	NGO
Slovakia	State
Slovenia	State
SlovenianRedCross	NGO
SLRC	News & Media
SMC	NGO
SMR	NGO
Solidaritélaique	NGO
Solidarité	NGO
SomaliRedCrescent	NGO
Somalia	State
SomalischerVereine.V.	NGO
SOSKinderdorf	NGO

SOSMalta	NGO
SOSVillagesd'enfants	NGO
SouthAfrica	State
SouthAfricanRedCross	NGO
Spain	State
SpanishRedCross	NGO
SRC	NGO
SriLanka	State
SRSA	State
StandardCharteredBank	Company
StichtingVluchteling	NGO
Sweden	State
SwedishRedCross	NGO
SwissEmbassy	State
SwissRedCross	NGO
SwissSolidarity	NGO
Switzerland	State
TaiwanRepublicofChina	State
TaiwanRedCross	NGO
TdHItaly	NGO
TdHSwitzerland	NGO
TEARFUND	NGO
TerredesHommes	NGO
TGH	NGO
ThaiTsunamiVictimIdentificationGroup	State
ThaiRedCross	NGO
Thailand	State
THW	State
Timor-Leste	State
TrickleUpProgram	NGO
Trinidad&TobagoRedCross	NGO
TrinidadandTobago	State
TRO	NGO
Trocaire	NGO
TSF	NGO
TurkishRedCrescent	NGO
Turkey	State
Tuvalu	State
UgandaRedCross	NGO
UkraineRedCross	NGO
UMCOR	NGO
UNAgenciesNGOsandRedCross	Unspecified
UnEnfantParLaMain	NGO
UNFoundation	NGO
UN	IGO
UNAIDS	IGO
UNDP	IGO
UNDSSpreviouslyUNSECOORD	IGO

UNEP	IGO
UNESCO	IGO
UNFPA	IGO
UN-HABITAT	IGO
UNHCR	IGO
UNICEFNationalCommittees	NGO
UNICEF	IGO
UNIDO	IGO
UNIFEM	IGO
UnitedArabEmiratesRedCrescent	NGO
UnitedArabEmirates	State
BritishRedCross	NGO
UnitedKingdom	State
UnitedNationsFundforInternationalPartnerships	IGO
UnitedNationsIndustrialDevelopmentOrganization	IGO
USAID	State
United States	State
UNJLC	IGO
Unspecified	Unspecified
UNV	IGO
URI/SUCCESS-LWA	NGO
UruguayRedCross	NGO
USAID/ANE	State
USAID/OTI	State
USCRI	NGO
UWI	NGO
VanuatuRedCross	NGO
VCGFR	Unspecified
VenezuelaRedCross	NGO
VHAI	NGO
Vitoria-GasteizMunicipalityofSpain	Municipality
VSO	NGO
WFP	IGO
WHO	IGO
WJAID	IGO
WorldBank	IGO
WorldConcern	NGO
WorldHopeInternational	NGO
WorldRelief	NGO
WorldVisionSriLanka	NGO
WPD	NGO
WV	NGO
WVICanada	NGO
WVIGermany	NGO
WVINetherlands	NGO
WVI	NGO
ZOARefugeeCare	NGO
OXFAMNetherlandsNOVIB	NGO

APPENDIX E

THE HUMAN SECURITY INSTITUTIONAL POWER NETWORK

This is the full matrix with labels for the human security institutional power network, consisting of 234 actors who attended meetings or otherwise cooperated in the provision of humanitarian aid. In the matrix, the value encoded represents the number of interactions, with "?" representing no transaction. Columns are separated by commas, rows are separated by paragraphs.

The matrix is followed by an attribute list which lists the actors by type.

Table 18: OCHA Situation Reports Full Matrix

```
DL
N=234
FORMAT = FULLMATRIX DIAGONAL PRESENT
ROW LABELS:
"WHO"
"UN"
"Indonesia"
"Maldives"
"ECHO"
"APTV"
"India"
"Thailand"
"IOM"
"SriLanka"
"Myanmar"
"MSF(Holland)"
"Somalia"
"US"
"YAPPIKA"
"IFRC"
"SavetheChildren"
"WVI"
"Oxfam"
"ICRC"
"GOARN"
"GermanRedCross"
"Solidarite"
"AmericanRedCross"
"Seychelles"
"ACF"
"DanishRedCross"
"CARE"
"TurkishRedCrescent"
"Australia"
"MSF"
"Merlin"
"ISP"
"NCA"
"FAO"
"ILO"
"BOBP-IGO"
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"Belgium"
"WorldBank"
"ADB"
"JBIC"
"JICA"
"AAH"
"ACTagencies"
"ADRA"
"GOAL"
"ACD"
"OxfamUK"
"TerredesHommes"
"AcehKita"
"CRS"
"Help"
"SavetheChildrenUS"
"ADRC"
"AF"
"ARC"
"APRACA"
"ARF"
"Austria"
"BusinessRoundtable"
"Canada"
"CareSociety"
"Chinatrust"
"CIDB"
"CII"
"COPI"
"DavidCowan"
"DavidJones"
"DEC"
"DhanFoundation"
"EC"
"Ernst&Young"
"EU"
"Finland"
"FinproPAS"
"France"
"Germany"
"ICSF"
"IDB"
"IMF"
"Italy"
"JALA"
"Japan"
"KasetsartUniversity"
"KCOC"
"Kuwait"
"Luxembourg"
"Malaysia"
"MCCI"
"NACA"
"NAFSO"
"Netherlands"
"Norway"
"PBEC"

"Portugal"
"PRC"
"ROK"
"SAHAYI"
"SaudiArabia"
"SEAFDEC"
"SIDA"
"SIFFS"
"SIMULInternationalInc"
"Singapore"
"Spain"
"SDF"
"Sweden"
"Switzerland"
"TaipeiChina"
"UK"
"UniversityofJaffna"
"WFFP"
"WorldFishCenter"
"AlAmi"
"Keumang"
"Muhammadiyah"
"ADT"
"ADPC"
"DisasterReliefNetwork"
"DVI"
"PanglimaLaut"
"AustralianEngineers"
"MalaysianEngineers"
"PakistaniEngineers"
"BBC"
"Reuters"
"BPA"
"HKI"
"MCI"
"TRO"
"VSF"
"CPA"
"CHA"
"RedR"
"ChildFund"
"ERM"
"MercyMalaysia"
"Pusaka"
"ChristianChildren'sFund"
"CollegeofPediatrics"
"ColomboUniversity"
"Dakonia"
"DRC"
"IRC"
"NRC"
"Ericsson"
"FatayatNU"
"FlowerAceh"
"GTZ"
"ZOA"
"RotaryInternational"

"SACB"
"HIC"
"UniversityofIndonesia"
"HandicapInternational"
"SriLankanRedCross"
"IFI"
"BritishRedCross"
"FinnishRedCross"
"FrenchRedCross"
"PMI"
"NorwegianRedCross"
"SpanishRedCross"
"SwedishRedCross"
"PlanInternational"
"IMC"
"VOICE"
"Denmark"
"ICMC"
"PLN"
"InternationalHumanitarianPartnership"
"InternationalRescueCommittee"
"IslamicRelief"
"JapaneseRedCross"
"JRS"
"MalaysianRedCrescentSociety"
"Mentor"
"NESOHR"
"Palyja"
"MSF(Belgium)"
"PDAM"
"PSF"
"TNT"
"ICMH"
"JohnKeels"
"Wahli"
"Internews"
"LAC"
"LAF"
"BankofMaldives"
"MATI"
"StateTradingOrganisation"
"MalteserHilfdienst"
"Greenpeace"
"LTTE"
"Women'sStudyCenter"
"PrakashamNGOsNetwork"
"SavetheChildrenUK"
"SayuraFM"
"Solidar"
"AdoptSriLanka"
"ArthachryaFoundation"
"CzechRepublic"
"DDG"
"IBM"
"MedicalFacultyofKarapitiya"
"SriLankaChamberofCommerce"
"SriLankaFoundationInstitute"

"SriLankaWidow'sSociety"
"WCDM"
"GeneCode"
"Interpol"
"ThaiRedCross"
"AnnaiIllam"
"BankofCeylon"
"BanyanTreeResort"
"Bupati"
"DeccanAviation"
"DialogTelekom"
"DMC"
"IDEP"
"RDF"
"IndonesianLactationCentre"
"IndonesianOff-roadFederation"
"IndonesianSocietyofPaediatricians"
"PompierssansFrontieres"
"RadioNewsAgency68H"
"SamataSarana"
"SewaLanka"
"SNLS"
"SomaliDisasterManagementCommittee"
"TISL"
"Women'sDisasterManagementCommittee"
"UNESCO"
COLUMN LABELS:
"WHO"
"UN"
"Indonesia"
"Maldives"
"ECHO"
"APTV"
"India"
"Thailand"
"IOM"
"SriLanka"
"Myanmar"
"MSF(Holland)"
"Somalia"
"US"
"YAPPIKA"
"IFRC"
"SavetheChildren"
"WVI"
"Oxfam"
"ICRC"
"GOARN"
"GermanRedCross"
"Solidarite"
"AmericanRedCross"
"Seychelles"
"ACF"
"DanishRedCross"
"CARE"
"TurkishRedCrescent"
"Australia"

"MSF"
"Merlin"
"ISP"
"NCA"
"FAO"
"ILO"
"BOBP-IGO"
"Belgium"
"WorldBank"
"ADB"
"JBIC"
"JICA"
"AAH"
"ACTagencies"
"ADRA"
"GOAL"
"ACD"
"OxfamUK"
"TerredesHommes"
"AcehKita"
"CRS"
"Help"
"SavetheChildrenUS"
"ADRC"
"AF"
"ARC"
"APRACA"
"ARF"
"Austria"
"BusinessRoundtable"
"Canada"
"CareSociety"
"Chinatrust"
"CIDB"
"CII"
"COPI"
"DavidCowan"
"DavidJones"
"DEC"
"DhanFoundation"
"EC"
"Ernst&Young"
"EU"
"Finland"
"FinproPAS"
"France"
"Germany"
"ICSF"
"IDB"
"IMF"
"Italy"
"JALA"
"Japan"
"KasetsartUniversity"
"KCOC"
"Kuwait"
"Luxembourg"

"Malaysia"
"MCCI"
"NACA"
"NAFSO"
"Netherlands"
"Norway"
"PBEC"
"Portugal"
"PRC"
"ROK"
"SAHAYI"
"SaudiArabia"
"SEAFDEC"
"SIDA"
"SIFFS"
"SIMULInternationalInc"
"Singapore"
"Spain"
"SDF"
"Sweden"
"Switzerland"
"TaipeiChina"
"UK"
"UniversityofJaffna"
"WFFP"
"WorldFishCenter"
"AlAmi"
"Keumang"
"Muhammadiyah"
"ADT"
"ADPC"
"DisasterReliefNetwork"
"DVI"
"PanglimaLaut"
"AustralianEngineers"
"MalaysianEngineers"
"PakistaniEngineers"
"BBC"
"Reuters"
"BPA"
"HKI"
"MCI"
"TRO"
"VSF"
"CPA"
"CHA"
"RedR"
"ChildFund"
"ERM"
"MercyMalaysia"
"Pusaka"
"ChristianChildren'sFund"
"CollegeofPediatrics"
"ColomboUniversity"
"Dakonia"
"DRC"
"IRC"

"NRC"
"Ericsson"
"FatayatNU"
"FlowerAceh"
"GTZ"
"ZOA"
"RotaryInternational"
"SACB"
"HIC"
"UniversityofIndonesia"
"HandicapInternational"
"SriLankanRedCross"
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"BritishRedCross"
"FinnishRedCross"
"FrenchRedCross"
"PMI"
"NorwegianRedCross"
"SpanishRedCross"
"SwedishRedCross"
"PlanInternational"
"IMC"
"VOICE"
"Denmark"
"ICMC"
"PLN"
"InternationalHumanitarianPartnership"
"InternationalRescueCommittee"
"IslamicRelief"
"JapaneseRedCross"
"JRS"
"MalaysianRedCrescentSociety"
"Mentor"
"NESOHR"
"Palyja"
"MSF(Belgium)"
"PDAM"
"PSF"
"TNT"
"ICMH"
"JohnKeels"
"Wahli"
"Internews"
"LAC"
"LAF"
"BankofMaldives"
"MATI"
"StateTradingOrganisation"
"MalteserHilfdienst"
"Greenpeace"
"LTTE"
"Women'sStudyCenter"
"PrakashamNGOsNetwork"
"SavetheChildrenUK"
"SayuraFM"
"Solidar"
"AdoptSriLanka"

"ArthachryaFoundation"
"CzechRepublic"
"DDG"
"IBM"
"MedicalFacultyofKarapitiya"
"SriLankaChamberofCommerce"
"SriLankaFoundationInstitute"
"SriLankaWidow'sSociety"
"WCDM"
"GeneCode"
"Interpol"
"ThaiRedCross"
"AnnaiIllam"
"BankofCeylon"
"BanyanTreeResort"
"Bupati"
"DeccanAviation"
"DialogTelekom"
"DMC"
"IDEP"
"RDF"
"IndonesianLactationCentre"
"IndonesianOff-roadFederation"
"IndonesianSocietyofPaediatricians"
"PompierssansFrontieres"
"RadioNewsAgency68H"
"SamataSarana"
"SewaLanka"
"SNLS"
"SomaliDisasterManagementCommittee"
"TISL"
"Women'sDisasterManagementCommittee"
"UNESCO"
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Table 19: Attribute List for Actors in OCHA Situation Reports

Name	Type
AAH	NGO

ACD	NGO
AcehKita	NGO
ACF	NGO
ACTagencies	NGO
ADB	IGO
AdoptSriLanka	NGO
ADPC	NGO
ADRA	NGO
ADRC	IGO
ADT	NGO
AF	NGO
AlAmi	NGO
AmericanRedCross	NGO
AnnaIIllam	NGO
APRACA	IGO
APTV	company
ARC	NGO
ARF	NGO
ArthachryaFoundation	NGO
ASEAN	IGO
Australia	state
AustralianEngineers	NGO
Austria	state
BankofCeylon	company
BankofMaldives	company
BanyanTreeResort	company
BBC	state company
Belgium	state
BOBP-IGO	IGO
BPA	company
BritishRedCross	NGO
Bupati	state
BusinessRoundtable	company
Canada	state
CARE	NGO
CareSociety	NGO
CHA	NGO
ChildFund	NGO
Chinatrust	company
CIDB	company
CII	company
CollegeofPediatrics	academic
ColomboUniversity	academic
COPI	NGO
CPA	NGO
CRS	NGO
CzechRepublic	state
Dakonia	NGO

DanishRedCross	NGO
DavidCowan	individual
DavidJones	individual
DDG	NGO
DEC	NGO
DeccanAviation	company
Denmark	state
DhanFoundation	NGO
DialogTelekom	company
DisasterReliefNetwork	multi
DMC	NGO
DRC	NGO
DVI	IGO
EC	IGO
ECHO	IGO
Ericsson	company
ERM	NGO
Ernst&Young	company
EU	IGO
FAO	IGO
FatayatNU	NGO
Finland	state
FinnishRedCross	NGO
FinproPAS	company
FlowerAceh	NGO
FrenchRedCross	NGO
GeneCode	company
GermanRedCross	NGO
Germany	state
GOAL	NGO
GOARN	multi
Greenpeace	NGO
GTZ	state company
HandicapInternational	NGO
HELP	NGO
HIC	multi
HKI	NGO
IBM	company
ICMC	NGO
ICMH	NGO
ICRC	NGO
ICSF	NGO
IDB	IGO
IDEP	NGO
IFI	multi
IFRC	NGO
ILO	IGO
IMC	NGO

IMF	IGO
India	state
Indonesia	state
IndonesianLactationCentre	NGO
IndonesianOff-roadFederation	NGO
InternationalHumanitarianPartnership	IGO
Internews	NGO
Interpol	IGO
IOM	IGO
IRC	NGO
IslamicRelief	NGO
ISP	NGO
Italy	state
JALA	NGO
Japan	state
JapaneseRedCross	NGO
JBIC	state
JICA	state
JohnKeels	company
JRS	NGO
KasetsartUniversity	academic
KCOC	NGO
Keumang	NGO
Kuwait	state
LAC	NGO
LAF	NGO
LOC	multi
LTTE	NGO
Luxembourg	state
Malaysia	state
MalaysianEngineers	NGO
MalaysianRedCrescentSociety	NGO
Maldives	state
MalteserHilfdienst	NGO
MATI	company
MCCI	company
MCI	NGO
MedicalFacultyofKarapitiya	academic
Mentor	NGO
MercyMalaysia	NGO
Merlin	NGO
MSF	NGO
MSF(Belgium)	NGO
MSF(Holland)	NGO
Muhammadiyah	NGO
Myanmar	state
NACA	IGO
NAFSO	NGO

NCA	NGO
NESOHR	NGO
Netherlands	state
Norway	state
NorwegianRedCross	NGO
NRC	NGO
Oxfam	NGO
OxfamUK	NGO
PakistaniEngineers	NGO
Palyja	company
PanglimaLaut	state
PBEC	company
PDAM	company
PlanInternational	NGO
PLN	state company
PMI	NGO
PompierssansFrontieres	NGO
Portugal	state
PrakashamNGOsNetwork	NGO
PRC	state
PSF	NGO
Pusaka	state company
RadioNewsAgency68H	company
RDF	NGO
RedR	NGO
Reuters	company
RMAF	state
RepublicofKorea	state
Rotary International	NGO
SACB	multi
SAHAYI	NGO
Samata Sarana	NGO
Sarvodaya	NGO
SaudiArabia	state
SavetheChildrenAlliance	NGO
SavetheChildrenUK	NGO
SavetheChildrenUS	NGO
SayuraFM	NGO
SDF	NGO
SEAFDEC	IGO
SewaLanka	NGO
Seychelles	state
SIDA	state
SIFFS	NGO
SIMULInternationalInc	company
Singapore	state
SNLS	NGO
Solidar	NGO

Solidarité	NGO
Somalia	state
Spain	state
SpanishRedCross	NGO
SriLanka	state
SriLankaChamberofCommerce	company
SriLankaFoundationInstitute	NGO
SriLankanRedCross	NGO
SriLankaWidow'sSociety	NGO
StateTradingOrganisation	company
Sweden	state
SwedishRedCross	NGO
Switzerland	state
TaiwanRepublicofChina	state
TerredesHommes	NGO
ThaiRedCross	NGO
TISL	NGO
TNT	company
TRO	NGO
TSF	NGO
TurkishRedCrescent	NGO
UK	state
UN	IGO
UNESCO	IGO
UNESCO	IGO
UniversityofIndonesia	academic
UniversityofJaffna	academic
US	state
VOICE	NGO
VSF	NGO
Wahli	NGO
WCDM	NGO
WFFP	NGO
WHO	IGO
Women'sDisasterManagementCommittee	NGO
Women'sStudyCenter	NGO
WorldBank	IGO
WorldFishCenter	NGO
WVI	NGO
YAPPIKA	NGO
ZOA	NGO

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