Glocalizing Forests: Transnational Networks and the Geography of Global Climate Policy

Dissertation

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By

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Abstract

Discussions of global climate policy center on proposals for reform of the United Nations Framework Convention on Climate Change (UNFCCC) negotiating process. The focus on state actors to the exclusion of other types of organizations active in global climate policy, however, glosses over the challenges of moving from agreement to implementation and underestimates the potential of sub-global actions. Reducing Emissions from Deforestation and Degradation (REDD+), a popular initiative which aims to support forest conservation with climate mitigation funds, provides an excellent example of the promises and pitfalls of thinking about climate policy from the perspective of the messy networks of transnational actors that make up its skeletal structure. The transnational networks supporting REDD+ policy development and implementation are geographically uneven, centered on donor countries of the global North and in particular cities like Washington, DC, and Geneva, Switzerland. This spatially centralized but institutionally decentralized structure, which I call “concentrated polycentricity,” may limit the ability of those affected by REDD+ activities to engage in democratic control over policy creation. Encouraging local ownership of REDD+ policies can help mitigate some of these problems.
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Chapter 1: REDD+, Polycentricity, and the Skeletal Structure of Global Climate Policy

1.1 Introduction

The Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Copenhagen in 2009 was much anticipated, and optimism was high (Lean, 2009). When the non-binding Copenhagen Accord was agreed at the eleventh hour, however, it was met with a mixture of shock, disappointment, and derision. Leaders like Gordon Brown noted the need for a full, legally binding treaty as quickly as possible (Vidal et al., 2009). Spokespersons from Greenpeace, Oxfam, Friends of the Earth, and the Worldwide Fund for Nature (WWF), divided on many issues, could all agree such a treaty should be the ultimate objective of negotiations (Vaughan & Adam, 2009; Batty, 2008).

Other commentators, however, counseled humbler aims. Even before Copenhagen, various writers had advanced plans advocating a “bottom-up,” as opposed to centralized, approach to global climate policy,\(^1\) and this trend has increased in the wake of

\(^1\)For an overview, see Bodansky et al. (2004). Other examples include Bodansky (2010); Falkner et al. (2010); Huettner et al. (2010).
the conference’s perceived failure. These commentators take a dim view of the odds of attaining strong and ambitious consensus amongst nearly 200 governments and highlight the potential advantages of dividing climate change into “a series of more tractable problems” (Rayner, 2010, p. 619).

The debate over how to create global climate policy, more pressing given the desire to conclude a new comprehensive treaty by 2015 (Light et al., 2012), tends to focus on states as central actors, with international deal-making the key concern (Mehling, 2011; Bodansky et al., 2004; Kuik et al., 2008; Falkner et al., 2010). Implementation, on the other hand, often is treated as unproblematic once an agreement is brokered (Shobe & Burtraw, 2012). As a variety of writers contend, however, the world of global climate policy is a crowded and messy place: sub-national governments, non-governmental organizations, and firms frequently join national governments and international organizations – and not just at the negotiating table. Failing to consider the full scope of “doing” climate policy renders debate unable to consider many challenges to the global governance of climate, as well as some possible solutions. To understand these risks and opportunities, we need to ask, “How is global climate policy made outside formal negotiations?”

Underlying this empirical concern is a normative question: “How can global climate policy become more democratic?” I understand democratic along the lines developed by theorists of deliberative democracy like Habermas (1996) and Dryzek (2009). This perspective on the principle that all those affected by a political act

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2For a general discussion, see Biermann (2008); Biermann et al. (2010); Bulkeley et al. (2012). On firms, see Pattberg (2012). On cities, see Bulkeley & Schroeder (2011); Castán Broto & Bulkeley (2013). On consultancies, development organizations, and other epistemic authorities, see Lansing (2010, 2011, 2012).
should have a say in the decisions that lead to it. This normative orientation justifies a geographic and political analysis of factors that can distort communication, understood as participation in political deliberation. To the extent that participation in global climate policy at present take place in large part within networks of informal relations, an analysis of the spatial and relational patterns of these networks can elucidate points where communication is inhibited.

These questions, of course, extend beyond the scope of a dissertation. To analyze the networks and actors involved in global climate policy with sufficient detail, I select a single issue area for study. Reducing Emissions from Deforestation and Degradation (REDD or REDD+) encompasses a wide range of efforts intended to lower greenhouse gas emissions by harnessing climate change mitigation funds for forest protection. I provide a brief overview of REDD+ here, saving more detailed discussion for Chapter 2. I argue that REDD+ is a telling example of the social and spatial relations supporting global climate policy and outline more specific questions about REDD+ addressed in the substantive chapters. First, however, I provide a more detailed discussion of the normative rationale for focusing on networks and communication in studying global climate policy, before moving on to briefly discuss how we can formulate more nuanced ways of characterizing global policymaking. After briefly introducing REDD+, I reflect on what it means to develop network-based geographies of global climate policy. I conclude this introduction with a preview of the primary findings and an overview of the succeeding chapters of the dissertation.
1.2 The Normative Dimension: Deliberation and Participation

There is a growing concern with the implications of transnational activities related to climate change for democratic governance and accountability (Lidskog & Elander, 2010; Biermann & Pattberg, 2008; Biermann & Gupta, 2011). As Biermann & Gupta (2011) argue, transnational spatial interdependence can pose significant challenges for accountability, as the weakness of international institutionalization offers limited opportunities for redressing grievances (see also Lidskog & Elander (2010)). Here I suggest that work in deliberative democratic theory can help clarify the normative stakes of the kinds of analysis undertaken in this dissertation and provide both normative and empirical justifications for placing communicative action at the center of the geography of global climate policymaking.

In the absence of formal institutionalization, deliberative civil society networks have been suggested as a means of ensuring democratic accountability (Lidskog & Elander, 2010). Theorists of deliberative democracy are inspired in particular by the work of Jürgen Habermas, whose discourse principle forms the basis for their normative claims. As Habermas (1996, p. 107) formulates it, “Just those action norms are valid to which all possibly affected persons could agree as participants in rational discourses.” This relatively dense statement implies several criteria for determining whether a political activity is genuinely participatory, which have been successively unpacked by other work in the deliberative democracy tradition.

The normative significance of deliberative theory comes from imagining the necessary social, economic, and political criteria required to create conditions under which
the discourse principle could be actualized. This is usually understood as approximating an “ideal speech situation.” For Habermas (1970), the ideal speech situation is a presupposition of the use of speech for communication at all. On his account, communicative speech presupposes an ideal situation of unconstrained discussion, in which there is the potential of mutual agreement, where this agreement is reached on the basis of mutually acceptable reasons. Of course, for such a situation to obtain, speech situations must “be immunized against repression and inequality” (Habermas, 1984, p. 26). This requires robust political, social, economic, and other forms of rights, as well as substantial equality (Habermas, 1996).

As Foucault (1997) has argued, the central place of uncoerced communication in deliberative democratic theory seems utopian, a failure to recognize the omnipresence of power relations. This essential insight informs the work of scholars like Li (2007, 2001a, 2010), who point out that people are often only allowed to participate on the basis of preexisting subject positions that frame and limit the ways in which they might speak or exercise power (for a more practical but in essence quite similar critique, see Tewdwr-Jones & Allmendinger (1998)). These theoretical considerations have been bolstered by research highlighting the gaps between the rhetoric and reality of participation and the ways in which participation can be manipulated to produce results desired by powerful actors (Chilvers, 2009).

While the limitations of participation in practice should certainly be acknowledged, this does not invalidate the utility of deliberative democratic theory. Indeed, the very idea that we could find participation lacking implies that we have normative grounds, whether acknowledged or not, for doing so. In contrasting his position with
that of Habermas, Foucault (1997, p. 298), for example, argues that we should find ways to “play these games of power with as little domination as possible.” Such a project would require a set of criteria for identifying and reducing domination – and even normative justification for trying to do so in the first place (Habermas, 1987, Ch. 10). As Olson & Sayer (2009) argue, while geographers – especially those who consider themselves radical – are often “on the side of the oppressed,” if their analyses and critiques are to be compelling, they must be able to articulate the basis of those critiques – the way they identify dominance and determine who is worthy of aid – to a general community.

Deliberative democratic theorists intend their analysis of the ideal speech situation to be such a normative ground, as it provides the basis for a full realization of the discourse principle. This ideal speech situation need not be empirically realizable to be aspirational, just as the fact that a perfectly just society will never exist does not prevent efforts to promote justice. We can – and, I would argue, often do – critique social and political arrangements to the extent that they fail to fulfill the promise of the discourse principle. In other words, deliberative democratic theory provides normative grounds for identifying distortions in communication understood as the unconstrained discourse of all those potentially affected by a political act. As Bridge (2008) glosses it, the political practice of deliberative democracy involves trying to leverage points of non-dominated deliberation found in everyday life to ever wider areas of formal political systems and informal public spheres.

In practical terms, this means that the accountability and legitimacy of political activities depends both on patterns of inclusion of stakeholders and the degree to
which included stakeholders are able and willing to maintain a “critical distance” from decisions (Dryzek & Stevenson, 2011). To maintain accountability, Dryzek (2009) argues, governance systems should be noncoercive, so people’s authentic perspectives can be expressed; inclusive, so all people affected by decisions are involved in decisionmaking; and consequential, in that participation can affect decisions. These three criteria can be understood as preconditions for the realization of the discourse principle, and many of the critiques of participation can be reinterpreted as claims that actually existing participation does not meet one or more of these criteria. The idea that people participate only on the basis of subject positions given prior to participation, for example, identifies a subtle form of coercion, while objections to the gaps between the rhetoric and results of participation highlight cases where participation is insufficiently consequential.

None of this implies that deliberation needs to take place in formal fora, such as meetings of stakeholders. Indeed, were these the only places deliberation took place political life would be ossified. Deliberative principles can and should be applied to broader areas in which deliberation takes place, where we can consider the degree to which people can be and are involved in debates over the issues affecting them in ways that have consequences for political acts (much of Habermas’s own work is aimed at developing a critique of distortions of deliberation in contemporary public spheres; see (Johnson, 2006)). In this dissertation, I am concerned with the analysis of how spatial and relational patterns of informal networks force political life away from an ideal speech situation. I present the theoretical framework I use for this analysis in the following section.
1.3 Polycentricity and Global Climate Policy: General Research Questions

Understanding informal patterns of global climate policymaking requires a more diverse conceptual toolkit than found in the centralization/decentralization debates. One of the most prominent proponents of a “third-way” approach, E. Ostrom (2010a, 2012) advocated “polycentric” global environmental policy. While there is a vast literature using the concept of polycentricity, I will keep my discussion here brief, leaving further explication for subsequent chapters. As outlined by V. Ostrom et al. (1961), the term describes a set of formally separate governing bodies which, despite their autonomy, are in regular consultation with one another. The relationships between the governing bodies should be flexible and may vary from issue to issue, depending on the degree to which events taking place within one administrative area affect others. The chief advantage of such a system, the authors argued, would be in reconciling the need for extensive local knowledge3 with more general coordination.

More centralized systems, on V. Ostrom et al. (1961)’s account, are likely to suffer from what we might call a “bandwidth problem.” In social settings, bandwidth refers to the strength and redundancy of connections that could transfer information between people or groups (Burt, 2005). Stronger, redundant connections provide more opportunities for information transmission, while more intermediaries and social or spatial distance attenuate communication, which is a prerequisite of deliberation.

3Local knowledge is generally required to translate abstract policy ideas, developed in places socially and spatially distant from the sites where policy is to be implemented, to specific situations (Mosse, 2005; Tsing, 2005).
Of course, political systems are often resistant to learning, critique, and participation as I have discussed it. As North (2005) argues, we interpret incoming information on the basis of pre-existing ideologies, with pre-given tools, matching new situations to previous patterns. This would not necessarily be a problem – these tools are required for cognition, choice, and creativity to be possible at all – except that our interpretive apparatuses are always faulty to a greater or lesser degree, and, moreover, “the information feedback is typically insufficient to correct these subjective models” (North, 1990, p. 16). The incredible amount of feedback required not only to provide the basic “facts” for policy decisions but – more importantly – to challenge the basic ideological and conceptual frameworks informing those decisions means systems with low-bandwidth connections are hampered in their ability to learn from mistakes, anticipate opportunities and problems, and effectively translate between policy and practice.

Polycentricity supports learning and policy innovation because it allows decisions to be made by actors with higher bandwidth connections to the people affected while facilitating general coordination. To the degree that it does this, it also in principle provides opportunities for more effective participation of those affected by political acts. As E. Ostrom (2010a, p. 552) explains: “Participants in the polycentric system have the advantage of using local knowledge and learning from others who are also engaged in trial-and-error learning processes.” The lack of centralized authority allows for experimentation, while “mechanisms for mutual monitoring, learning, and adaptation” provide opportunities for successes to be replicated or improved upon. This ability to utilize local knowledge and address externalities makes polycentric
systems particularly appropriate for environmental concerns (E. Ostrom, 1998), and polycentricity has been proposed as a promising model for climate change mitigation (E. Ostrom, 2012, 2010a) and, specifically, REDD+ (Nagendra & Ostrom, 2012).

Like the ideal speech situation, polycentricity can be understood as an aspirational condition, which might apply to varying degrees to different political systems. From this perspective, the informal structure of global climate policymaking is not (yet) polycentric, any more than it is completely centralized or decentralized. As contended in Chapter 3, the discussion of centralization, decentralization, and polycentricity in climate policy conflates spatial and social dimensions of centralization. A social system, for example, could be centralized if there were a single governing body creating policy for a given issue or a single organization acted as a “hub” in a network of interorganizational relationships. Systems also may be centralized spatially. In this case, there might be no hub or authority, but several key organizations might be located in roughly the same area, facilitating access to information and resources for some and raising barriers to others. I contend that while there is no one organization managing REDD+, the creation of REDD+ policy is spatially consolidated. I call this situation “concentrated polycentricity,” a concept explicated in Chapter 3.

Spatial concentration of transnational policymaking can be problematic for several reasons. The first of these is that it is likely to result in considerable bandwidth problems, which erodes the ability of people to engage in consequential deliberation to challenge dominant ideas or political acts affecting them. To take one example, the state of California is currently developing a REDD+ offsetting program with the states of Chiapas, Mexico, and Acre, Brazil. Having recently published a set of draft
recommendations for the system, the REDD Offset Working Group has scheduled three workshops to discuss the proposal in detail. While the policy will have direct effects on forest-dwelling peoples in Chiapas and Acre, the workshops will be held at Stanford, University of California, Davis, and University of California, Los Angeles (REDD Offsets Working Group, 2013b).

Second, and following on from this problem, spatial concentration is unlikely to give rise to the institutional diversity necessary for creative evolution and learning (North, 2005). If, as North (2005) argues, institutions (or policies) reflect the beliefs of those creating them, then a spatial concentration of policy innovation may not lead to an adequate diversity of models. Proponents of decentralization in climate policy, for example, advocate “letting a thousand flowers bloom” (Bodansky, 2010), but this approach is unlikely to be particularly effective if most of the seeds are coming from the same packet.⁴

These two issues can be especially problematic in the early period of institutionalization. Institutions are often created to serve the interests (North, 1990) or at least reflect the beliefs (North, 2005) of those with sufficient bargaining power. Over time, these institutional arrangements accumulate organizations with a stake in the status quo who are willing to defend the institutional arrangement, irrespective of its effectiveness or equity (North, 2005). As a result, systems that are not primed to learn effectively can easily ossify over time.

⁴North et al. (2009) suggest this is already the case in the world of development policy, which they contend attempts to replicate institutional arrangements from donor countries in places where they can have perverse interactions with extant institutional, economic, and belief systems. Li (2007), similarly, notes how limited participatory activities allow conservation NGOs essentially to rubber stamp preconceived sustainable development models.
I have suggested global climate policy is a messy arena including states, sub-national governments, non-governmental organizations, and others. To justify this claim and begin to explicate the geography of climate policy outside the UN regime, I first ask, “How is global climate policy produced?” That is, I begin by clarifying what “counts” as doing climate policy.

Only after I clarify what doing global policy is can I ask the second key question: “Who produces global climate policy?” As suggested already, I believe global climate policy is made not just by states, but also by non-state actors, sub-national governments, and firms, amongst other organizational types. This claim, of course, is not new, and there is a voluminous literature on the diversity of types of organizations active in global climate policy. I press this discussion further in two key ways. First, I ask the question who in a geographical as well as functional sense. That is, where are the organizations most active in global climate policy to be found? Where are the policy centers? Second, I depart from a prevailing approach in many studies of global climate policy: I do not focus on a specific type of organization. While we have a growing knowledge of ways NGOs, firms, sub-national governments, and other organizational types can impact climate policy, little research has addressed the system of relationships that can arise from these organizational types acting as a whole.

Asking the who question involves not just specifying the interests with a voice in global climate policy. It also has a negative sense: “Who is not a part of climate policymaking?” It is from asking this question that the empirical interest of the dissertation slides into the normative interest. The discourse principle suggests that
for political acts to be legitimate those affected should be able to be involved in con-
sequential deliberations about those actions. Should the analysis in this dissertation
suggest people affected by political acts are not participants in consequential deliber-
ation about those choices, then an understanding of how these policies are made can
be used to diagnose barriers to deliberative democratic participation.

For this reason, the who and how questions must be answered in order to envision
more participative climate governance. In this dissertation, my answers will necessarily
and unfortunately be somewhat limited and negative. They will be limited in the
sense that I cannot make sweeping claims about how to bring about emancipation on
the basis of limited, even preliminary, research. They will be negative in the sense
that I can identify problem areas or points of deliberative blockage or distortion, but
I cannot confidently articulate specific alternatives without further research, though
I reflect on some implications in the concluding chapter.

1.4 REDD+ as an Example of Global Climate Policymaking

At the UNFCCC COP held in Montreal in 2005, the governments of Costa Rica
and Papua New Guinea, speaking on behalf of the newly formed Coalition of Rainfor-
est Nations, echoed arguments circulating in the policy literature that “in the absence
of revenues streams from standing forests, communities and governments in many de-
veloping nations have little incentive to prevent deforestation” (Papua New Guinea &
Costa Rica, 2005). The proposal to develop a compensation mechanism to reduce de-
forestation rates has become a central part of UNFCCC negotiations, under the name
Reducing Emissions from Deforestation and Forest Degradation (REDD+). Despite rapid evolution since 2005, REDD+ is still fundamentally “a mechanism to reduce global greenhouse gas emissions by compensating countries for avoiding deforestation and degradation” (Center for International Forestry Research, 2009, p. 10). The logic is simple enough: if deforestation occurs in expectation of short-term economic advantages (Bonnie & Schwartzman, 2003), compensating people for the opportunity costs of preservation should make forest clearance less attractive. In principle, therefore, REDD+ is a form of payment for ecosystem services (PES) (Angelsen et al., 2009). In practice, there has been and continues to be considerable debate about the shape a UNFCCC-based REDD+ system should take, and the experimental “pilot projects” currently underway are highly varied.

Though “REDD+ has been a remarkably successful idea,” implementation requires complex legal and bureaucratic reforms in the face of entrenched status quo interests (Angelsen & McNeil, 2012, p. 32). Initially expected to be “big, quick, and cheap” (Angelsen & McNeil, 2012, p. 33), REDD+ presently is limited to voluntary markets, where transacted volumes have declined as the complexities of implementation slowed project development (Peters-Stanley et al., 2012). As a result, Seymour & Angelsen (2012) suggest, there has been an “aidification of REDD+” as projects

5A note on terminology: the initiative was initially called Reducing Emissions from Deforestation in Developing Countries, abbreviated RED (or sometimes RED-DC). Over time, the acronym has changed to REDD, standing for Reducing Emissions from Deforestation and Degradation, then REDD+, adding sustainable forest management and enhancement of forest carbon stocks, and even REDD++, encompassing many forms of land use (ASB Partnership for the Tropical Forest Margins, 2009). In this dissertation, I use the term REDD+, as it encompasses the majority of activities under the REDD umbrella and is less amorphous than REDD++. Other terms for this policy approach in general (outside the UN context) include “avoided deforestation” and “compensated reductions.”

6These claims were made most prominently in the influential Stern (Stern, 2007) and Eliasch Reviews (Eliasch, 2008) on climate policy sponsored by the Government of the United Kingdom.
continue to rely on development funds, reshaping REDD+ into a sustainable development initiative with an emphasis on forests (Angelsen & McNeil, 2012).

These challenges notwithstanding, REDD+ already affects many places, with the bulk of activity occurring outside the formal UN system. There are currently around 275 REDD+ “pilot projects,” covering an area at least twice the size of Germany (see Chapter 3), and “REDD-readiness” activities are being undertaken in many tropical forest countries to build national and sub-national government capacity for REDD+. Precisely because so many activities are taking place without formal authority, REDD+ is often cited as an example of the decentralized forms of global climate policy thought likely to become the norm in the absence of a strong successor to the Kyoto Protocol (Falkner et al., 2010; Nagendra & Ostrom, 2012). As such, REDD+ provides a useful example not only of where we are, but also where we might be going.

I focus on answering “How is global REDD+ policy produced?” and “Who produces global REDD+ policy?” in the same sense as in the previous section. While REDD+ is still clearly in its infancy, it is possible to ask a third question: What are the effects of the global structure of REDD+ on policymaking? That is, how do patterns of relationships in the network of organizations engaged in REDD+ activities affect policy processes in specific places? Answering this final question requires combining a low resolution analysis of the network of organizations engaged in REDD+, with a much more detailed study of REDD+ at a particular site. To accomplish this, Chapter 4 presents results from research undertaken during four months of fieldwork in the province of Central Kalimantan,
Indonesia, where one of the largest REDD+ pilot projects yet attempted is being undertaken. Looking at this subset of the global REDD+ network in detail allows us to study the challenges involved in bringing REDD+ “out” of the places in which it is created and “in” to the places where it is to be implemented. I provide background on REDD+ and forest policy in Central Kalimantan in Chapter 2.

1.5 What Is a Geography of Global Climate Policy?

In geography, it is very common to see the phrases “geography of X” or “geographies of X,” where X is any of a very large number of potential subjects of interest. There have been “geographies of power” (Allen, 2003), “conservation geographies” (Zimmerer, 2000), “process geographies” (Routledge, 2003), “poststructural geographies” (Doel, 1999), even “geographies of smell” (Hoover, 2009). The types of phenomena amenable to geographies are so diverse, the methods used to study them so diverging, and words used to describe them so disparate that we might be forgiven for thinking that a “geography of X” simply means “X, as written about by a geographer.”

In fact, of course, there is no stable meaning of “geography/geographies of X” outside its usage in a particular study, within a particular philosophical or theoretical framework. Doel (1999)’s poststructural geographies, for example, center on describing a world in flux, reflecting particular interpretations of the collaborative work of Deleuze and Guattari. Whatmore (2002)’s “hybrid geographies” draws particularly on actor-network theory and biophilosophy to develop an understanding of the networked agency of a world lacking clear distinctions between social and natural.
“Geographies” emerge from particular epistemological, ontological, and theoretical perspectives and, despite that to a certain extent all geographies implicate space, what this space might be is often very differently understood.

For these reasons, it is not enough to simply undertake a “geography of global climate policy” without specifying clearly what such a geography entails. Bailey & Compston (2010) argue that geographers studying climate policy are particularly well positioned to contribute to debates on the effectiveness of various political strategies in different contexts and develop explicitly spatial analyses of the construction of global political strategies by complex networks of actors. Brace & Geoghegan (2010), while also contending that geography can contribute to knowledge of climate change, are more interested in particular local effects of global change processes, paying attention to a triad of landscape, temporality, and local knowledge.

This tension between the global and the particular runs throughout other geographic contributions to climate policy. Whereas Bulkeley (2005) studies how transnational networks of cities rescale climate policies globally, Gustavsson et al. (2009, p. 60) contend that “by looking at city networks from the point of view of particular cities we get a deeper understanding of the arguments and motives behind city networking than by only looking at the networks themselves as collective entities.” Bumpus & Liverman (2008) analyze the production of carbon offsets as a global strategy of capitalist accumulation which may be more or less effective in particular contexts (Bumpus, 2011), while Lansing (2011, p. 734) resists analyzing the growth of offsetting as the “extension of global-scale capitalist approaches,” instead focusing on
how discourses of development in particular places lead to the selection of offsetting as an appropriate option.

While I do not intend to deny these significant tensions, it is important to point out that even these authors do not necessarily see global and local accounts as conflicting. Lansing (2011)'s account of offsetting, for example, relies on global logics of neoliberal accumulation once offsetting has been chosen, and Bumpus (2011) identifies technical and social contexts that limit the extension of offsetting mechanisms. An effective geography of climate policy would need to reconcile – or at least accommodate – these tensions. This is one of the reasons for adopting the network perspective taken in this dissertation. Studying the networks of relationships formed between organizations of different types obviates the need to make clear distinctions between “global” and “local” processes. Taking a network perspective, we can think of overall network patterns as both a product of and a constraint on “local” interactions.

An example of this might be familiar to many geographers. Suppose we were engaging in a research project and wanted to interview a local government official. We are not personally acquainted with her, and we doubt we are likely to get an interview without a personal connection. We are fortunate enough, however, to know some other government officials, so we ask them if they know her. One says that while he does not, he has a friend who might, and this friend does turn out to be willing and able to broker a connection with the desired interviewee. In this case, our action was enabled by our particular network of connections, which we can think of as the “global” pattern. At the same time, if the interview goes well, we ourselves might
have formed a new connection with the interviewee and/or the friend of a friend, initiating a “local” process that has changed the “global” pattern.

In network geography, in other words, “global” and “local” are not isolated “scales” but, rather, relative terms. “Global” patterns refer merely to the configuration of all “local” processes in the network at any given time. Lest it be thought this is a reductionist view, we should remember that the configuration of all these local processes together have significant implications for how the network is likely to evolve in the future, which means that the network could still be considered more than the sum of its parts.

In addition, a network geography would also have to acknowledge that the “actors” or “nodes” in any networks are themselves composed of networks. This geography, to paraphrase the popular quip, is networks “all the way down” (Hawking & Mlodinow, 2008, p. 3). Of course, it impossible to take the sort of omniscient view that such an ontological commitment seems to necessitate, so we are necessarily always stuck in some sort of “local” or “global” analysis. Throughout the dissertation, I take different and shifting pictures of the evolving network of organizations with which I am concerned. These pictures are of specific times and places at particular resolutions. Because I expect patterns of relationships across the entire network of interest to affect events in particular places, I require a series of pictures of the network as a whole. These are presented in Chapters 3 and 5. Because these pictures are of necessity at a very low resolution, if I want to understand how these a particular place is embedded within connections with other places and processes, I need also to perform a higher resolution analysis in a particular place. This is done in Chapter 4.
Empirically, this dissertation focuses on networks produced by organizations based in different places. There are, however, other types of entities relevant for REDD+. In Chapter 2, I also discuss the geography of institutions, forests, pilot projects, and deforestation in a more traditional sense, providing the reader with background for the network geographies by detailing the absolute spatial – and some of the relative – geographies of these phenomena. While an analysis of REDD+ in such terms is far too limited, this discussion is necessary to lay the groundwork for the network geographies in subsequent chapters. This overall strategy is outlined in the following section.

1.6 Overview

1.6.1 Key Findings

This dissertation provides evidence that the development of REDD+ policy is spatial centralized, with the networks engaged in REDD+ policy development focused in particular around Washington, DC, and Geneva, Switzerland. Large conservation organizations, development agencies, and international organizations all perform active but differentiated roles in the development of REDD+, and the most active conservation NGOs, in particular, are headquartered in these cities. Chapters 3 and 5 provide evidence that this spatial centralization applies across a range of activities that survey a number of ways in which organizations can be involved in the creation of REDD+. 
Chapter 4 suggests the global pattern does impede participation, deliberation, and learning. Surveying REDD+ policy development in Central Kalimantan, Indonesia, it appears that the general and abstract policy models produced in centers of REDD+ policy development are difficult to translate into practice. As a result, REDD+ has empowered particular groups with claims to technical expertise and transnational connections in the creation of policy, while failing to incentivize the effective participation of people living in the villages most likely to be affected by REDD+ policy. While not conclusive, the analysis at these two resolutions suggests patterns of informal relationships among organizations engaged in REDD+ policymaking are not conducive to effective participation.

1.6.2 Chapter Overview

This dissertation consists of three substantive chapters, as well as a background chapter on global REDD+ policy and forest politics in Central Kalimantan, in addition to this introduction and a concluding discussion. Here, I outline the argument developed across the following chapters.

- **Chapter 2: Reaching Out and Reaching In: The Export and Import of REDD+ Policy.** Before it is possible to specify who are central actors in REDD+, it is necessary to establish the range of actions involved in policymaking. This chapter has two primary purposes. First, I provide a background on REDD+, discussing the range of activities through which REDD+ is made. I develop this answer further by examining broad trends in the geography of REDD+ policymaking, saving more systematic analysis for Chapters 3 and 5.
Second, I introduce a brief history of deforestation and forest politics in Central Kalimantan and describe REDD-related activities taking place in the province leading up to and during the fieldwork period. This provides some more precise examples of ways organizations engage in REDD+ and prepares the ground for the discussion in Chapter 4 of the challenges of implementation.

- **Chapter 3: Reaching Out: Centralization in the Global REDD+ Pilot Project Collaboration Network.** In Chapter 3, we take up the discussion of polycentricity begun here, asking whether or not the transnational network formed by organizations' collaboration on REDD+ pilot projects can be understood as a polycentric system. We argue that the literature on polycentricity and discussions of centralization and decentralization more generally conflate social-relational centralization with spatial centralization. Arguing that these two dimensions are not synonymous, we develop the concept of “concentrated polycentricity” to describe cases when systems are spatially – but not institutionally – centralized. We provide a brief history of the development of REDD+ policy and the main types of actors involved. Drawing upon a new dataset detailing collaboration on some 275 pilot projects that began on-ground operations between 1989 and June 2012, we suggest that REDD+ has been characterized by concentrated polycentricity for some time. The global network, we argue, is centered in particular on the community of organizations engaged in forest conservation and climate change mitigation in the United States. We suggest

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7Versions of chapters 3, 4, and 5 are being submitted to journals as articles in collaboration with co-authors. In this dissertation, when the pronoun “we” is used, it refers both to the author and the co-authors of the articles in question. Co-authors and anticipated outlets are noted at the beginning of each of these chapters.
that – should this structure remain unaltered – REDD+ policymaking could suffer from a bandwidth problem, potentially eroding both effectiveness and democratic participation.

• **Chapter 4: Reaching In: The Challenges of REDD+ Implementation in Central Kalimantan, Indonesia.** Responding to the questions regarding how organizations implementing REDD+ policy are embedded within broader networks and what effects the overall structure of the global REDD+ policy network has on attempts to implement policy in specific areas, this chapter reports on fieldwork undertaken in Central Kalimantan, Indonesia, from January to June 2012. Triangulating results from qualitative interviewing, participant observation, and a detailed survey of representatives of organizations involved in REDD+ policy in the province, we suggest REDD+ has been an approach brought – though not necessarily imposed – from the outside. Given the province’s low governance capacity and the difficulty of travel within the region, effective participation in policy creation has yet to develop. We suggest the bandwidth problem emerging from the structure of the global REDD+ policy network is indeed real and can be found also in sub-national contexts.

• **Chapter 5: Reaching Forward? The Structure of the International REDD+ Policy Network.** Returning to the discussion of concentrated polycentricity, in this chapter we use data on a wide range of activities to model the structure of the global REDD+ policy network more rigorously than in Chapter 3. Drawing from policy, political science, and geography literatures, we outline five potential structures for the global REDD+ network. Based on
a structural blockmodeling analysis of data on five REDD-related activities, we suggest that the global REDD+ network is best characterized as exhibiting concentrated polycentricity but note that there is some evidence the system could evolve into polycentricity under the correct circumstances.

- **Chapter 6: Conclusion.** Here I review the evidence presented in Chapters 2 through 5. I reflect on what the findings of this dissertation might mean for discussions of climate policy more broadly and close with some ideas for future research.

## 1.7 Conclusion

Discussions of climate policy must be adapted to a messier world in which states do not always behave territorially and are not alone. In this respect, the concept of polycentricity offers an ontological reorientation, while the discourse principle provides an aspirational objective. With the modifications noted above, polycentricity can provide a way to characterize the informal and quasi-formal creation of global climate policy, while deliberative democratic theory provides a perspective from which to understand its potential shortcomings.

Having previewed the key questions addressed in this dissertation, in the next chapter I provide some of the necessary background for the empirical analyses undertaken in Chapters 3 through 5. The patterns of REDD+ governance and its geography are consistent with the “messy” understanding of global climate policy outlined in this introduction, and the situation only gets messier when REDD+ “reaches in” to places like Central Kalimantan.
Chapter 2: Out and In: Geographies of REDD+ Exports and Imports

2.1 Introduction

Because it is a relatively new addition to the discussion on global climate policy – and continues to lack an institutional form – Reducing Emissions from Deforestation and Degradation (REDD+) is a relatively fuzzy concept that encompasses a perhaps even fuzzier set of activities. Here, I provide a more detailed introduction to REDD+ and its contemporary geography than offered in the previous chapter, leaving a discussion of the history of REDD+ and a more formal treatment of the geography formed by transnational connections to chapters 3 and 5, respectively.

As a form of transnational governance, REDD+ activities are intended not only to reach “out” from the policy centers in which they are designed, but also “in” – to particular places facing diverse deforestation drivers. In the second half of this chapter, I provide an introduction to Central Kalimantan, an Indonesian province that has been thrust to the forefront of REDD+ as a result of a $1 billion agreement between the governments of Norway and Indonesia to promote forest protection. As one of the largest REDD+ projects yet attempted, Central Kalimantan is seen by many in...
Indonesia and abroad as a laboratory for sub-national or national REDD+ policies to be used in other places. The challenges involved in bringing abstract REDD+ models “in” to the province and developing effective forest protection policies amidst Indonesia’s complex system of forest management, a severe lack of institutional capacity, and economic dependence on resource extraction has proven quite challenging for the provincial government, an issue I address in greater detail in Chapter 4.

2.2 The Diversity of REDD+ Involvement

Reducing Emissions from Deforestation and Degradation (REDD+) attempts to lower greenhouse gas emissions by protecting forests, paying for increased protection with funds derived from carbon markets or some other climate finance source. Because there is not yet – and there may never be – a formal REDD+ regime under the United Nations Framework Convention on Climate Change (UNFCCC), REDD+ is more of an adjective than a noun. While there is no REDD+ as an entity or institution in the sense that there is a Clean Development Mechanism (CDM), there are REDD+ activities – essentially any forest conservation for the sake of carbon benefits.

In the absence of a formal global framework, REDD+ activities tend to fall into one of three very broad (and occasionally overlapping) classes. On the one hand, organizations implement concrete pilot projects. On the other, they often support “REDD-readiness” – activities intended to build state capacity, improve legal clarity, develop measurement techniques, or otherwise prepare national or sub-national government agencies for REDD+. Somewhere between these two modes, organizations
can also engage in voluntary governance efforts. These activities range from reviewing pilot projects or policy options to sitting on standards-setting committees under organizations like the Climate, Community, and Biodiversity Alliance (CCBA) or the Verified Carbon Standard (VCS).

While distinct in principle, the three modes interact, and organizations can use activity in one to justify authority in another. Experience in developing pilot projects, for example, can be an rationale for membership on standards-setting committees. Given the significance of these interconnections, the subsequent chapters of this dissertation will consider multiple modes of REDD+ governance activities simultaneously in order to develop a clearer understanding of patterns that can emerge from these activities taken as a whole.

On the ground, REDD+ is diverse. In the absence of expected funds from compliance carbon markets, REDD+ pilots focus on a range of integrated conservation and development projects (ICDPs), including agroforestry, beekeeping, and similar livelihoods activities intended to reduce pressure on forests. ICDP models tend to be combined with REDD+’s emphasis on payments for ecosystem services (PES). The PES model, in principle, is intended to improve the long-term viability of the project by providing funding sources beyond the medium-term time horizons characteristic of ICDPs, while ICDP interventions provide compensation for reduced forest use (Sunderlin & Sills, 2012).

Figure 2.1 highlights some of the most common approaches employed in the pilot projects in the dataset discussed in Chapter 3. Sustainable forest management, not surprisingly, is an element of many projects, especially those aimed at the California
cap-and-trade market. Approximately one third of the projects in the dataset involve the creation or strengthening of protected areas. Reflecting its roots in ICDPs, several REDD+ projects also include some element of agroforestry or other alternative livelihood approach intended to reduce demand for forest use.

Figure 2.2, showing trends in the number of projects targeting a range of land manager types, also reflects the influence of ICDP models. While the number of projects primarily targeting firms and larger landowners has grown over time – particularly amongst projects geared toward the California and voluntary markets in the
US – the steepest growth since the REDD+ concept was formally introduced has been in projects affecting smallholders. Land uses targeted by these projects vary, though they are often some form of agriculture or fuelwood gathering. Reducing pressure on forests from these activities is a primary motivation for many projects to include agroforestry or some other form of alternative livelihoods component.

Despite interest in REDD+ in UNFCCC negotiations, it has been a relatively controversial initiative, in no small part due to association with the ICDP model. Various indigenous rights organizations consider REDD+ a new form of enclosure, arguing it blocks peoples’ access to forest products that have traditionally been essential for their livelihoods, actions which are seen by some as tantamount to seizures of indigenous lands (Boas, 2011; Reed, 2011). Forest-dwelling peoples on multiple continents report a lack of consultation and understanding of REDD+ (Asia Indigenous Peoples Pact, n.d.; Freudenthal et al., 2011; Resosudarmo et al., 2012), and case studies of some REDD+ projects and similar schemes have found evidence of expulsion and human rights abuses (Beymer-Farris & Bassett, 2012; Milne & Adams, 2012). Some environmental organizations based in the global North have pressed these arguments as part of their own opposition to REDD+ or carbon offsetting mechanisms in general (Barrett & Castillo, 2012), and alliances between indigenous and other forest-dwelling peoples’ groups and some Northern environmental organizations have become important voices in the debate about REDD+.

Given these continuities with ICDPs, we might be tempted to think of REDD+ simply as “old wine in new bottles.” While perhaps true for individual projects, this position seems less supportable for REDD+ as a whole, for two reasons. First, as I
Figure 2.2: Primary group or organization whose activities are targeted by REDD+ projects, by number of projects, 1995-2011. Based on dataset described in Chapter 3. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
discuss in the following section, REDD+ is characterized by a much more sophisticated (albeit nascent) institutional ecosystem than ICDPs have ever been. There have been considerable efforts to produce standards for REDD+ projects, as well as several parallel tracks of transnational institutionalization. As a result of these emerging connections, the relational space of REDD+ is quite different from more isolated, one-off ICDPs.  

Second, interest in eventually enacting REDD+ across entire jurisdictions, as, for example, in Central Kalimantan, raises the possibility of very different techniques being used than those that were possible under ICDPs. Government moratoria on primary forest clearance or spatial planning to refocus agricultural activities on previously degraded lands are measures that could not be contemplated within the ICDP framework. Of course, projects with this scope are only now beginning and, as demonstrated in Chapter 4, they often meet with considerable difficulties.

While the institutional development of REDD+ is in a sense a break with the history of ICDPs, institutional relationships are themselves embedded within even broader histories of development activities. As we will see in the following section, the geography of REDD+ reflects long-term patterns in the geography of development, in which policy models developed in a few key places in the global North are applied to countries in the South – in this case, particularly those where tropical forests may be found.

This does not necessarily mean that the geography of network relations is starkly different in the two cases, however. It is certainly possible that the ICDP world is also characterized by concentrated polycentricity.
2.3 The Geography of REDD+ Governance

The creation of REDD+ policy is inherently transnational, characterized by complex network geographies. While relations are the particular subject of the three substantive chapters of this dissertation, it can be instructive here to consider some introductory elements of the geography of REDD+ governance efforts, more colloquially understood, which are analyzed in greater detail in subsequent chapters. Here, I present some basic contextual information on the distribution of REDD+ pilot projects, standards-setting committees, funding flows, and membership in transnational REDD+ programs. While not an exhaustive catalog of REDD+ activities, these examples highlight key patterns that will be developed in more detail in subsequent chapters.

As noted above, REDD+ is currently most directly implemented via pilot projects. While relatively small-scale, pilot projects are already quite numerous, and their proponents can be crucial supporters of REDD+ more generally. Figure 2.3 presents the global distribution of pilot projects as defined in Chapter 3, containing projects with at least some on-ground operations taking place between 1989 and June 2012.

Pilot projects are unevenly distributed and highly varied in size. As might be expected, there is a higher concentration of projects in tropical forest areas, particularly Brazil and Indonesia. While there are are a few very large projects – in some cases over ten million hectares in extent – the vast majority are considerably smaller.\textsuperscript{9}

\textsuperscript{9} These numbers are often based on project proponents’ initial plans and may be scaled back substantially as the project progresses.
Figure 2.3: Global distribution of REDD+ pilot projects, 1989-2012, based on dataset described in Chapter 3. Projects for which size was unavailable coded as the median size. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
North America plays host to many small projects that – while not so named – fit the definition of REDD+ adopted in this dissertation. For the most part, these projects are undertaken to generate voluntary offsets, particularly for the Climate Action Reserve, a voluntary forerunner to California’s compliance carbon market. With both domestic and international forestry offsets figuring prominently in California’s cap-and-trade strategy, several additional forest owners in the US are considering offsets production for this market (Barringer, 2012).

This spatial pattern partly reflects the fact that REDD+ is in some sense an American product. As discussed in more detail in the following chapter, US utility firms and conservation groups were instrumental in developing early methodologies for “avoided deforestation” or “compensated reduction,” which provided the models and rationale for REDD+. The legacy of this early involvement can be seen in Figure 2.4, which presents the distribution of committees that have been or are currently engaged in developing standards for voluntary market projects or, in a few cases, social and environmental standards for emerging national or sub-national REDD+ policies.

While there are relatively few standards under development at present, there is much more activity in North America than elsewhere. In part, this is because the VCS, based in Washington, DC, has a number of committees producing REDD-related standards, but the city also is home to the CCBA, the American Carbon Registry, and the REDD+ Social Environmental Standards (SES), which in turn operates regional committees in Nepal, Ecuador, and Brazil. In California, work is being done by the Climate Action Reserve and the state government to develop standards for REDD+
Figure 2.4: Headquarters of committees engaged in standards-setting activities relevant to REDD+ pilot projects and REDD-Readiness activities, aggregated by city from a dataset described in Chapter 5. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
offsets on both the voluntary and compliance markets, and similar standards-setting activities are underway in Victoria, British Columbia, for that province’s market.

Figure 2.5 presents a final set of contextual data, showing pledged funding flows reported in the Voluntary REDD+ Partnership database (Voluntary REDD+ Partnership, 2012c). Despite the spatial concentration of pilot projects, organizations based in the majority of countries in the world are in some way involved in REDD-related financial flows. The bulk of these flows are relatively small, often less than $1 million, but a few key relationships – particularly large funding agreements contracted by the government of Norway with the governments of Brazil and Indonesia – are many times the median funding. There are also some relatively high pledges between regional neighbors, as, for example, between the US and Mexico and Australia and Indonesia.

As would be expected, the bulk of flows come from core countries, particularly the US and Western Europe, and are directed toward developing countries. The US appears to be a hub in part because Western European governments have pledged significant sums to the World Bank’s Forest Investment Program and Forest Carbon Partnership Facility, as well as the Global Environmental Facility, which are then redistributed to projects in tropical forest areas. While these flows are to some extent the contingent result of past choices regarding the siting of the headquarters of

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Flows represent the total sum of pledges from all organizations in the sending country to all organizations in the receiving country. The duration of some of the pledges is quite long (pledges utilized here are in theory to be paid between 2005 and 2021). While there is considerable uncertainty as to whether these pledges will actually be fulfilled, and the database does not provide an exhaustive accounting of funding flows related to REDD+, the map is useful in that it highlights some important general trends in the support of REDD+ activities.
Figure 2.5: REDD-related financial flow commitments reported in the Voluntary REDD+ Partnership database (Voluntary REDD+ Partnership, 2012c). Lines grow darker in the direction of flows. Connection between Norway and Indonesia added manually to reflect a $1 billion agreement between the countries (see discussion on REDD+ in Central Kalimantan in this chapter). Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
international institutions, they also reinforce the importance of the network of organizations based in Washington, DC, engaged in REDD+ policy, an issue discussed in more detail in Chapter 3.

While REDD+ lacks a strong formal framework under the UNFCCC, there are nevertheless important voluntary institutional arrangements that provide both resources and guidelines for national and sub-national governments interested in engaging in REDD+. While many governments are involved in multiple programs, membership is far from uniform. Figures 2.6 through 2.10 present the distribution of membership of four of the most prominent institutional arrangements for REDD+. The first of these, UN-REDD, is a partnership of the United Nations Environment Program, United Nations Development Program, and the Food and Agriculture Organization. Based in Geneva, UN-REDD provides funding to support REDD-readiness activities in tropical forest countries, planning to disburse up to $400 million to its partner countries between 2011 and 2015 (UN-REDD Programme, n.d.-b), though as of the end of 2011, total deposits were only $118 million (United Nations Development Programme Multi-Partner Trust Fund Office, 2012). In addition to its funding role, UN-REDD provides information and capacity-building support to national governments (UN-REDD Programme, 2012).

Two other institutional arrangements are managed by the World Bank. The Forest Carbon Partnership Facility (FCPF), proposed by the World Bank in 2006, became operational in June 2008 to provide financing to developing countries for REDD+ policies and “set the stage for a much larger system of positive incentives and financing flows for REDD in the future” by engaging in experimental policy
Figure 2.6: Membership in UN-REDD (UN-REDD Programme, n.d.-a). Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 2.7: Membership in the Forest Investment Program (FIP) (Climate Investment Funds, 2013). Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 2.8: Membership in the Forest Carbon Partnership Facility (FCPF) (Forest Carbon Partnership Facility, 2012). Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 2.9: Membership in the Voluntary REDD+ Partnership (VRP) (Voluntary REDD+ Partnership, 2012b). Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
development (Forest Carbon Partnership Facility, 2008, p. 2–3). As of the end of 2012, 37 countries were members and had begun to apply for funds by submitting papers detailing plans for national REDD+ implementation. At present, only nine states have concluded an agreement for funding beyond the initial $200,000 grant provided for the preparation of a planning paper, while 17 have yet to reach this first stage (Forest Carbon Partnership Facility, 2012). Other funding comes from the Climate Investment Funds (CIF), housed in the World Bank and managed jointly with the African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, and Inter-American Development Bank (Climate Investment Funds, 2012a). In 2009, a Forest Investment Program (FIP) was added to the CIF to provide “scaled-up financing” in support of national REDD-readiness reforms, as well as public and private investments (Climate Investment Funds, 2011). The funding available from the FIP is substantial, with pledges of $639 million as of fall 2012 and an expected leverage of $881.3 million (Climate Investment Funds, 2012b).

The final two institutional arrangements are less formal intergovernmental networks including members from both developed and developing countries. The Voluntary REDD+ Partnership (VRP), formed during the Oslo Climate and Forest Conference in 2010, is a loose network of 75 governments that coordinate and share information on REDD+, particularly though meetings and workshops conducted in various member countries. The Partnership coordinates discussion around concerns like measurement, funding, stakeholder rights, and biodiversity and constructed the dataset on REDD+ funding used in Figure 2.5 (Voluntary REDD+ Partnership, 2011). The
partnership is explicitly understood to be interim, and members intend the network to be included within a formal REDD+ framework to be negotiated under the UNFCCC (Voluntary REDD+ Partnership, 2012a).

Smaller in terms of both members and spatial extent, the Governors’ Climate and Forests Task Force (GCF), established in part due to the active leadership of California Governor Arnold Schwarzenegger (Environment News Service, 2010), was formed during the Governors’ Global Climate Summit, held in California in November 2008. Like the VRP, the GCF is a transnational cooperation network, in this case for sub-national governments interested in REDD+ policy, who share information through conferences and workshops that rotate among the membership. Backed by the Moore and Packard Foundations, the GCF’s funding is considerably more limited than that of the other institutions, though a fund was started for members in 2011, with a donation of $1.5 million from the US Department of State (Governors’ Climate and Forests Task Force, 2011b). The forum is more important, however, in forging connections between California and states like Chiapas, Mexico, and Acre, Brazil, both of which are developing jurisdictional REDD+ efforts intended to generate offsets for California’s cap-and-trade market (Government of California et al., 2011).
Figure 2.10: Spatial distribution of members of the Governors’ Climate and Forests Task Force (GCF) (Governors’ Climate and Forests Task Force, 2012; Hijmans et al., 2012). Projection: WGS84. Visualized in Quantum GIS (Quantum GIS Development Team, 2013).
Several developing countries are involved in at least one of the two largest funding programs – UN-REDD and FCPF – generally concentrated in the tropical forest band where several pilot projects are also located. Despite its significant levels of funding, the FIP is currently only at a pilot stage, with efforts focused on a few key countries, notably Brazil, Democratic Republic of Congo, and Indonesia, three of the most active REDD+ sites. As a coordination mechanism, the VRP is more extensive than the other institutions, including several donor countries whose governments are interested in shaping the evolving REDD+ regime. The GCF, finally, clearly has a very different geography, though patterns of membership broadly reflect the distribution of REDD+ pilot projects. Despite its limited resources, GCF members include most of the highest concentration areas of pilot projects and several governments anticipating sub-national activities, including Chiapas, Mexico, Acre, Brazil, and Central Kalimantan, Indonesia.

These diverse institutional geographies highlight that global REDD+ policy is decentralized in an institutional sense. Even the body officially tasked with overseeing REDD+ in the UN system cannot be understood as the core institution “running” REDD+. Hampered by limited funding, UN-REDD often plays more of a supporting than a leadership role, and both its disbursements and those of the FCPF and FIP are dwarfed by the funds being committed by countries like Norway to forest protection efforts. The VRP, despite ambitions of becoming a formal body under the UNFCCC, is largely ad hoc and serves primarily as a discussion forum.

I began by suggesting REDD+ is an adjective, not a noun, and the preceding survey supports this claim. Government bodies at multiple administrative levels have
been quite active in moving resources, undertaking research, and providing advice, while firms and NGOs have provided information and developed pilot projects. All this messiness could lead some to think of REDD+ as inherently “fragmented” (Biermann et al., 2009), but, as I argue in subsequent chapters, broad patterns emerging from this messiness may lead us to different conclusions.

Thinking about aggregate patterns can sometimes make us forget that each dot on the pilot project map is a direct engagement in people’s lives. Understanding how global policy “reaches in” to particular places requires a more detailed study than is possible with large-N research, making comparative analysis useful. In this dissertation, I report on one example of REDD+ reaching into Central Kalimantan, Indonesia, in an attempt to begin to understand how global patterns of REDD+ policymaking interact with efforts to make policy real in particular places. In the following section, I provide an introduction to Central Kalimantan, explaining how deforestation came to be a key challenge in the province and providing an overview of how sometimes controversial REDD+ projects have been developed in the name of addressing these problems.

2.4 Deforestation in Central Kalimantan

At the G20 Summit held in Pittsburgh, Pennsylvania, in 2009, Indonesian President Susiljo Bambang Yudhoyono – much to the surprise of the attendees\textsuperscript{11} – pledged to reduce Indonesia’s greenhouse gas emissions 26% below business as usual levels by 2020 – or up to 41% with foreign assistance (Fogarty, 2009). Forest policy has

\textsuperscript{11}And, reportedly, his own staff.
figured prominently in the Indonesian government’s approach to climate change for nearly two decades (Office of the Minister of Environment of Indonesia, 1994), as deforestation and degradation alone account for five times the country’s emissions from energy, agriculture, and waste combined (Sari et al., 2007). Seizing an opportunity from growing interest in forest protection, the Yudhoyono administration has become a prominent proponent of REDD+ policy.

The province of Central Kalimantan, on Borneo, was catapulted onto the international stage in late December 2010, when Yadhoyono announced it would be the first pilot province as part of a $1 billion deal with the Government of Norway to promote forest protection (Butler, 2010). The region was already a center of interest in REDD+ circles. In 2010 and 2011, in addition to running an annual meeting of the GCF (Governors’ Climate and Forests Task Force, 2011a), Central Kalimantan hosted guests including George Soros (Kalteng Pos, 2010), the Secretary General of the UN (Office of the Spokesperson for the Secretary General of the United Nations, 2011), the chief of the UN Development Programme (United Nations Development Programme, 2011), the Norwegian Minister for Environment and International Development, the British Minister of Agriculture and Rural Development, the Ambassador of Norway (Sekretariat REDD+ Bersama Kalimantan Tengah, 2011), and former British Prime Minister Tony Blair (Jawa Pos National Network, 2011), all of them visiting to discuss REDD+.

There certainly was much to talk about. The problem of forest loss is common knowledge in the province, and several people I met during my fieldwork grimly joked that studying REDD+ might be interesting, but the forest was already gone.
Indeed, Central Kalimantan had the highest absolute deforestation of any province in Indonesia between 2000 and 2009, accounting for approximately 13% of forest loss in the country as a whole (Sumargo et al., 2009, p. 56).

This is not a new problem. Forestry licenses were central to Soeharto’s efforts to build a network of supporters, and in the 1960s and 1970s his regime centralized authority in the national Ministry of Forestry (MoF), rolling back traditional (adat) land rights in order to exploit forests for political patronage (Ross, 2001, ch. 7). Official statistics – which almost certainly underestimate volumes – suggest the three provinces of Indonesian Borneo produced almost 1 million cubic meters of timber in 1968 and over 17 million in 1979 (Brookfield & Byron, 1990). The toll of this large-scale conversion was social as well as ecological. Rural communities in the province are highly dependent on forests for swidden cultivation, timber, and non-timber forest products, so legal and illegal logging often threatened traditional livelihoods and sparked social conflict (McCarthy, 2001a).

Following a rise in oil prices in the 1980s, which offered an opportunity for Soeharto to further centralize his patronage network, official timber exploitation declined (Ross, 2001, pp. 181-189). While illegal logging continued in the late Soeharto period – sponsored largely by the Indonesian military (J. Smith et al., 2003) – food production was also becoming a political concern. In 1995, Presidential Decree No. 82 mandated conversion of 1.4 million hectares of peatland in Central Kalimantan to rice production. The area of this “Mega-Rice Project” (MRP) had once been under forestry concessions and was logged a second time during conversion. Its hydrosphere was vulnerable and its soils could reach high acidities if oxidized, making the drained
land marginal for agriculture. Nevertheless, canals were constructed to drain the peat, simultaneously providing a path for felled timber and leading to drying, resulting in acidification and massive wildfires (Sabiham, 2004; Jaya & Inoue, 2010). While the logging was lucrative, rice production never became a meaningful component of local livelihoods, and after Soeharto the area was dubbed a “mega disaster” (Suyanto et al., 2009, p. ii). As timber stock in the MRP region declined, logging shifted to other parts of the province, notably to the second large peatland region of Sebangau (Muhamad, 2001; Boehm & Siegert, 2001). Like the ex-MRP area, 85% of Sebangau is covered in peat swamp, also drying due to drainage channels cut to haul timber out of the wetlands.
Following Soeharto’s ouster, forest policy took a different turn as power was decentralized to the provinces and districts. By the early 2000s, central government authority had been reformulated to primarily encompass oversight and standard-setting, while provinces gained planning authority and the districts and municipalities – the big winners – took over lucrative licensing processes (Sudradjat & Yustina, 2002). The spirit of decentralization was relatively short-lived, however. Claiming district governments’ low capacity rendered them unable to manage forests on their own, the MoF canceled district authority to issue licenses for small concessions in February 2002. In June of that year, a further regulation returned primary authority for granting forest concessions to the central government (Dermawan et al., 2006). Finally, the Regional Governance law of 2004 required that the Minister of Home Affairs review draft regulations before they were passed by provincial governments, which in turn were to review district regulations, ensuring centralized purview over regulatory processes more broadly (Barr et al., 2006).

As a result of low capacity, protected areas are often ineffective and were increasingly under pressure throughout both the Soeharto and decentralization periods (Curran et al., 2004), and illegality remains a problem. In 2011, the MoF admitted, somewhat incredibly, that only 67 of 352 plantation firms and nine of 615 mining operations in Central Kalimantan were operating with full legal permits (Jakarta Globe, 2011).
Figure 2.12: Regrowth in a cleared area near Palangkaraya. Photograph by author.
2.5 REDD+ Pilot Projects in Central Kalimantan

Given the area’s history, it should be unsurprising that peatland restoration has been a central component of emissions reduction strategies for several organizations working in Central Kalimantan. International projects, sponsored by the Netherlands (Central Kalimantan Peatland Project Consortium, 2008), the EU, Australia (Olbrei & Howes, 2012), and the Worldwide Fund for Nature (WWF) (Jemadu, 2012), have blocked canals, attempting to rewet the peat. Other projects, such as the Rimba Raya REDD+ project funded by Gazprom and Shell (Brock et al., 2010; Norman, 2011) and the smaller project planned near the Lamandau Wildlife Reserve, have been developed to protect Central Kalimantan’s iconic orangutan population. Together, peat and orangutans made the REDD+ model attractive even prior to the province’s designation as a pilot under the agreement with Norway.

The most prominent and controversial REDD+ project in the province is the Kalimantan Forest Carbon Partnership (KFCP), developed as part of the Australia-Indonesia Partnership and funded to the tune of $47 million by AusAID (Olbrei & Howes, 2012). In 2007, government representatives from both countries undertook a scoping mission to determine the project site. The area initially chosen covered 120,000 hectares, bounded by the Kapuas and Mantangai Rivers and inhabited by some 10,000 people (Forest Peoples Programme et al., 2011). Project activities were to include livelihoods improvement, fire management, reforestation, and peatland rewetting (Partnership, 2009, p. 16).

Its optimistic origins notwithstanding, Olbrei & Howes (2012) report the KFCP has been quietly rolled back to about 10% of its originally planned area. The project
Figure 2.13: General reference map of Central Kalimantan, Indonesia. Land conflicts shows land conflict events from approximately 2000 to present recorded with precise longitude and latitude coordinates in (Jaringan Kerja Pemetaan Partisipatif et al., 2012). Other spatial data from InfiniteEARTH (2013); Starling Resources (2012); Central Kalimantan Peatland Project Consortium (2013); Friends of the Earth Sydney (2012); International Union for the Conservation of Nature & United Nations Environment Program World Conservation Monitoring Center (2010) and Yaysan Orangutan Indonesia (2012).
was plagued by problems, including a lack of funding, changes in the Australian government that made climate change less of a priority, trouble obtaining relevant permits and permissions, and limited interest on the part of district and provincial governments. Even agreeing on the terms of reference for an environmental impact assessment was difficult. The provincial government refused to approve the terms without the support of Kapuas district, while the district would not endorse the assessment without a formal Letter of Decision from the MoF.

In addition to these problems, Pearse & Dehm (2011) and Forest Peoples Programme et al. (2011) further contend that the KFCP has made inadequate efforts to ensure Free, Prior, and Informed consent. Three years into the project, most affected communities had yet to see the complete design document, and there were several reports of inadequate communication to village residents. In addition, the KFCP has been criticized for failing to consider local knowledge or Dayak land management practices. Tree planting, for example, is a means of claiming land in Dayak communities, meaning reforestation is inherently controversial, and community leaders and NGOs have charged that the KFCP amounts to land grabbing (Jakarta Post, 2011; Satriastanti, 2011).

While the KFCP is certainly the most high-profile project in the province, the planned Katingan Peat Forest Restoration Project, to be carried out by the private firm Rimba Makmur Utama (RMU), is intended to be nearly twice as large, at 200,000 hectares (Starling Resources, 2012), populated by around 100,000 people (Fogarty, 2010). The project involves registering an ecosystem restoration concession on areas previously designated for production or conversion. The concession will
be used to implement a project to avoid forest conversion to palm oil or mining or
forest loss by illegal logging. RMU began community engagement efforts, including
participatory mapping, in 2009, expanding to work with Free, Prior, and Informed
consent (Hartono, 2011). In the longer term, project proponents envision sponsoring
livelihoods activities ranging from agroforestry and non-timber forest products to mi-
crofinance and healthcare provision (Hartono, 2012) and plan to disburse around 20%
of the revenue from offset sales to local communities (the REDD Desk, 2012). Like
the KFCP, the project encountered challenges. The Katingan district head issued
nine mining and six oil palm plantation licenses in the ecosystem restoration area,
halting the project for over a year (Hartono, 2011), though at the time of writing it is
undergoing verification under the VCS (Hartono, 2012) and plans to acquire CCBA
certification (Starling Resources, 2012).

The Rimba Raya Biodiversity Reserve REDD Project rounds out the prominent
pilots in the province. At 91,000 hectares, it is smaller than both the KFCP and RMU
projects, focused on protecting orangutan habitat in the buffer zone of Tanjung Put-
ing National Park. Managed by the Hong Kong-based forest-carbon firm Infinite
Earth in partnership with Orangutan Foundation International (Brock et al., 2010),
the project gained funding support from energy giants Shell and Gazprom, as well as
logistical support from the Clinton Foundation, and was initially expected to generate
$750 million in offset sales over 30 years (Fogarty & Creagh, 2010). The project did
not engage in a formal process for community approval. Instead, proponents con-
sulted village heads, reporting “tacit approval.” (Brock et al., 2010, p. 23). Rimba
Raya focuses primarily on providing a buffer for the national park and strengthening monitoring through the construction of guard towers and establishment of a fire management plan and fire response system, a concern it shares with the KFCP. In terms of community benefits, the project envisions agroforestry activities to help offset some of the loss of forest use for local inhabitants, as well as providing education and perhaps even low-cost laptops for children (Brock et al., 2010).

The permitting process has been especially challenging for Rimba Raya (Brock et al., 2010, p. 23-24). Citing issues with the project’s support from Gazprom,12 and expressing incredulity that it would pay sufficient revenues, the MoF cut the project in half, licensing a section of the original area to a palm oil firm (Fogarty, 2011; Norman, 2011). Gazprom, in response, announced it was putting some $100 million in green investments in Indonesia on hold (Norman, 2011). In the face of a Corruption Eradication Commission investigation and under pressure from both the provincial governor of Central Kalimantan and the wife of Indonesia’s State Intelligence Agency head, the MoF reversed its decision, announcing the change on the sidelines of the Doha COP to the UNFCCC in 2012 (Barrett, 2012; Fogarty, 2012).

Often in opposition to these project proponents, local, national, and international civil society actors have advanced several criticisms of REDD+ in the province, some of which have been noted already. Organizations including Yayasan Petak Danum13 and Aliansi Masyarakat Adat Nusantara Kalteng14 have been particularly vocal both

12 People in business circles in Indonesia suggested the Gazprom connection “fell foul of nationalist sentiment” (Bachelard, 2012).

13 This is a Dayak name meaning, literally, the Land and Water Foundation, though perhaps more correctly the Homeland Foundation.

14 Indigenous Peoples’ Alliance of the Archipelago, Central Kalimantan.
in contesting the way REDD+ projects – particularly the KFCP – have been implemented and promoting the sustainability of traditional forest management practices. Like project proponents, these groups take advantage of connections in Jakarta and abroad. Contacts with organizations in the Friends of the Earth International network, Rainforest Foundation Norway, and Robin Wood of Germany have been important sources of support and provide opportunities to directly lobby foreign governments – particularly the government of Australia, which funds the KFCP. An additional connection that has been incredibly important is Chris Lang, who operates the blog REDD-Monitor, one of the key international sources on REDD-related activities, particularly among skeptics. Yayasan Petak Danum and Walhi, an Indonesian affiliate of the Friends of the Earth network, have made numerous press releases via this website, and their criticisms of the KFCP, in particular, have brought the project to the attention of many outside the province, as well as placing pressure on the Australian government.

NGOs have also tried to adapt REDD+ to local concerns. Several, for example, have formed a coalition to develop a text-message-based microblogging platform to encourage people living in village areas away from the provincial capital to become more involved in discussions about REDD+ (Borneo Climate, 2012b). Some members of this coalition have partnered with the provincial government to undertake participatory mapping of adat land claims in order to empower groups utilizing traditional tenure both to protect their land and – potentially – stake claims to carbon-based income streams (Borneo Climate, 2012a).
Ongoing efforts to develop a province-wide REDD+ policy take place within this complicated social and political milieu. As we discuss in Chapter 4, while REDD+ activities have been ongoing and a subject of debate for some time, the community of organizations engaged in REDD+ has yet to emerge as a solidified policy community, and the provincial government’s efforts to build REDD+ policy for the province as a whole have met with serious challenges.

2.6 Conclusion

At first, REDD+ seems to exhibit characteristics of prior sustainable development projects. Despite an understanding of REDD+ as decentralized, there is evidence much of the impetus comes from the developed countries of Western Europe and the US. This initial interpretation, however, could benefit from further nuance, which I attempt to develop in the following chapters. As the case of NGO activities in Central Kalimantan should already suggest, even if REDD+ is in some sense “top-down,” the act of translating abstract REDD+ policies into local conditions can provide opportunities for groups to take on some ownership of REDD-related issues and use them to further existing concerns and take on their own voice in the process, so there is some scope for leveraging deliberation.

In the following chapter, we explain in more detail what might be meant by the idea that REDD+ could be centralized, drawing in particular upon the concept of polycentricity introduced in the first chapter. Using additional data on global
REDD+ policy activities, we describe the history of REDD+ and provide more detailed quantitative analysis of the evolution of the network of organizations implementing pilot projects.

Moving from a global to a more detailed resolution, we discuss in Chapter 4 how organizations in Central Kalimantan are embedded both within local networks and within more extensive networks of organizations engaged in REDD+ policy creation. We examine in particular the challenges faced in extending REDD+ from the provincial capital to other parts of the province and consider the limitations of the network of organizations engaged in REDD+ policy in bringing the policy into full development and engaging those affected by emerging policies.

In Chapter 5 I return to a global analysis, using data on multiple types of REDD+ activities to study different countries’ positions in the network of transactions producing REDD+. Drawing from the qualitative findings in Central Kalimantan, I suggest the global network of REDD+ activities could in principle be amenable to more deliberative participation, should certain strategies be adopted.
Chapter 3: Reaching Out: Centralization in the Global REDD+ Pilot Project Collaboration Network

3.1 Introduction

Having introduced “doing REDD+” in Chapter 2, here we develop this discussion by addressing who produces REDD+ policy and considering the implications of our findings for deliberative participation. Examining the history of REDD+ development and drawing on a new dataset on collaboration on pilot projects, we study the development of global REDD+ policy from a network perspective. Using a time-series analysis of betweenness centrality (Freeman, 1978), we find that the organizations most central to the network implementing projects tend to be based in donor countries and in Washington, DC, in particular. We suggest this spatial concentration of central but formally separate organizations complicates the characterization of central role.

An version of this chapter was co-authored with Professor Darla K. Munroe and has been accepted for publication by *Global Environmental Change*. The use of the pronoun “we” is therefore retained here. Preliminary research for this project was generously funded by the Environmental Policy Institute at The Ohio State University, and we are very grateful for the advice of two anonymous reviewers for *Global Environmental Change*. 
of REDD+ as a polycentric or decentralized system and introduce the concept of “concentrated polycentricity” as an alternative.

As argued in Chapter 2, many concrete REDD+ activities take place outside of – despite being informed by – the UN system. Existing research provides insights into how REDD+ models are being or have been enacted in particular places (Padwe, 2002; Brown et al., 2000; McElwee, 2011; Beymer-Farris & Bassett, 2012; Milne & Adams, 2012), as well as how REDD+ is situated within the UN system (Okereke & Dooley, 2010; Schroeder, 2010). There is, however, less understanding of the informal and quasi-formal relationships linking these two arenas. Because relationships like these may be important for flows of information and resources crucial to adaptive governance more broadly (Holling, 2001; Holling et al., 2002; Adger et al., 2005; Cash et al., 2006), it is important for us to understand the structure of these informal and quasi-formal networks. Moreover, we are interested in what an understanding of these network structures might tell us about the way organizations engaged in transnational environmental governance interact and what these patterns of interaction might mean for opportunities for participation in the formation of environmental policy.

In this chapter we introduce a framework for answering these questions, using REDD+ as an example. We present an original dataset containing 276 avoided deforestation, sustainable forest management (SFM), and REDD+ projects that began on-the-ground operations between 1989 and June 2012, building on existing data by including information on organizations collaborating on each project. We create a network dataset consisting of organizations linked by common sponsorship of pilot projects (N=763). Adopting a social network analysis (SNA) approach (Wasserman

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we calculate betweenness centrality, a measure of the degree to which organizations connect different groups in a network (Freeman, 1977), presenting scores for organizations, as well as cities. We provide additional context for this analysis with a historical analysis of the development of REDD+ and an exploratory examination of 1547 organizations’ involvement in consultation on major policy planning documents, membership on voluntary and governmental standards-setting committees, and co-authorship of “gray” literature. We find evidence of a spatially centralized system, with REDD+ policy development directed by organizations in relatively few places, despite the involvement of many.

We begin by presenting conceptual background drawing on work in Earth System Governance (ESG) and polycentric governance. These literatures provide conceptual tools for studying the informal and quasi-formal dimensions of global climate policy, but, we argue, their conceptualization of centralization and decentralization suffers by conflating spatial centralization with formal, institutional centralization. This problem, we argue, can be addressed by combining a network and a spatial perspective on transnational environmental governance. We then begin our empirical discussion by providing background on the types of organizations most active in REDD+ policy development before explaining the ways these organizations have been active in developing REDD+. In the second part of our empirical analysis, we present detailed statistics from the pilot projects dataset, as well as more exploratory analysis from the other datasets mentioned above. We conclude with a discussion of the potential normative implications of spatial centralization and the need for further research.
3.2 Theory: Centralization in Governance Architectures

Despite nearly three decades of decentralization of natural resource governance in many tropical forest countries, national agencies have incentives to maintain control over forests, and decentralization can often be incomplete (Larson & Soto, 2008). Phelps et al. (2010) and Sandbrook et al. (2010) warn that REDD+ might promote further recentralization of forest governance in tropical forest countries by empowering national forest ministries and increasing the value of forest control. While this outcome is uncertain (Toni, 2011), these concerns are raised in a growing literature, exemplified by debates on the relative merits of national, project-based, or “nested” approaches to REDD+ (Chagas et al., 2011; Pedroni et al., 2009). The consolidation of decision-making authority in higher levels of state bureaucracies, however, is only one way centralization might take place. Given that REDD+ is a predominantly transnational governance system, centralization could also take place within the less formal transnational networks that act as conduits for knowledge, advice, and resources.

Recent discussions of Earth System Governance (ESG) provide a conceptual framework for thinking about centralization and decentralization beyond the state. ESG is “the interrelated and increasingly integrated system of formal and informal rules, rule-making systems and actor-networks at all levels of human society” dealing with human-environment interactions (Biermann et al., 2010, p. 203). Research on ESG extends institutionalist studies of global environmental politics to complex networks
of public and private organizations that collaborate (and sometimes clash) in implementing environmental governance (Biermann, 2008). From this perspective, environmental governance does not happen just within the territory of states but takes place across borders, carried out by NGOs, development agencies, and private firms undertaking projects in multiple places simultaneously. Students of ESG refer to these middle-range phenomena, the networks or clusters of organizational relationships and activities that connect concrete projects on the ground with more generalized discourses and norms, as “governance architectures” (Biermann et al., 2009).

Within the ESG and related literatures, there is an emerging consensus that global environmental governance is “fragmented” (Biermann & Pattberg, 2008; Biermann et al., 2009) in the sense that many environmental issue areas are governed via a diversity of institutional types (such as treaties, international organizations, or customary rules) with differing spatial scopes and emphases. These fragmented architectures are sometimes described as “polycentric” (Abbott, 2012). As outlined by V. Ostrom et al. (1961), polycentric systems consist of formally separate governing bodies which, despite their autonomy, are in regular consultation with one another. The relationships between the governing bodies are flexible and may vary from issue to issue, depending on the degree to which events taking place within one administrative area affect others. E. Ostrom (2010b, 2012) and Nagendra & Ostrom (2012) advocate a “polycentric” approach to global environmental policy as a way to balance local knowledge and innovation with coordination (E. Ostrom, 1998) by combining experimentation with “mechanisms for mutual monitoring, learning, and adaptation” (E. Ostrom, 2010b, p. 552).
Several writers suggest that REDD+ is already an emerging multi-level governance project (Skutsch & Van Laake, 2008; Thompson et al., 2011; Korhonen-Kurki et al., 2012), embedded within a fragmented or polycentric governance architecture (Kanowski et al., 2011; Nagendra & Ostrom, 2012). As such, REDD+ offers an opportunity to advance our understanding of ESG. Here, in particular, we address two emerging questions. First, how does interaction take place within fragmented architectures (Zelli, 2011)? In our analysis, this is essentially a question of network structure: what are the patterns of key relationships between organizations engaged in REDD+? Second, how might the patterns of these interactions affect the potential for participation (Biermann & Pattberg, 2008) and accountability (Biermann & Gupta, 2011)? As Biermann & Gupta (2011) argue, transnational spatial interdependence can pose significant challenges for accountability, as the weakness of international institutionalization offers limited opportunities for redressing grievances. As a result, accountability can depend heavily both on patterns of inclusion of stakeholders and the degree to which included stakeholders are able and willing to maintain a “critical distance” from decisions (Dryzek & Stevenson, 2011). To maintain accountability, Dryzek (2009) argues, governance systems should be noncoercive, so people’s authentic perspectives can be expressed; inclusive, so all people affected by decisions are involved in decisionmaking; and consequential, in that participation can affect decisions.

The ability of the ESG and polycentric governance frameworks to answer questions about interaction and accountability, however, is compromised by conflating spatial and institutional centralization. It is uncontroversial to consider a social system
centralized if a single governing body creates policy or a single organization acts as a “hub” in a network of interorganizational relationships. In the absence of such a structure, it is generally presumed systems are polycentric or fragmented. The problem with this assumption is that systems may be centralized spatially without corresponding institutional centralization. In this case, there might be no single hub or authority, but several key organizations might be located in roughly the same area, facilitating access to information and resources for some and raising barriers to others, potentially limiting both the inclusiveness and consequences of participation. At the time of writing, for example, California is developing a REDD+ offsetting program with the states of Chiapas, Mexico, and Acre, Brazil. Having recently published a set of draft recommendations for the system, the REDD Offset Working Group has scheduled three workshops to discuss the proposal in detail. While the policy will have direct effects on forest-dwelling peoples in Chiapas and Acre, the workshops will be held at Stanford, University of California, Davis, and University of California, Los Angeles (REDD Offsets Working Group, 2013b), a choice which may limit the interests that can be directly represented in discussions.

A second barrier to overcome is a continued focus on state institutions. As Beymer-Farris & Bassett (2012) contend, centralization need not mean that state actors are the only ones who gain influence. We tend to think of centralization as a property of states because national governments can give orders to sub-national governments who are themselves unable to command sub-national actors at their level in the hierarchy, but there are other examples less reliant on national territory. REDD+
activities in Brazil, for example, have been supported in large part by state governments (Toni, 2011). This approach might be seen as decentralized, but if, as in the case of the state of Acre, these activities link Amazonian states to the California cap-and-trade market, policy decisions may now be affected by events in Sacramento, and, depending on how the system evolves, centralization might occur transnationally.

Galaz et al. (2012)’s suggestion that a network perspective is appropriate for studying transnational polycentric systems helps assuage these two problems. From a network perspective, there are multiple forms of polycentric order, characterized both by the nature and the structure of relationships between organizations. Adopting this approach, we conceptualize centralization and decentralization as properties of configurations of networks through which ideas, resources, and information flow, rather than the points at which decisions are made in institutional hierarchies. We build on Galaz et al. (2012)’s understanding of polycentricity by adopting a spatial perspective in our analysis of network structures.

We often think of spatial and institutional centralization as equivalent, but the relationship is more nuanced. Many benefits claimed (with considerable dispute; see Bardhan (2002)) for decentralization, such as local knowledge (V. Ostrom et al., 1961; Scott, 1998) or increased participation and responsiveness (Faguet, 2004, 2008, 2009), are as closely linked to spatial proximity as institutional structure. While institutional centralization implies spatial centralization (the federal government of the US, for example, is located in one place), the inverse does not hold. From this perspective, centralization and decentralization form a continuum (see Figure 3.1). Discussions of state and non-state political processes tend toward the two poles, with
the state understood as relatively centralized, while non-state systems are generally thought of as decentralized, polycentric, or fragmented. Between these two poles – where, we argue, we find the REDD+ governance architecture – is concentrated polycentricity. Systems with this configuration, while polycentric in an institutional sense, are centralized spatially. While multiple organizations and institutions comprise the architecture, they are all sited in relatively few places, not necessarily accessible to all those affected by their activities.

Advantageous positions in the network skeleton of a governance architecture can provide individuals or organizations important sources of power and influence. One way this happens is through brokerage. Brokers are individuals or organizations who are positioned between two or more distinct groups in a network (Burt, 1995, 2005). They can use their position to leverage access to resources or information

Figure 3.1: Stylized continuum of centralization from polycentricity/fragmentation to hierarchy/centralization. Scale-free networks in left and center panels generated with igraph in R (Csardi & Nepusz, 2006).
or, conversely, influence flows within the network. In situations where cooperation is necessary to achieve particular goals, brokers can have influence by virtue of their advantages in bringing together parties for cooperation (Lake & Wong, 2009; Carpenter, 2011). In the case of REDD+, which combines ecological and development objectives, requirements for knowledge and resources often outstrip what organizations can muster on their own. Development institutions need organizations with the technical capacity to undertake REDD+ projects. These organizations, in turn, require access to local knowledge and expertise, just as local organizations require access to technical facility and resources to carry out their objectives.

As a payment for ecosystem services (PES) approach, REDD+ should in principle be based on voluntary participation, which might be expected to place control in local hands. While there has been considerable discussion of the need for stakeholder engagement and free, prior, and informed consent, there also have been claims that consultation on REDD+ has been limited (Accra Caucus on Forests and Climate Change, 2011; Greenpeace International, 2012; Forest Peoples Programme & Yayasan Pusaka, 2012; Indrarto et al., 2012; Di Gregorio et al., 2012), and even people residing in project areas have been shown to have very limited knowledge of REDD+ (Resosudarmo et al., 2012).

Organizations with ties to places where expertise and resources can be sourced may be at a comparative advantage in becoming brokers and forming beneficial coalitions. Transnational conservation NGOs like The Nature Conservancy would be a good example. The combination of its connections with some large American firms,
its operations in many iconic forested landscapes, and its connection to social networks in Washington, DC, place The Nature Conservancy in a favorable position to bring together the funding, expertise, and site selection necessary to implement pilot projects.

Brokers might expect their position to become more advantageous over time, as the growth of use of particular methodologies for REDD+ projects could create “network power” Grewal (2008), an increasing attractiveness of access to a particular set of standards as the number of adherents increases. Organizations sponsoring private standards for REDD+ projects’ social and biodiversity effects, for example, became increasingly attractive as partners of cooperation as these standards became de rigueur for high profile projects.

The implications of brokerage are ambiguous. On the one hand, these connections facilitate information exchange, monitoring, coordination, and, in certain conditions, innovation (Burt, 2005). On the other, centralization can reinforce the perspectives of brokers at the expense of others (Bodin et al., 2006; Crona & Hubacek, 2010; Bodin & Crona, 2009). As Burt (2005, p. 84), puts it, “it is brokerage beyond a group that makes for opinion leadership within the group,” particularly given that resources available for REDD+ may alter organizational strategies (Agrawal et al., 2011). Brokers, in other words, could help connect up and learn from diverse experiences but might also direct flows of resources and ideas in ways that reinforce dominant perspectives, meaning influential actors might lack the critical distance required for effective accountability.
Brokerage could generate other perverse incentives. To the extent that a broker connects up organizations operating in many different places with different endowments of resources and expertise, their influence and access to resources and information should increase correspondingly. To the extent that these brokered connections lead to longer term partnerships on the part of the organizations brought together, however, the need for brokerage – and the broker’s influence – might diminish. These factors could distort – but also highlight the need for – accountability. We identify some of the organizational types that can operate as brokers in the following section.

3.3 Background: The REDD+ Governance Architecture

In this section, we outline the key players and history of REDD+. From its origins in avoided deforestation projects, the structure of the REDD+ architecture has remained centered on organizations based in donor countries, which are becoming imbricated in the forest policies of diverse tropical forest countries through funding, implementation of pilot projects, and policy advocacy. This presents something of a paradox. On the one hand, proponents of REDD+ understand the need to integrate development and alternative livelihoods activities in conservation projects adapted to local contexts (Oestreicher & Benessaiah, 2009; Mustalahti & Bolin, 2012). On the other, organizations developing and implementing REDD+ are likely responsive to changes in funding incentives and opportunities to “have an impact” (Bosso, 2005). This may have led to decisions that perpetuate concentrated polycentricity.

We begin our analysis by outlining the key roles of different types of organizations in REDD+, before presenting a history of how these organizations have interacted to
produce the current governance architecture. While our dataset reports sub-national pilot projects, these activities necessarily interact with the development of formal policies, so we also discuss national and sub-national policy arenas. We emphasize transnational connections, but it is important to remember that domestic actors can be very active in developing both pilot projects and policies in at least some countries.

3.3.1 The Key Players

States

Because REDD+ projects are often implemented in the hope of selling credits on compliance carbon markets, proponents are ultimately reliant on state policy and the positions taken by states in UNFCCC negotiations. State actors – whether national or sub-national – have been very important in pushing REDD+ forward. Papua New Guinea and Costa Rica, for example, can take credit for placing deforestation back on the UNFCCC agenda at the Montreal Conference of Parties (COP) in 2005, following a 2001 decision to disallow avoided deforestation offsets in the Kyoto Protocol. Since that time, Germany, Japan, the United States, and, especially, Norway have been notable supporters.

In addition to traditional donors, several states in tropical forest countries have also taken on roles in REDD+ policy. Governments must draft policy plans to access funding from organizations like the World Bank, which outline key objectives for REDD+ implementation. In addition, land-use regulations in many tropical forest countries entail state involvement in permitting and planning for REDD+ projects, and states are the ultimate arbiters within their territories. States also provide funds
for domestic ventures. Skeptical of the benefits of a market-based REDD+ system, Brazil, for example, established the Amazon Fund, which provides financial support to forest conservation work in the Amazon Basin.

While national governments’ positions on REDD+ can be quite varied, governments of wealthy countries generally see avoided deforestation as a cost-effective approach to greenhouse gas mitigation (Agrawal et al., 2011), potentially leading to an emphasis on the verifiability and certainty of emission reductions over other concerns (McDermott et al., 2012), while tropical forest country governments tend to see REDD+ both as a way to engage in the climate change regime and as a potential source of income (Agrawal et al., 2011). Governments like Bolivia, however, have taken an adversarial approach to REDD+, citing concerns with the commodification of forests, a perspective echoed by many activists and even some countries, like Brazil, where REDD+ pilot projects are already prevalent.

**International organizations (IOs)**

International organizations (IOs) have served as arenas for negotiating REDD+ in parallel to the UNFCCC debates, but they are also agents in REDD+ policy themselves. The UN is naturally a key player, particularly through the UN-REDD Programme, a collaborative effort of the UNDP, UNEP, and FAO. While the actual funds disbursed are somewhat limited, UN-REDD serves as an important source of information exchange and a policy cheerleader. In addition, the World Bank, through its Forest Carbon Partnership Facility (FCPF) and Forest Investment Programme, has taken on a major role in shaping REDD+ policy in national government circles.
The FCPF offers funds for the development of national policies and institutions, contingent on drafting a series of strategies akin to the Bank’s Poverty Reduction Strategy Papers. These documents, in turn, become key elements of governments’ REDD+ strategies and objectives. Governments have also established “softer” coordination institutions such as the Voluntary REDD+ Partnership (VRP), formed during the Oslo Climate and Forest Conference in 2010 to coordinate and share information on REDD+, particularly through meetings and workshops conducted in various member countries. Sub-national governments have a similar – though smaller – collaboration mechanism, the Governors’ Climate and Forests Task Force (GCF), which has become central to the REDD+ offsetting strategy under California’s cap-and-trade market.

Agencies of IOs are in principle responsible to the state governments that make them up, but there are often opportunities for staff at international organizations to further interests in the expansion of institutional budgets and mandates (Vaubel, 2006; Vaubel et al., 2007). In addition to the slipperiness brought about by having multiple principals (that is, multiple state governments with diverging concerns) and information asymmetries, IOs are often principals themselves, contracting and managing their own projects (Gutner, 2005), and this is certainly the case with REDD+. For IOs, REDD+ presents a considerable expansion of sustainable development portfolios, which could mean increased budgets and influence. REDD+ also could present political risks, and the World Bank and UN-REDD utilize risk management tools to lower the likelihood of perverse ecological or social outcomes (McDermott et al., 2012).
Non-governmental organizations (NGOs)

While states have the ultimate say in the development of REDD+ policy and IOs join them as donors and sources of advice and technical knowledge, NGOs are key partners for information and project implementation. Local civil society organizations can be important for their cultural and political expertise and the air of legitimacy they can lend to projects; many national NGOs can be active in policy processes, though their influence is uncertain (Di Gregorio et al., 2012). NGOs also may appropriate REDD+ debates to address longstanding issues including land tenure and illegal extractive activities and McDermott et al. (2012) contend, are more likely to include considerations of social and biodiversity implications of REDD+ in their policy advocacy than governmental or IO actors. Transnational NGOs may provide access to resources and expertise, and often act as consultants in the policy development process, in some cases taking on the dominant role in policy creation (Di Gregorio et al., 2012).

NGOs are even more heterogeneous than other types of organizations, their interests difficult to specify. It is likely the case, as Agrawal et al. (2011, p. 386) suggest, that “REDD+ is becoming a central feature of the business models” of organizations like World Wide Fund for Nature, The Nature Conservancy, and Conservation International, transnational conservation organizations that can potentially garner resources and political influence brokering REDD+ pilot projects, providing policy advice, and participating in the development of private and public standards. The partners of these organizations in tropical forest countries may be seeking funding for planned projects or support for recognition of indigenous or other traditional land
claims, among other motivations. Still other NGOs (though, of course, not ones that appear in the pilot project network) are critical of REDD+ or even reject it outright due to fears of the potential implications of the commodification of carbon.

**Academic Institutions**

Due to their highly technical nature, REDD+ activities often are undertaken with the support of academic institutions. These may be local, such as the University of Palangkaraya, which has been active in REDD+ in Central Kalimantan, Indonesia, but connections may also be transnational. Faculty at Stanford University, for example, provide support for developing California’s offsetting programs with Chiapas and Acre. In these and similar arenas, academics not only have prominent voices in debates about measurement and modeling but also can serve crucial roles in helping to translate abstract objectives and technical demands into policies or pilot projects in particular places.

The interest of academics in REDD+ is quite complex. On the one hand, there are certainly activist strains in academics’ work. Several prominent remote sensing and land-use and land-cover change experts, for example, have assisted in developing standards for measurement and verification of emission reductions from pilot projects and jurisdictional policies. Others have published quite vocal critiques of REDD+, concerned with its implications for the rights of people living in and near tropical forests. Activism aside, however, there is likely some motivation on the part of academics – at least those working at research universities – to use REDD+ to get publications and boost the public image of their institution.
Firms

Firms round out the set of actors in the REDD+ network. While they are not necessarily the most central, they have become dominant numerically. Some are large operations that provide funds for voluntary projects, while others are more specialized – often start-ups – and purvey technical expertise in areas like forest carbon measurement, project development, and remote sensing, serving as conduits for information and expertise (Bouteligier, 2011).

One notable firm does not fit this general classification. McKinsey & Co. is perhaps the most well-known firm providing consulting on REDD+. Founded as a management consultancy in Chicago in 1926, the company now has 99 global offices advising two-thirds of Fortune 1000 firms (McKinsey and Company, 2012a). Several national and sub-national governments have consulted the firm while developing REDD+ plans, and in some cases, according to NGO critics, McKinsey consultants write large parts of the plans wholesale (Greenpeace International, 2011). The firm is able to act as a broker due to its large network of connections, particularly via 24,000 “alumni” who have gone on to other employment in some 120 countries (McKinsey and Company, 2012b).

The interests of firms are perhaps a little more transparent than the interests of the other organizational types. Firms providing funding often do so either as a way to gain expertise and influence in the development of emissions regulation or for corporate social responsibility reasons. For these firms, REDD+ is attractive both as a low-cost offset option and because forest protection, especially if coupled with biodiversity and social benefits, can make for good public relations. Carbon market
firms are likely more interested in direct profits from offset sales. It is clearly in these firms’ interest for REDD+ to become a fully market-based mechanism, though they may vary in the degree to which they are concerned with effects on biodiversity or livelihoods.

The Aggregation of Interests

While the interests of organizations in REDD+ are heterogeneous, there are sets of interests that are complimentary. IOs and donor governments have incentives to see REDD+ become established as a part of overall efforts to mitigate climate change so long as REDD+ clearly remains a cost-effective mitigation option. Transnational NGOs, similarly, have an incentive to support REDD+ inasmuch as it potentially provides funds for the expansion of conservation interests and influence on policy in tropical forest countries. Firms, similarly, have an interest in seeing REDD+ develop into a fully market-based system that would increase demand for their expertise and services.

These convergences of interest likely lead to cooperation between these organizational types. To the extent that interests and expertise are complimentary, these organizational types may “feed” one another, with donor governments, IOs, and other funders providing resources to transnational NGOs that can act as brokers connecting funds with particular projects and contract firms for required technical expertise. In addition, organizations engaged in many pilot projects are likely to find themselves able to influence the development of private and public standards and policies. We see how these patterns have developed historically in the following subsection.
3.3.2 Evolution of REDD+

REDD+ began as a series of avoided deforestation projects sponsored by American utility firms in the early-to-mid-1990s. Since then, the model has been taken up more broadly by certain NGOs, IOs, and states, while NGOs and some niche firms have been heavily involved in project implementation. These pilot projects, as their name suggests, are used to legitimate avoided deforestation and REDD+ as policy options, fund conservation, and increase the influence of first-mover NGOs and firms. Over time, the network power of REDD+ has attracted even former opponents, who began implementing projects to support their own conservation objectives.

The first avoided deforestation project undertaken for carbon benefits was a 1989 collaboration between Applied Energy Services (AES) of Arlington, VA, the World Resources Institute, and CARE International, to offset emissions from a new power plant (World Resources Institute, 2006). Other American utility firms quickly recognized forest carbon offsets as a way to get out in front of UNFCCC negotiations. Expectations of cost-effectiveness were a much-cited benefit of the approach (Lile et al., 1998), and in the mid-1990s several utility firms formed the UtiliTree Carbon Company, committing $2.4 million to five forest carbon pilots (PR Newswire, 1996; Kinsman et al., 1997).

Initial interest in avoided deforestation was tempered when the 2001 Conference of Parties (COP) to the UNFCCC decided to limit forest carbon projects under the Clean Development Mechanism (CDM) to afforestation and reforestation. The Climate Action Network (CAN), a loose coalition of NGOs that acts as one of the most prominent civil society voices at UNFCCC negotiations, was particularly trenchant in
its criticisms not only of avoided deforestation but forest carbon projects in general. Some members of CAN, however, lamented the absence of deforestation in the climate change agenda (Brown et al., 2002), and debate continued through the early 2000s, as think tanks and NGOs advocated reconsidering the role of forests in the climate regime (Santilli et al., 2005).

At the Montreal COP in 2005, a group of states led by Papua New Guinea and Costa Rica authored a submission arguing that a mechanism to compensate emissions reductions from avoided deforestation should be developed, introducing Reducing Emissions from Deforestation (RED) in UNFCCC negotiations. This time, CAN called for the establishment of a formal work program on the issue (Climate Action Network, 2005). It was a pivotal change of heart: many CAN members are now leading REDD+ proponents. By 2007, CAN was calling for the development of pilot projects to “build capacity and guide future UNFCCC decisions” (Climate Action Network, 2007), endorsing the actions of its first-mover members.

Convert NGOs may have been persuaded by the growing number of private governance initiatives aimed at managing forest carbon projects, many undertaken by CAN members themselves (Green, 2012). The Climate, Community, and Biodiversity Alliance (CCBA), for example, was formed in 2004 as a collaboration between The Nature Conservancy, Conservation International, and CARE International (Climate Community and Biodiversity Alliance, 2008) and develops standards for certifying project benefits for biodiversity and local livelihoods. This and other initiatives including the Verified Carbon Standard, REDD+ Social and Environmental Standards,
and CarbonFix Standard provided legitimacy and directly involved transnational conservation NGOs in the informal constitutionalization of REDD+.

At the same time, civil society groups, as well as some governments, raised concerns about perverse incentives resulting from including avoided deforestation in the UNFCCC. Responses began with the expansion of the remit of Reducing Emissions from Deforestation to include degradation (REDD), and, later, enhancement of forest carbon stocks (REDD+). There has also been more discussion within the UNFCCC and parallel fora of the challenges of implementing social and environmental safeguards and avoiding perverse incentives (Pistorius, 2012). Language on safeguards was included in an appendix to the Cancun Agreement in 2010 and reaffirmed in 2011, and the Doha COP in 2012 agreed to begin work on methodologies for assessing non-carbon benefits.

The transnational REDD+ network took on its current shape relatively rapidly following 2005, as large conservation NGOs, donor governments (especially Norway, Australia, the Netherlands, and Switzerland), and funding arms of major IOs all began to direct efforts and resources to project development. Pilot projects expanded rapidly both in numbers and areal extent (see Figure 3.2 on page 90). Conservation NGOs and development agencies, in particular, partnered with local organizations in locations where they had ongoing development or conservation interests, enrolling these partners in REDD+. In forming these interorganizational linkages, conservation NGOs and development agencies became bridges between organizations in different tropical forest countries and, at times, brokered flows of information and resources. We discuss these patterns in the following sections.
3.4 Material and Methods

We adopt a social network analysis (SNA) approach (Wasserman & Faust, 1994) to the study of interorganizational collaboration on REDD+. There is a growing interest in SNA as a way of understanding the characteristics and implications of transnational networks (Lake & Wong, 2009; Carpenter, 2010, 2011; Murdie & Davis, 2011) and environmental governance (Bodin et al., 2006; Bodin & Crona, 2009; Crona & Hubacek, 2010; Osterblom & Bodin, 2012). This literature has been particularly useful in highlighting methods for the study of informal and quasi-formal relationships that may not be captured by other techniques. We build on these studies by explicitly considering spatial patterns in our analysis.

3.4.1 Data

Our primary dataset was coded between April 2011 and June 2012 and reflects sources available during that period. In particular, our data draw on compilations of forest carbon projects collected by the Varming et al. (2010); Ecosystem Marketplace (2012); Forest Carbon Asia (2012b); Cenamo et al. (2009); and, especially, the Center for International Forestry Research’s Global Database of REDD+ and Other Forest Carbon Projects (Center for International Forestry Research, 2012). Projects were included only if they had begun on-the-ground activities other than initial research by June 2012 and involved either an avoided deforestation or a sustainable forest management component. To distinguish REDD+ activities from the establishment of protected areas more broadly, only projects referencing REDD+ or carbon reductions as a specific goal were included. Drawing upon project documents, reports, websites,
and news articles, projects were coded for organizational involvement, where involvement was defined as an organization implementing, funding, or providing technical support for a project.

There are several potential sources of error in this dataset. First, while involvement likely fluctuates over time, we presume some connection between the organizations engaged in project activities remains over the duration of the project. Second, determining start and end dates for projects was challenging, as some documentation likely did not mention preliminary research activities and the line between preliminary research and project initiation is often blurry. Third, there is likely variation between projects in the level of organizational involvement that merited mention in project documentation. Fourth, our definition of an avoided deforestation pilot project and data collection methods have led to a slightly different sample from other extant datasets, as our definition includes projects also present in developed countries. Fifth, many of the organizations we consider (the World Wide Fund for Nature, for example) might be better modeled as networks themselves. As this research is exploratory, we make the simplification of coding them as single entities because there is no obvious non-arbitrary way to make a binary decision about centralization or decentralization and because the documentation available does not always ascribe involvement to particular organizational branches. Finally, utilizing datasets produced primarily by transnational organizations may bias our findings toward larger projects.
with “North-South” connections instead of projects exhibiting “South-South” cooperation, though a truly South-South project would itself be a point of interest, meaning that sources like Ecosystem Marketplace (2012), which act as clearinghouses for REDD-related news, might be more likely to take notice.

While the large coalition of transnational NGOs and social movements mobilizing against REDD+ have affected its development, these groups by definition tend not to engage in pilot projects, so our empirical focus is on REDD+ proponents. As there is no systematic difference between the types of organizations that emerge as prominent in our contextual analyses and those studied in the project network, however, we do not think this omission significantly biases our interpretations.

Our contextual data cover activities on standards-setting, policy planning, and co-authorship of policy documents. The standards dataset records organizational representation on governing bodies producing standards relevant to REDD+. Standards were collected by searching the websites of organizations identified in Green (2011) and Peters-Stanley et al. (2012) to find those relevant for REDD+ projects and policies. We then recorded the number of times an organization sits on a standards committee. The Forest Carbon Partnership Facility dataset characterizes organizational involvement in drafting planning papers written as part of the process of obtaining funding from the FCPF, and we count the number of times an organization is consulted in drafting such papers. For the final indicator, metadata on important policy documents related to REDD+ were collected from Forest Carbon Asia (2012a). We use these data to count the number of times an organization co-sponsors a report, position paper, or other policy document with another organization.
3.4.2 Methods

The pilot project network was analyzed using normalized betweenness centrality, which provides an indicator of the degree to which organizations connect other organizations that are otherwise unconnected (Freeman, 1977). Betweenness is calculated by finding the number of shortest paths between pairs of organizations in the network that pass through each organization. In principle, the more shortest paths passing through an organization, the more different groups are connected by that organization’s activities, and the more opportunities that organization has to benefit from or influence flows of information and resources between organizations in the network.

Because we are interested in the evolution of the network over time, we need a means of comparing networks with different numbers of organizations. Freeman (1977) suggests dividing betweenness scores by the maximum score theoretically possible given the number of organizations, which occurs when only one organization is connected to all other organizations and no other organizations are connected to one another. This maximum value is a function of network size \( n \):

\[
\frac{n^2 - 3n + 2}{2} \tag{3.1}
\]

Dividing by this value yields a number scaled between zero and one that is more comparable across networks (because generally the betweenness of the most central organization increases more slowly than the number of organizations, however, the measure is imperfect).
A second challenge is that our networks are weighted – that is, the connections between organizations include a variable denoting the number of projects on which they collaborate. Opsahl et al. (2010) present an approach for calculating shortest paths in weighted networks. In our case, this approach would require calculating the reciprocal of the number of projects on which organizations collaborate and then finding the least-cost path connecting each pair of organizations. Opsahl et al. (2010) suggest accounting for both the strength of connections and the number of steps in the path in making this calculation, so we weight steps and connection strength equally.

To provide a clear representation of geographic concentration, we aggregate our network by cities, summing the connections for all organizations located in each city and calculating normalized betweenness centrality on the resulting networks. To explore the relative position of organizations of different types, we provide summaries of normalized betweenness in the form of a box and violin plot, which provides a visualization of distributional characteristics across organization types. We also calculate normalized betweenness for individual organizations over time, presenting the evolution of this value for the top 20 organizations (using the entire dataset for the calculation). Together, these measures provide a picture of a collaboration network whose spatial centralization is relatively stable over time, despite some changes in the actual organizations occupying the most central positions.

To provide context for these findings, we identify the most active organizations across all the types of activities discussed above. We select the top 20 organizations, determined by dividing the count of their activities in each dataset (including pilot projects) by the total activities reported in each dataset and then finding the mean
of this value across all activity types. We present these 20 organizations, along with their involvement across all the activities discussed.

3.5 Results

3.5.1 Pilot Projects

As avoided deforestation and sustainable forest management projects have been folded into REDD+, they also have experienced rapid growth in both numbers and spatial extent (see Figure 3.2). Of the 276 projects in the pilot projects dataset, the vast majority were created since 2005, when avoided deforestation returned to UN debates.

The expansion of project numbers implies a corresponding expansion of organizational involvement and network connections. Figure 3.3 presents snapshots of the evolution of the REDD+ project collaboration network since 2000. By 2012, the collaboration network involved over 700 organizations, so presenting it in detail is not particularly informative. Instead, we highlight the geographic concentration of REDD+ pilot project connections by presenting the normalized betweenness centrality of cities over a series of years from 2000 to 2012, where connections between organizations have been aggregated by the city in which they are located. While normalized betweenness is easier to compare across networks, the measure does not scale perfectly with changes in network size (Prell, 2012, pp. 170-171), so the comparative findings are indicative only.
There is unfortunately no clear line defining what level of centralization counts as centralized, as the distribution of centrality measures is very complex. In the case of the networks outlined here, however, the normalized betweenness centrality of Washington, DC, is remarkably high for a network with this many nodes. At approximately 0.5, it has about 50% the maximum theoretically possible betweenness centrality for networks of the sizes displayed in Figure 3.3.
Figure 3.2: Growth of avoided deforestation, sustainable forest management, and REDD+ projects represented in our dataset, 1995-June 2012, visualized in ggplot2 (Wickham, 2009) in R.
Figure 3.3: Normalized betweenness centrality (Freeman, 1977; Opsahl et al., 2010) of cities in the REDD+ pilot project collaboration network, 2000-2012. Calculated with tnet (Opsahl, 2009) and igraph (Csardi & Nepusz, 2006) in R (R Core Team, 2012). Projection: Robinson.
The prominence of some places changes with the evolution of the network. Seattle’s betweenness, for example, declines between 2000 and 2005 as new projects are created, while San Francisco’s grows as a result of the buildup to California’s cap-and-trade market. Paris and especially Geneva grow in prominence after 2005. Other places remain prominent over time. Washington, DC, in particular, emerges as an early center of avoided deforestation and sustainable forest management activity due to the activities of nonprofits like The Nature Conservancy and Winrock International, and the city remains the most prominent node in the pilot project collaboration network through 2012. Indeed, one or more of just seven Washington-based organizations (The Nature Conservancy, Conservation International, Care International, Winrock International, the Blue Moon Fund, Forest Trends, and the World Bank) are involved in about 22% of the projects in the dataset. Washington is not the only prominent site in the US, however. New York and San Francisco are also among the top 5 cities by normalized betweenness in 2012, and about 56% of projects in the dataset located outside the US involve one or more US-based organizations.

The only city located in a tropical forest country that emerges as a prominent center is Jakarta, partially a product of the fact that Indonesian law ensures a significant role for national agencies in permitting processes and partially a result of the activities of several firms and nonprofits headquartered in the city. Despite hosting a similar number of projects, this spatial pattern is not visible in Brazil, perhaps because Brazil has three world cities (Brasilia, Sao Paulo, and Rio de Janeiro), and REDD+ in the country has tended to be led by state governments (Toni, 2011).
Figure 3.4 shows the distribution of normalized betweenness centrality by organizational type, as of 2012. Immediately, we notice that very few organizations of any type have betweenness scores greater than zero. The vast majority of organizations in the dataset are connected only to one project, so projects in different places are connected by only very few groups. Only a few organizations – notably governments and NGOs – exhibit normalized betweenness centralities higher than about 0.025. International organizations look strange because there are only four in the dataset, all of which have non-zero normalized betweenness. Firms, despite their numerical dominance, are not particularly well-connected, and neither are academic institutions or funds and foundations. NGOs are the only organizational types that have moderate numbers at low non-zero values, though it is in fact a government that has the highest normalized betweenness centrality in 2012. These organizations are more clearly identified in Figure 3.5.

Figure 3.5 depicts the evolution of normalized betweenness centrality (Freeman, 1977) of the top 20 organizations by this measure as of 2012. Top organizations have changed as the network has grown, and many of the organizations with the highest centrality in 2012 were not even network members as recently as 2005. World Wide Fund for Nature (WWF), for example, is now the third most central organization in the REDD+ network, but it only started its first project in 2007.

Some of these patterns can be explained by the cooperation of donors and large transnational NGOs. 48% of the projects in our dataset undertaken by the large conservation NGOs Conservation International, Fauna & Flora International, The Nature Conservancy, World Wide Fund for Nature, and Wildlife Conservation Society,
Figure 3.4: Violin and box-and-whisker plots of the distribution of normalized betweenness centrality by organizational type (2012). Boxes show the 25th and 75th quartiles, and whiskers extend 1.5 times the difference between the 25th and 75th quartiles. Dots denote values outside the whiskers. Kernal widths are scaled such that the maximum width for each kernal is equal for all organizational types. Calculated with tnet (Opsahl, 2009) and igraph (Csardi & Nepusz, 2006) and visualized with ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 3.5: Evolution of normalized betweenness centrality of top 20 organizations by normalized betweenness in 2012, where betweenness centrality is defined by the number of shortest paths between pairs of nodes passing through a given node, normalized by dividing by the theoretical maximum. Calculated with tnet (Opsahl, 2009) and igraph (Csardi & Nepusz, 2006) and visualized with ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
for example, include the involvement of a donor country agency, the UN, World Bank, or a foundation, as compared to only 29% of other projects.

3.5.2 Contextual Data

Table 3.1 provides a sense of state, international organization, and NGO involvement in REDD+ policymaking and is a good example of the types of linkages leading to centralization in governance architectures. Organizations are ranked by their mean level of activity across all types of activities presented, where scores are normalized by the total level of activity in each dataset.
<table>
<thead>
<tr>
<th>Organization</th>
<th>Standards</th>
<th>Forest Carbon Partnership Facility</th>
<th>Projects</th>
<th>Policy Papers</th>
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<td>Winrock Int’l</td>
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<td>Forest Trends</td>
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<td>Wildlife Conservation Society</td>
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Table 3.1: Top twenty organizations by activity across multiple domains, ranked from top to bottom. Values indicate the number of standards committees at which an organizational representative has a seat (Standards), the number of times an organization is cited as being consulted as part of the process of drafting policy documents as part of the Forest Carbon Partnership Facility process (Forest Carbon Partnership Facility), the number of pilot projects an organization is involved in (Projects), and the number of times an organization co-sponsors a REDD-related policy paper with another organization (Policy Papers). Calculated in R (R Core Team, 2012).
Table 3.1 includes several types of organizations, though NGOs and governments (and particularly donor governments) figure most prominently. When multiple forms of involvement are considered, UN system organizations come out as the most active, in part due to the considerable number of policy documents co-sponsored by UN organizations. Several other groups overlap with the top 20 organizations identified in Figure 3.5. The World Bank, Conservation International, The Nature Conservancy, and Winrock International, for example, are all included. The geographic patterns noted in the case of pilot projects are still visible. Of the top 10 organizations in Table 3.1, five (the World Bank, Conservation International, The Nature Conservancy, Winrock International, and Forest Trends) are based in Washington, DC, as are the Rights and Resources Initiative, the Rainforest Alliance, and, of course, the Government of the United States.

3.6 Discussion

Examining the transnational networks of collaboration underpinning pilot projects complements the existing literature on REDD+ by beginning to investigate the “skeletal structure” connecting projects and international policy developments. This exercise not only reveals patterns of organizational interaction within the REDD+ governance architecture, but also raises important questions about inclusiveness. We began this article by arguing that centralization could occur in non-state networks and suggested we would find spatial centralization in places like Washington, D.C., which serve as sites of information exchange and can be important for accessing resources. We also contended that many kinds organizations influence REDD+, though in notably different ways. Though we find evidence of spatial centralization, some aspects of organizational roles have been a bit surprising.
The maps presented in Figure 3.1 suggest the network of organizations engaged in avoided deforestation and REDD+ pilot project development has been spatially centralized since 2000. Based on an exploratory look at several other indicators of REDD-related activities, presented in Table 3.1, it is possible that this geographical pattern applies beyond the network formed by collaboration on pilot projects.

Rather than the flatter network we would expect in a polycentric or fragmented system, we find a small number of core organizations, located primarily in the US and Europe, holding the collaboration network together (see Figure 3.5). That the most active organizations engaged in REDD+ appear to be located in just a few places suggests brokerage may be a source of influence. Organizations headquartered in key cities like Washington, Geneva, and London seem to be better equipped to build connections between funders and local groups and as a result support projects in a variety of places. By engaging in multiple projects, they also form connections amongst developing country activities.

In terms of the importance of different organizational types, we had some surprising findings. While we anticipated differences in centrality across organizational types, the level of heterogeneity is greater than expected. Figure 3.4 provides evidence that the collaboration network we treat here is held together in large part by donor governments (as well as the governments of Indonesia and Brazil), only two international organizations (the World Bank and the United Nations), and a few transnational NGOs. While, as anticipated, many firms are involved in REDD+ projects, each tends to be active in very few, a trend we find also for academic organizations. As a result, the most important brokers in the network are governments, international organizations, and transnational NGOs.
It has been suggested REDD+ could grow within a loose global institutional framework (Kanowski et al., 2011). While concentrated polycentricity might on the one hand provide opportunities for coordination and exchange in the context of institutional fragmentation (Biermann et al., 2009; J. Gupta, 2012), it also raises questions about who is positioned to do that coordinating. As we noted in our theoretical discussion, the implications of spatial centralization can be ambiguous. While spatial proximity can facilitate technical exchange, potentially supporting consensus on issues like measurement, reporting, and verification (MRV), it can also mean that intrinsically political decisions are made under the guise of technical issues (Li, 2007; Corbera, 2012; A. Gupta et al., 2012; Thompson et al., 2011) without effective engagement, reinforcing particular policy models that may not adequately reflect concerns and needs in the places where projects are to be developed and policies implemented.

National governments’ sovereignty, carefully guarded under the UNFCCC process, might check the power of transnational brokers. In many cases, however, governments adopt discourses and policy models initially developed in the centers identified in this study. As a result, transnational brokers are positioned to advise governments in translating emerging standards into national policies. Future research could benefit from developing a clearer qualitative picture of how these models are developed and translated into particular national, sub-national, and project implementations.

3.6.1 Possible Explanations

While a final explanation of these spatial patterns is beyond the scope of this dissertation, there are two candidate processes that could be tested in further research, and it is likely that a complete explanation would incorporate these and other factors. The first candidate is path-dependence. The dominance of organizations based
in Washington, DC, New York, and Geneva reflects the prominence of these cities in diplomatic and transnational NGO networks more generally (Taylor, 2004a, 2005b). Hosting several major IOs, these cities have been centers for global governance activities for some time. In addition, the prominence of Washington likely reflects continued institutional hegemony of the US government in the broader international system (Ikenberry, 2001; Buttel, 2006). On this account, the spatial concentration of REDD+ actors merely reflects broader spatial concentrations of political influence that are legacies of geopolitics.

A second explanation would be that this spatial concentration is really a form of agglomeration. On this account, REDD+ policy development activities are more likely to be undertaken in cities where local social networks already exist among organizations with sufficient resources, expertise, and motivation to engage in REDD+ policy. Like a knowledge-intensive industry, in which positive externalities emerge from social networks where knowledge can be shared, transmitted, (Gluckler, 2006; Bathelt & Gluckler, 2003) and combined with flows from more distant connections (Bathelt et al., 2004; Gertler & Levitte, 2005), one organization’s involvement in REDD+ facilitates the involvement of others within its staff’s social networks. While not subject to the same profit motives as private sector firms, the development community is increasingly subject to performance-based measures (Abdel-Kader & Wadongo, 2011; Beamon & Balcik, 2008), contracts (Cooley & Ron, 2002), competition for donor funds (Aldashev & Verdier, 2010; Nunnenkamp & Öhler, 2012; Ly & Mason, 2012), and upward accountability, simulating market pressures. Highly technical and integrative domains like REDD+, therefore, could mirror the agglomerative patterns of private sector knowledge-intensive industries. In Washington, DC,
as noted above, organizations like The Nature Conservancy, the World Resources Institute, and Winrock International, who were first movers on forest protection greenhouse gas offsets in the 1990s, served as an anchor for the formation of a strong set of interorganizational links in that city that supported the adoption of REDD+ by other Washington-based organizations like Conservation International.

### 3.7 Conclusion

Avoided deforestation and REDD+ provide an interesting case for students of environmental governance, highlighting that non-state is not necessarily synonymous with polycentric or fragmented. Somewhat ironically, given that many core actors in the REDD+ network espouse the virtues of decentralization, traditional forest management regimes, and even polycentricity, sources of funding and policy advice on REDD+ are predominantly located in just a few cities, a pattern we have called concentrated polycentricity. The implication here for proponents of decentralization of forest governance is that decentralization in terms of territorial states is logically separable from decentralization in terms of global networks. Where such actors are relevant, centralization is less about the level at which policy decisions are made within the hierarchy of nation-state bureaucracies and more about how particular organizations or actors are positioned relative to one another in networks of information, resource exchange, collaboration, and command.

Taking this perspective can be disheartening. If it is the case that governance architectures that are often touted as progressive and efficient have their own risks, we may need to take a more skeptical, even critical, view of these arrangements. Because organizations involved in the creation of policy are not necessarily directly accountable to people living in places where projects are actually implemented, and the
lines of communication from policy implementation to policy creation are stretched or indirect, concentrated polycentricity could limit the potential for deliberative participation in REDD+ and generate perverse incentives for brokers. The challenge for proponents of REDD+ – and, perhaps, other environmental governance architectures emerging from similar networks – will be to develop a clearer understanding of the incentives and structures promoting spatial centralization and finding ways to improve lines of communication and strengthen deliberation. It is necessary, in other words, to turn the informal networks underpinning policy into objects of policy concern themselves.

These issues are taken up in the following chapter, where we report the results of fieldwork undertaken in Central Kalimantan, Indonesia, as part of the Center for International Forestry Research’s Global Comparative Study on REDD. Drawing on participant observation, semi-structured interviews, and survey results, we suggest that organizations interested in developing REDD+ in the province are severely hampered in their efforts to facilitate “reaching in” to the areas where policy is to be implemented. These challenges, we suggest, interact with the global patterns of REDD+ policymaking observed here and in the previous chapter, which make it difficult to translate abstract policy ideas into actual practices in areas with relatively low governance capacity. In turn, these dynamics impede the ability of those affected by these broader discourses and political acts to engage in deliberations that have consequence of steering debates and policies in the directions desired by those affected.
Chapter 4: Reaching In: The Challenges of REDD+
Implementation in Central Kalimantan, Indonesia

In the previous chapter, we examined some of the ways in which Reducing Emissions from Deforestation and Degradation (REDD+) has “reached out” from the sites where the policy idea was developed. We concluded by speculating that spatial centralization could pose bandwidth problems, limiting translation of policies to specific places, the ability of network members to innovate and learn from successes and failures, and the capacity of those affected to participate in consequential deliberation. We develop this discussion here, responding to the questions outlined in Chapter 1 regarding how the global patterns of the REDD+ network might interact with processes in particular places and what implications these interactions might have for participation in climate change governance. In this chapter, we report on

This research is part of the policy component of CIFOR’s global comparative study on REDD (GCS), led by Dr. Maria Brockhaus. The methods applied in this study build on work undertaken in COMPON (“Comparing Climate Change Policy Networks”), led by Jeffrey Broadbent and financially supported by the National Science Foundation (NSF). Monica Di Gregorio and Maria Brockhaus adapted the COMPON research “Protocol for Policy Network Analysis” for an analysis of REDD+ policy networks. Funding for CIFOR’s research was provided by the Norwegian Agency for Development Cooperation, the Australian Agency for International Development, the UK Department for International Development, and the European Commission. Funding for myself and my research assistant, Rut Dini Prasti, was provided by the Mershon Center for Security Studies at The Ohio State University. An earlier version of this chapter is under review at CIFOR for inclusion in a planned special issue of Ecology & Society, co-authored Rut Dini Prasi, and my CIFOR advisor, Dr. Moira Moeliono, so the pronoun “we” is retained here.
the results of fieldwork undertaken in the province of Central Kalimantan, Indonesia, currently in the process of creating REDD+ policy over one of the largest extents yet attempted. We highlight the challenges faced in this process and relate these issues to the context of the global REDD+ network.

We are interested specifically in a few key questions. Most basically, we want to know if bandwidth problems emerge in the implementation process—that is, we want to know if barriers to communication and learning arise in the process of implementing REDD+ “on-the-ground.” Building on this, we ask, “Who benefits from bandwidth problems?” If bottlenecks arise, they could in principle privilege certain actors over others. If this is in fact the case, we would also like to know what are the effects of bandwidth problems and the power relations they generate for the viability of REDD+? If the concentrated polycentric structure of REDD+ generates particular kinds of power relations, we would like to know how these relationships are likely to affect REDD+ policy (Di Gregorio et al., 2012).

Research on socioecological systems emphasizes the importance of cross-scale feedbacks amongst a variety of nested human and natural systems (Holling, 2001; Holling et al., 2002). Complex interactions between bottom-up innovations and top-down controls, these writers contend, structure systemic evolution. Management across these heterogeneous scales, while imperative, is challenging Cash et al. (2006). Informational bottlenecks, transaction costs, and power asymmetries can be significant barriers to effective learning and collaboration across different spatial scales and governmental levels, as organizations and other actors often must devote considerable resources to the maintenance and management of relationships bridging governance scales (Adger et al., 2005).
Social network analysis is a useful way to explicate the formal and informal relations between actors or organizations that underpin environmental governance, policymaking, natural resource management, and social learning (Crona & Hubacek, 2010; Bodin et al., 2006; Bodin & Crona, 2009; Bodin et al., 2011). The “relational perspective” advocated by writers like Bodin et al. (2011) can provide analytic traction in the study of politics of learning, policy adaptation, and deliberation across scales and levels. Ernstson et al. (2010), for example, draw on social network concepts in their analysis of cross-scale governance to develop the concept of “scale-crossing brokers.” Scale-crossing brokers are a type of “bridging organization” (Olsson et al., 2004; Hahn et al., 2006; Olsson et al., 2007) that connect local organizations to networks operating at different governmental levels concerned with the management of different spatial scales, providing a special case of the brokers discussed in Chapter 3. While scale-crossing brokers can establish “bridges” between relatively unconnected sectors of networks, their structural position can also provide brokers and highly central nodes influence in their relationships with other network members (Bodin & Crona, 2009; Crona & Hubacek, 2010).

In this chapter, we address the challenges of constructing cross-scale brokerage in areas with low governance capacity. Empirically and theoretically, we contribute to the literature on networks in natural resource management by studying the process of building cross-scale brokerage relationships. We also introduce a methodological innovation by combining a qualitative case study with exponential random graph models (ERGMs) (Cranmer & Desmarais, 2011) to begin developing an account of some of the processes that lead to particular structures within networks engaged in the governance of natural resources. Cross-scale brokerage does not emerge – it must
be built, and this process can be difficult in areas with poor transportation, communication, and governance infrastructure, in addition to perverse incentives generated by power relations within broader transnational networks.

We examine the construction of scale-crossing brokerage using a case study of the politics of REDD+ policy development in Central Kalimantan, Indonesia. In December 2010, Central Kalimantan, on the island of Borneo, was selected as a “pilot province” under a $1 billion REDD+ agreement between the governments of Indonesia and Norway to promote tropical forest conservation. Since that time, the provincial government, local and national NGOs, and a set of donor agencies and international organizations have been engaged in an effort to produce a province-wide strategy for REDD+ (STRADA). A key component of this effort has been developing the institutional infrastructure and information assimilation capabilities to govern REDD+ at the provincial scale.

We begin with a review of work on forests and conservation in Indonesia and Central Kalimantan in particular. We then start our analysis with a qualitative discussion of the development of REDD+ policy in the province, highlighting the mixed results of the provincial government’s efforts to establish a scale-crossing institution for REDD+ governance. We argue that path dependence of extant development projects, the geographical unevenness of the causes of deforestation in the province, and infrastructural limitations have all contributed to the challenges the provincial government has faced in producing cross-scale brokerage. Using betweenness central-ity (Freeman, 1978) and exponential random graph modeling (Cranmer & Desmarais, 2011), we find that cooperation is based primarily upon organizational agreement on REDD+ and the organization’s scale of operation (provincial, national, or international). We also find that organizations active in multiple districts tend to be less
likely to cooperate with other organizations on REDD+ issues. The tendency of actors to cluster by scale of operation and not activity in common areas, we argue, compounds the problem of effective cross-scale participation, such that brokerage fails to promote inclusive deliberation.

4.1 Complexity and the Need for Cross-Scale Participation

Deforestation is certainly not a new problem in Indonesia. Forestry licenses were central to Soeharto’s efforts to build a network of supporters, and in the 1960s and 1970s his regime centralized authority in the national Ministry of Forestry (MoF), rolling back traditional (adat) land rights in order to exploit forests for political patronage (Ross, 2001, ch. 7). Official statistics – which almost certainly underestimate volumes – suggest the three provinces of Indonesian Borneo produced almost 1 million cubic meters of timber in 1968 and over 17 million in 1979 (Brookfield & Byron, 1990).

The beginning of the democratic period in 1998 and subsequent decentralization policies did not stop forest loss. By the early 2000s, central government authority had been reformulated to primarily encompass oversight and standard-setting, while provinces gained planning authority and the districts and municipalities – the big winners – took over lucrative licensing processes (Sudradjat & Yustina, 2002). Districts were thought to be too small for centrifugal forces of decentralization to get out of hand. Instead, decentralization would “foster competition between districts and provinces” (McCarthy, 2004, p. 1203). The ambiguities and uncertainty resulting from decentralization allowed district governments to draft forest laws that contradicted regulations established by the MoF (McCarthy, 2004). In Central Kalimantan, district governments sought increased revenues from control over forest use permits and
taxes on extractive activities considered illegal under MoF regulations (McCarthy, 2001a,b).

Villages also gained more control over forests through decentralization. While brokers, timber and plantation firms, and government officials certainly had strong bargaining positions vis-a-vis village heads, village elites could negotiate lucrative accommodations with these interests (Mccarthy, 2002). Though there is evidence of increased rent-seeking at the village level as a result of decentralization, decentralization also is associated with more revenues being directed toward local residents and an increased sense of empowerment over forest lands (Palmer & Engel, 2007), and villages sometimes collaborate to strengthen their hand in negotiations (Palmer, 2007). Should firms fail to abide by agreements, villagers may resort to confiscation of equipment (Palmer, 2007), protests, land occupations, and violence, sometimes in the face of police action (Mccarthy, 2004; McCarthy, 2007). Of course, staking these claims in the first place is difficult in the face of conflicting or non-existent records of village territories and a legal system not well equipped for recognizing traditional adat land claims (McCarthy, 2007).

Of course, what counts at adat and, perhaps more importantly, who can claim adat rights is unclear and often racialized. As Li (2001a) notes, the idea of indigeneity is not straightforward, and the masyarakat adat movement, often glossed as a movement of Indonesia’s indigenous peoples, is engaged in an ongoing project of contestation and consolidation of identities within hegemonic understandings of autonomous communities, living in “harmony” with nature, despite their intimate connection with broader economic and political networks (Li, 2001b). As a consequence, “indigenous” people are assigned a subject position as non-farmers who should hold property collectively and not be engaged in broader capitalist networks (Li, 2002, 2010).
Though constructed, these identities and subject positions can have deadly political consequences. The Dayak identity claimed by many people in Central Kalimantan, for example, was reinforced through colonial policies as part of a racialized system of legal pluralism and indirect rule (Peluso, 2009). Despite a long history of familial connections across Dayak and non-Dayak lines, ethnic identities were hardened in the mid-to-late 1990s, with extreme violence breaking out in West Kalimantan between Dayak and Madurese groups (Peluso, 2008). During decentralization, violence also erupted in Central Kalimantan, partially a result of conflict amongst district officials over emerging opportunities for revenues from resource extraction, resulting in the eviction of over 100,000 Madurese (Peluso, 2007).

The complexity and fluidity of forest politics in Indonesia, coupled with the potential for racialized conflict, has significant implications for REDD+. As Engel & Palmer (2008) point out, the weak bargaining and enforcement power of communities might render them unable to ensure forest protection under a payment for ecosystem services (PES) scheme, and the potential income from such a scheme might just be used to increase bargaining power in negotiations with timber or plantation firms. People living near project areas often report interest in forest protection only if that means livelihood improvements, and many households in these areas derive little or no income from forest use (Resosudarmo et al., 2013). REDD+ projects in Central Kalimantan have also been claimed to lead to social conflict, as communities become divided over whether to support or oppose project activities (Berita Satu, 2011).

These complexities put a premium on inclusive and consequential deliberation. Local residents often desire to make use of lands designated for conservation (Harada, 2003) and their participation and day-to-day interactions with staff are crucial to
successful conservation (Kubo, 2010; Wadley et al., 2010). Conservation efforts in Indonesia, however, have often reflected “fortress” approaches, sometimes even leading to violent deaths (Elliot et al., 2001; Li, 2007; Peluso, 2007; Erb, 2012).

As Li (2007) argues, transnational conservation efforts often involve “rendering technical.” That is, they must simplify complex social relationships and fields of force to a more orderly understanding with which to link project plans to projected ends. Even in projects understood to be participatory, this may often mean glossing social relationships as bounded communities understood to be social actors in themselves who can contract to engage in conservation. This can erase traditional land claims and limit the scope and means of participation.

REDD+ projects may not yet have broken with these top-down forms of conservation. The Kalimantan Forest Carbon Partnership (KFCP), begun in Central Kalimantan in 2007 and funded to the tune of $47 million by AusAID (Olbrei & Howes, 2012), for example, has been charged with inadequate consultation of residents and poor consideration of local livelihood practices (Pearse & Dehm, 2011; Forest Peoples Programme et al., 2011). Indeed, household surveys in the project area in 2010 found that only 23% of respondents were even aware of the project’s existence (Resosudarmo et al., 2012).

Because REDD+ is “multi-level governance in-the-making,” (Skutsch & Van Laake, 2008) effective deliberation must necessarily be cross-scale deliberation. In order to overcome the failures and violence of previous conservation interventions, REDD+ proponents must solve a very challenging participation problem – and should be prepared for the people living in the places where interventions are envisioned to be able to contest plans and objectives. In the rest of this paper, we consider the challenges of creating such a system in Central Kalimantan.
4.2 Bridging Scales in Central Kalimantan

4.2.1 The Global Comparative Study on REDD Policy Network Survey

The research presented here is part of CIFOR’s Global Comparative Study on REDD and included participant observation alongside a semi-structured interview and survey of representatives of organizations with an interest in REDD+ policy development in Central Kalimantan. Our data were collected at the level of the organization, usually via an interview with a designated organizational representative, though in some cases we interviewed multiple organization members simultaneously upon their request.\(^{15}\) From an initial list of approximately 100 organizations, 40 were selected in consultation with a panel of four experts heavily involved in REDD+ in Central Kalimantan as being active in provincial policy discussions. Of these, 36 provided interviews and answered survey questions, a response rate of 90%. Interviews were approximately 2 hours in length, with the exception of organizations previously interviewed for the national policy network study in Indonesia, which provided an abbreviated interview of 30 minutes to 1 hour, focusing on network items.

Interviews consisted of three main components. First was a set of open-ended questions regarding the process of REDD+ policymaking in Central Kalimantan, highlighting issues like consultation, the development of the province’s REDD+ Strategy, and general organizational perspectives on REDD+. The second component was a battery of Likert-scale questions measuring organizational perspectives on REDD+ policy (35 items) and activities related to REDD+ (33 items). The third component

\(^{15}\)Of course, the internal politics of organizations are themselves complex, and organizational boundaries are quite porous. Because REDD+ is such a politically contested concept, however, it is best in the interest of protecting our respondents to study relationships between organizations.
was a series of eight questions eliciting organizations’ relationships with other organizations. Organizational representatives were given a list of all organizations involved in either the provincial or the national REDD+ policy network study and asked to nominate those organizations in the list with which their organization was involved in a series of relationships, including information-sharing, provision of resources, disagreement, and direct collaboration. In addition, organizations were asked to nominate those organizations whom they believed to be influential on REDD+ policy in the province.

Despite the structured nature of the survey, the interviewees often responded to numerical questions by explaining organizational positions, activities, or thoughts related to REDD+ in the province before providing a final response. These discussions were recorded along with the semi-structured portion of the interview and provided invaluable information adding nuance to our understanding of the meaning of the numerical and network items. These responses, in addition to information from the semi-structured interviews, participant observation, and review of policy documents, frame our discussion of REDD+ in the following sub-section.

Data on organizational activities at the district level were collected by archival searches of organizations’ websites, newspapers, and local blogs. Organizations were coded as having presence in a district if there were found to have undertaken projects or extensive research in that area or had a local office or other administrative body in the district (with the exception of the city of Palangkaraya, where most provincial organizations are headquartered and only project-based activities were coded).
4.2.2 Building REDD+ in Central Kalimantan

Central Kalimantan was catapulted onto the international stage in late December 2010, when Indonesian President Susilio Bambang Yadhoyono announced the province would be the first pilot in a $1 billion deal with the Government of Norway to promote REDD+ policy (Butler, 2010). Deforestation has been a significant problem in the area. The province’s forests were a major source of timber for Soeharto’s forestry-concession-based patronage system, undermining the livelihoods of forest-dwelling communities. (Ross, 2001; Brookfield & Byron, 1990; Bruenig, 1987; McCarthy, 2001a). When the patronage system waned, food production became a political concern, and, in 1995, the government mobilized the conversion of an immense 1.4 million hectares of peatland in Central Kalimantan to rice production under the
Mega Rice Project (MRP). Canals were constructed to drain the peat but caused overdrainage. The peat dried, leading to vegetative degradation and increased fire risk (Sabiham, 2004; Jaya & Inoue, 2010). Rice production never became a meaningful component of local livelihoods, and after Soeharto the area was dubbed a “mega disaster” (Suyanto et al., 2009, p. ii). Things did not improve significantly after democratization, and between 2000 and 2009 Central Kalimantan accounted for approximately 13% of deforestation in Indonesia as a whole (Sumargo et al., 2009, p. 56).

In 2009, prior to its selection as a pilot province, the government of Central Kalimantan contracted the management consultancy McKinsey to support drafting the provincial Green Government Policy. A key problem, the document noted, was the lack of a central institution to organize REDD+ activities (Dewan Nasional Perubahan Iklim & Government of Central Kalimantan, 2010). This role has been taken up by an ad hoc Provincial Committee on REDD+ (KOMDA) and its executive office, the Cooperative REDD+ Secretariat (Sekber). KOMDA, composed primarily of heads of provincial agencies and headed by the Governor and Secretary of State, began building policy around the development of the Provincial REDD+ Strategy (STRADA), intended to establish clear guidelines for REDD+. Producing the document was challenging. While in July 2011 a member of KOMDA’s Team of Experts, a group composed primarily of academics from the University of Palangkaraya (Unpar) and tasked with providing technical support for drafting the Strategy, announced it would be completed in two months (Kementerian Kehutanan Republik Indonesia, 2011), it was only on 10 May 2012 that the document was finalized (Narang, 2012).
Confusion about the respective roles of the provincial and national governments accounted for some of the delay, but the informational and creative challenges involved in translating abstract REDD+ policy models to provincial circumstances were severe, as were the challenges of developing a picture of REDD-related activities in the districts, where several large pilot projects were planned or ongoing. Several respondents pointed out that despite nearly constant meetings and discussion, useful information was difficult to come by. As REDD+ expanded to include more traditional development concerns, including land tenure, scientific measurement, and sociology, actionable knowledge was imperative, but the information and advice available was generally too abstract. One government official was quite direct in expressing his exasperation: “[REDD+] causes headaches. There’s a lot that’s confusing. Yeah, very unclear. If we can note here: very unclear.”

The highly technical nature of discussions privileged certain groups that were more well-connected to networks beyond the province. A group of academics at Unpar, for example, were particularly important in drafting STRADA, while the key NGO representative on the writing team had both strong ties to the provincial government and was the head of the local office of a major international conservation NGO. Membership on the writing team conferred considerable power in directing REDD+, but many respondents reported a lack of knowledge about the status of the draft as it developed.

Not only were the technical challenges of REDD+ policy itself severe, they were compounded by the difficulty of bridging the policy discussion in Palangkaraya with the areas likely to be affected. One respondent noted that discussions in the provincial capital failed to capture the challenges of on-the-ground implementation: “[REDD+] is very clean and clear when discussed in the province level, in the national level,
in a seminar [...]. It’s not enough.” Several respondents noted that, at the time of research, knowledge about REDD+ was limited to a relatively small number of people, mostly in the provincial capital, and communication with people living in villages in forested areas would be difficult. Indeed, even district governments – with the notable exception of Kapuas district, home to the Kalimantan Forest Carbon Partnership (KFCP), and Katingan district, home to the Katingan Peat Restoration Project – were generally unfamiliar with REDD+. Even those districts hosting prominent projects, however, had little involvement in discussions in the provincial capital at the time of fieldwork.

In part, this situation reflects the absolute and relative geography of REDD+ outreach activities underway in the province at the time of the research. While there
were numerous seminars, workshops, and fora regarding REDD+ in Palangkaraya, there were fewer activities in the areas that would actually be affected by policy. One official noted, “There are 100 meetings at a hotel [for every] 10 meetings in the village.” This is in no small part a result of the challenges and expenses involved in transportation within the province. Travel from Palangkaraya to the capital of the heavily forested Murung Raya district, for example, could take around twelve hours by road – and travel outside the district capital is even slower. Driving to the capital of the more proximal Kapuas district takes three or four hours, while a flight to Jakarta is only about two. The problem is a reciprocal one, as accessing Palangkaraya is also difficult, meaning most meetings held in the capital are attended primarily by officials and civil society members based either there or in Jakarta. In addition, NGOs and offices of international organizations – generally based in either Palangkaraya or Jakarta – face resource constraints leading them to focus their activities in particular areas, specifically peatlands, where potential carbon emissions (and, potentially, donor or carbon market funds) are higher (see Figure 4.3).

Provincial officials encountered their own difficulties in acquiring information on activities ongoing in the districts. A few months after the designation as a pilot province, KOMDA convened a meeting of local NGOs (and local offices of national or international NGOs) to stress the need for coordination and legal registration and licensing of REDD+ activities going forward, citing a need for “synchronization, harmonization, and synergy” (Sekretariat Bersama REDD+ Kalimantan Tengah, 2011). One person described this meeting: “They called us into the office some time ago and they said [. . . ] – I mean all the NGOs - you have to now tell us what your involvement in REDD is. Because you’re all out there, and we don’t know what you’re doing.” At meetings attended during our fieldwork, government officials would frequently express
concern that the activities of project developers were inadequately reported, continuing to stress the need for coordination. As one observer put it, “[The provincial government] felt like they were in the dark about REDD. […] They were sort of on the fringes.” While necessary as part of a strategy to develop a coordinated approach to REDD+, the provincial government also requires information to establish itself as the clear broker for discussions with representatives from Jakarta and abroad.

At the time of the fieldwork, however, there was little motivation to devote substantial efforts to outreach. Over the long drafting process for the provincial strategy the focus of the organizations involved in the drafting process was more on figuring out how to translate technical and political models from Jakarta and abroad into actual implementation than engaging stakeholders. As a result, it was external, rather than internal, connections that seemed to be the most important.

The concerns have continued throughout the policy development period. In one draft of STRADA, for example, international actors were reminded to be aware of Indonesian law regulating their activities “so that international partners do not forget their role and responsibility to government and local people.” To promote this outcome, STRADA establishes KOMDA as the clear center for REDD+ policy in the province and requires organizations engaged in REDD-related activities to submit reports on their projects to the Committee for approval.

STRADA continues a historical focus on forest fires in drying peatlands as a target for REDD+ intervention, despite acknowledging and taking some steps to address the challenge of palm oil and mining. In spatial terms, the focus of provincial REDD+ activities is placed on the peatland areas of Barito Selatan, Kapuas, and Kotawaringin Timur districts (Zuhri, 2012), though the provincial government has implemented a
temporary moratorium on and audit of mining and plantation permits in wider areas of the province (Sriyanti, 2012; Media Indonesia, 2012).

While peatlands certainly have very high potential emissions, this focus also reflects a concentration of the activities of organizations involved in the provincial REDD+ policy network in these areas, as seen in Figure 4.3. Organizations with close ties (as defined in the following section) to KOMDA tend to be most active in the districts surrounding the capital city of Palangkaraya, where the bulk of the province’s peatlands are found.

While organizations active in REDD+ tend to concentrate activities near the capital, threats to forests are more spatially distributed. Katingan district, with the largest timber harvests in 2011, and Sukamara, with the most area affected by coal exploration (Badan Pusat Statistik Provinsi Kalimantan Tengah, 2012), are excluded from the provincial moratorium, as are several districts with relatively high timber harvest and plantation activities. Organizational activities do not necessarily overlap with zones with the highest forest threats (nor, it is important to note, are organizational activities at all evenly distributed within districts).

The need to integrate policy across the entire province is significant. Different areas suffer from different deforestation drivers and have differing levels of proxy representation in the REDD+ network centered on Palangkaraya. The tendency of both legal and illicit forms of forest destruction to shift across the province (Muhamad, 2001; Boehm & Siegert, 2001) implies an integrated approach is necessary to prevent leakage. The first map in Figure 4.3 suggests the policy network in Palangkaraya does not cover all districts of Central Kalimantan evenly, and, as we will see in the next section, integration even within this group has been hard to achieve.
Figure 4.3: Unevenness of REDD+ and deforestation activities in Central Kalimantan. Maps show organizations that collaborate with KOMDA (see Section 4.3.1) with activities in each district, presented as a percentage of total connections between these organizations and all districts, timber extraction ($m^2/km^2$) by district, and the percentage of each district permitted for coal and palm oil production in 2011. Dark gray districts are affected by the governor’s moratoria. Organization data were collected from web searches. Moratorium areas are reported in Sriyanti (2012); Media Indonesia (2012). Statistical data are sourced from Badan Pusat Statistik Provinsi Kalimantan Tengah (2012).
4.3 Exploring the REDD+ Network in Central Kalimantan

4.3.1 Data and Variables

We triangulate our interview findings with an analysis of the network of organizational collaboration on REDD+ in the province. Our outcome observation is a network of relationships constructed by coding an edge between organizations when both reported some form of positive relationship, though these relationships needed not be the same. For example, if a local NGO reports receiving funds from a donor organization, while the donor organization reports sharing information with the NGO, this is coded as an edge, even if the donor organization does not report funding the local NGO.\(^{16}\)

Figure 4.4 presents the network in Central Kalimantan, where organizations are scaled by betweenness centrality (Freeman, 1978), defined by a count of the number of shortest paths between all pairs of nodes in the network incident on a given node. The challenges discussed above notwithstanding, KOMDA (the node with the highest betweenness) has clearly emerged as the central organization in REDD+ in the province. This central organ of the provincial government has connections to almost all network members and is clearly the most important broker for REDD+ policy.

\(^{16}\)Computations for the statistical portion of these analyses were done utilizing the Statnet (Handcock et al., 2003), and ergm (Hunter et al., 2008) packages in R (R Core Team, 2012). Visualizations, calculations of centrality measures, and modularity clustering were produced using NetDraw 2.123 (Borgatti, 2002).
Figure 4.4: Network of cooperation on REDD+ in Central Kalimantan. Node size is scaled by betweenness centrality (Freeman, 1978). Labels indicate organizations’ primary spheres of operation, Central Kalimantan (K), Jakarta (J), or abroad (A). Network visualized in NetDraw (Borgatti, 2002).
There also seems to be clustering by operational scale, particularly among organizations based in the province versus those based in Jakarta and abroad. This pattern, tested statistically in the following section, is consistent with our qualitative findings, with organizations based outside the province preferentially working with one another or with a few key players on the team drafting the Provincial Strategy.

In addition to the observed network presented here and a set of network statistics discussed below, we utilize four other key variables to specify our models. First, as a measure of the opinion distance between organizations, we utilize organizational responses on 35 opinion items, measured using a 1 through 5 Likert scale from “strongly disagree” to “strongly agree,” consisting of statements on a range of issues related to REDD+ policy. We calculate the Euclidean distance between every pair of organizations, which is entered as a relational variable in the model (Opinion Distance). To test for the effects of involvement in similar geographic regions, we include a dyadic variable that is a count of the number of districts in which both organizations are active, as defined above (Geographic Specialization). We also include a control version of this variable, which is simply the total number of districts within which an organization has activities (Geographic Extent). In addition to these variables, we code organizations according to whether they are headquartered in Central Kalimantan, in the Jakarta metropolitan area, or abroad, adding a variable to capture links occurring between organizations operating across similar extents (Place Homophily) and control for the effects of institutional power by recording the number of representatives of an organization on the Provincial REDD+ Committee (Committee) and on the Team tasked with drafting the Provincial Strategy (Writers). As further controls, we code a binary variable denoting organizations other than provincial government organizations (Not Government), which we interact with Geographic Extent in one
of our models to control for differences in the implications of operations in different districts in the province for the provincial government versus other actors. We also include a covariate measuring the number of times an organization was cited by other organizations as being influential on REDD+ policy in the province (Influence). Finally, we include three network statistics discussed in the following section.

4.3.2 ERGM Estimation

Overview of ERGMs

Because edges in a network are often not formed independently, traditional tools like logistic regression, which assume independence of observations, are generally not applicable (Cranmer & Desmarais, 2011). ERGMs avoid this problem by taking the observed network as a single observation from a distribution of all possible networks consisting of the same number of nodes (Robins et al., 2007). They are designed to model local social processes generating the observed network by testing for a greater than random presence of network structures that would result from those processes (Robins et al., 2007, p. 179).

The core equation of an ERGM gives the probability of drawing the observed network from a distribution of networks with the same number of nodes (Robins et al., 2007):

\[ Pr(Y = y) = \frac{1}{k} \exp(\sum \eta_A g_A(y)) \]  \hspace{1cm} (4.1)

Where we sum over a set of graph configurations \( A \) arising from the hypothesized local social processes, \( \eta \) is the parameter corresponding to \( A \), and \( g_A(y) = \prod_{y_{ij} \in A} y_{ij} \) is a network statistic that is 1 if \( A \) is observed in network \( y \) and 0 if not.
Because ERGMs take the network as a single observation, ERGM terms have a somewhat novel logic. Coefficients are based on network statistics, which measure structural properties of the observed network and are compared to the distribution of networks with the same number of nodes. Estimated coefficients in an ERGM are more readily intelligible in a specification of the model suggested by Hunter et al. (2008), based on change statistics – the change in the conditional log-odds of observing a given edge in the network with each unit increase in a given network statistic resulting from the presence of an edge, holding the rest of the network constant. Hunter et al. (2008) define the change statistics vector with the equation:

$$\delta_g(y_{ij}) = g(y_{ij}^+) - g(y_{ij}^-)$$  (4.2)

Where the $y$ terms are the networks that result when an edge between nodes $i$ and $j$ is present or absent, respectively, and $g$ is a network statistic calculated on $y$. $\delta_g(y)_{ij}$ is the change in the statistic should an edge be created between $i$ and $j$, holding the rest of the network constant.

We can express the distribution of networks in terms of the vector of change statistics:

$$\text{logit}[P_{\theta y}(Y_{ij} = 1|Y^c_{ij} = y^c_{ij})] = \theta^T \delta_g(y)_{ij}$$  (4.3)

Where $\theta$ is the vector of parameters and $Y^c$ is the remainder of the network, held constant in each change of $Y_{ij}$, the edge between nodes $i$ and $j$, from absence (0) to presence (1) (Hunter et al., 2008). That is, a positive conditional log-odds coefficient on a given network statistic means that our chances of observing the network
(specifically, of observing an edge between nodes $i$ and $j$) increase with the amount an edge’s presence increases that statistic.

ERGMs are ideally estimated by maximum likelihood (MLE) (Robins et al., 2007), but MLE is often intractable even at relatively small network sizes. This has led proponents of ERGMs to adopt Markov-Chain Monte Carlo (MCMC) MLE, which produces a simulated distribution of networks from a set of parameter values that are iteratively adjusted by comparing the distribution to the observed network and generating new parameters until the log-likelihood of the model is maximized (Robins et al., 2007).

There are several ways of testing the goodness of fit of an ERGM model, but one of the most straightforward is to use the model to simulate a distribution of random networks and compare various measures of the observed network to the distribution of these measures in the simulated networks. A good model should differ from the mean of these measured values with a relatively low probability (that is, the p-value for difference from the mean should be high) (Robins et al., 2007).

**ERGM Terms**

Because ERGMs are designed to address dependencies amongst edges, it is common to explicitly include statistics measuring the occurrences of specific relational patterns. We present a summary of the terms used in our model in Table 4.1. First, we include a variable to account for the residual propensity of edges to form (Edges). On its own, this term predicts edges form with equal probability (Goodreau et al., 2008). Similar to an intercept term in a regression, Edges helps capture unexplained variance in edge-formation.
<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
<th>Process Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic Specialization</td>
<td>Co-presence in a district</td>
<td>Partnership resulting from common geographical focus.</td>
</tr>
<tr>
<td>Geographic Extent</td>
<td>Count of districts where organization operates</td>
<td>Cross-scale brokerage</td>
</tr>
<tr>
<td>Opinion Distance</td>
<td>Euclidean distance between opinion item responses</td>
<td>Cooperation based on similarity</td>
</tr>
<tr>
<td>Influence</td>
<td>Respondents citing organization as influential</td>
<td>Organizational prominence and attractiveness</td>
</tr>
<tr>
<td>Place Homophily</td>
<td>Organizations operating on similar extents (e.g. international)</td>
<td>Cooperation based on similarity</td>
</tr>
<tr>
<td>Committee</td>
<td>Representatives on REDD+ Committee</td>
<td>Institutional power</td>
</tr>
<tr>
<td>Writers</td>
<td>Representatives in group writing REDD+ Strategy</td>
<td>Institutional power</td>
</tr>
<tr>
<td>Not Government</td>
<td>Organizations other than provincial government</td>
<td>Control</td>
</tr>
<tr>
<td>Dyadwise Shared Partner</td>
<td>Dyads with exactly one shared partner</td>
<td>Unexplained popularity</td>
</tr>
<tr>
<td>Edgewise Shared Partner</td>
<td>Edge pairs with exactly one shared partner</td>
<td>“Friend of a friend is a friend”</td>
</tr>
<tr>
<td>Edges</td>
<td>Total edges</td>
<td>Residual propensity of nodes to form edges</td>
</tr>
</tbody>
</table>

Table 4.1: Explanation of ERGM terms used in the model estimation.

Based on the network graph presented in Figure 4.4, we would expect a high level of centralization and – as there seem to be several complete triangles in the network, a tendency for friends of friends to be friends. We include two additional network variables to test these structures.

First, we add a statistic that counts the number of times any dyads, whether connected or not, have exactly one shared partner (Dyadwise Shared Partner) (Morris et al., 2008). This term provides a control for unexplained popularity of a few nodes. Second, we include a statistic that counts the number of times edges are linked to a common partner (Edgewise Shared Partner), which allows us to control for friend-of-a-friend dynamics (Goodreau et al., 2009).
The role of exogenous covariates in ERGMs is slightly different from the way variables work in standard regression models. In testing for the propensity of organizations headquartered in similar places to form edges (Place Homophily), for example, we add a network statistic that counts the number of times organizations that share values of these categorical variables share an edge. In our model, we assume that the propensity to form relationships within locales is constant across the different groups (Robins et al., 2007; Morris et al., 2008). Two other relational covariates included in the model (Opinion Distance and Geographic Specialization) are estimated somewhat differently. The network statistics for these variables are calculated by summing the values corresponding to each dyad in the network for which an edge is present.

We also include a node-level covariate. Influence is a network statistic measuring the sum of influence scores for the two nodes on either end of every edge in the network. In other words, the more edges present between nodes with high influence scores, the higher the estimated effect of this term (Morris et al., 2008).

4.3.3 Results and Discussion

We present the results of our MCMCMLE estimation of the ERGMs in Table 4.2 on page 131. We estimate three initial models, beginning with a model including all variables and then a series of models removing variables that do not appear to be statistically significant. In each case, the Bayesian information criterion improves upon removal. Model fit, tested in Table 4.3, is good, and in only a few cases is the observed network significantly different from networks simulated from the model. The most parsimonious models seem to be best in terms of its Bayesian Information Criterion, and do not suffer systematically in goodness-of-fit compared to the more complex models.
Perhaps the most puzzling finding is the statistically significant negative relationship between cooperation and organizational involvement in the same districts. One possible explanation would be that organizations with a more limited geographic scope (and, hence, forming dyads with low levels of Geographic Specialization) are more likely to cooperate than organizations with a greater geographic scope. To test if this is case, we estimate an additional model (Model 4) replacing the dyadic variable with a count of the number of districts in which an organization has activities. Because these models are not nested, they cannot be directly compared via Bayesian information criteria, but the model with the individual count variable rather than the dyadic variable still performs well in goodness-of-fit tests, and can be interpreted in a more straightforward manner, so we focus on it in our discussion here.

Model 4 highlights a series of further challenges the provincial government faces in building a scale-crossing institution and developing an inclusive network engaged in REDD+ policy. Variations in Influence, Opinion Distance, and Geographic Extent variables account for significant variation in the probability of observing a connection between two organizations.

Several variables indicate expected bottlenecks in cross-scale communication. Not Government*Geographic Extent retains the negative relationships with cooperation found for Geographic Specialization. This suggests organizations outside the provincial government that are engaged in activities in multiple areas are less likely to be central members of the network, suggesting organizations that could potentially link diverse areas are not prominent in the network in Palangkaraya. There is preferential cooperation among organizations based in the province, those based in Jakarta,
<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (SE)</th>
<th>Model 2 (SE)</th>
<th>Model 3 (SE)</th>
<th>Model 4 (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place</td>
<td>0.946***</td>
<td>0.939***</td>
<td>0.946**</td>
<td>1.042***</td>
</tr>
<tr>
<td>Homophily</td>
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<td>(0.304)</td>
<td>(0.306)</td>
<td>(0.307)</td>
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<td>0.142***</td>
<td>0.145***</td>
<td>0.158***</td>
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<td></td>
<td>(0.022)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Committee</td>
<td>0.142</td>
<td>0.171</td>
<td>0.177</td>
<td>0.163</td>
</tr>
<tr>
<td></td>
<td>(0.107)</td>
<td>(0.104)</td>
<td>(0.103)</td>
<td>(0.100)</td>
</tr>
<tr>
<td>Writers</td>
<td>-0.306</td>
<td>-0.304−</td>
<td>-0.310−</td>
<td>-0.393*</td>
</tr>
<tr>
<td></td>
<td>(0.159)</td>
<td>(0.159)</td>
<td>(0.160)</td>
<td>(0.171)</td>
</tr>
<tr>
<td>Opinion Distance</td>
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<td>-0.423***</td>
<td>-0.429**</td>
<td>-0.510***</td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td>(0.121)</td>
<td>(0.121)</td>
<td>(0.124)</td>
</tr>
<tr>
<td>Geographic Specialization</td>
<td>-0.417−</td>
<td>-0.412−</td>
<td>-0.416−</td>
<td>-0.416−</td>
</tr>
<tr>
<td></td>
<td>(0.230)</td>
<td>(0.228)</td>
<td>(0.230)</td>
<td>(0.217)</td>
</tr>
<tr>
<td>Geographic Extent</td>
<td>116*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.047)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Government</td>
<td>1.358*</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.565)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Not Government*</td>
<td></td>
<td></td>
<td></td>
<td>-0.239***</td>
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<td>G. Extent</td>
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<td></td>
<td>(0.067)</td>
</tr>
<tr>
<td>Dyadwise</td>
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<td>0.101***</td>
<td>0.095*</td>
<td>0.084*</td>
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<tr>
<td>Shared Partner</td>
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<td>(0.044)</td>
<td>(0.024)</td>
<td>(0.043)</td>
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<td>Edgewise</td>
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<td></td>
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<tr>
<td>Shared Partner</td>
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<td>(0.214)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-4.35***</td>
<td>-4.435***</td>
<td>-6.599***</td>
</tr>
<tr>
<td></td>
<td>(1.174)</td>
<td>(1.157)</td>
<td>(1.152)</td>
<td>(1.587)</td>
</tr>
<tr>
<td>BIC</td>
<td>399.73</td>
<td>393.48</td>
<td>387.19</td>
<td>386.9</td>
</tr>
</tbody>
</table>

Table 4.2: MCMC MLE estimation of ERGMs for collaboration network in Central Kalimantan. Predicted probabilities are calculated for a one-unit change in the network statistic, with all other change statistics except the number of edges held constant. - = Significant at 0.1; * = Significant at 0.05; ** = Significant at 0.01; *** = Significant at 0.001. Estimated with the ERGM package (Hunter et al., 2008) in R (R Core Team, 2012).
Table 4.3: Goodness-of-fit results for the estimated models. P-values express the probably that the value of the measure for the observed network does not differ from the mean value for 100 networks simulated from the estimated equation. Estimated with the ERGM package (Hunter et al., 2008) in R (R Core Team, 2012).
and those based abroad, even controlling for opinions about REDD+. The negative relationship between the number of organizational representatives involved in writing the Provincial Strategy and cooperation is also consistent with the idea that connections internal to the network have not been particularly important in actual policy formation, an interpretation supported by the significant positive effect of Not Government.

These findings could have important implications for the ability of civil society in parts of the province further away from the capital to communicate with and have an impact on REDD+ policy. Together, the effects of the variables suggest embeddedness within the province was not – at the time of the fieldwork – as important in determining an organization’s role in REDD+ policy discussions as relationships outside the network. These findings highlight significant distortions in deliberation. Even within the relatively limited geographical bounds of the policy network centered on Palangkaraya, cooperation and information transmission is likely to take place between organizations that already broadly agree – or between organizations that are influential on REDD+ policy as a result of institutional position or resources. Outside KOMDA, provincial agencies – the organizations having the most general geographic scope – are not particularly well connected, and organizations that have a wider geographic scope in the province also are unlikely to be well connected.

4.4 Conclusions and Implications

There are significant barriers to cross-scale deliberation regarding REDD+. These occur both in translating abstract policy models into a provincial approach, which empowers actors with transnational connections, and within the province itself, where there are very weak connections between people dwelling in the areas targeted by
REDD+ activities and the process of creating REDD+ policy. Organizations with technical facility, external connections, or both have been advantaged and may serve prominent roles in policy creation. At the time of the fieldwork, organizations with more connections to areas in the province had fewer connections within the network, although this may change following the completion of the Provincial Strategy. As we discuss below, several organizations have been quite active in building the kinds of connections that would be necessary for more inclusive policymaking, and such organizations may be positioned as brokers themselves in the future. While the implementation of REDD+ in Central Kalimantan is nascent, we have suggested that the policy network as it was during the time of fieldwork was unlikely to be able to facilitate effective learning, local ownership, and deliberation. REDD+ policymaking, as exemplified in the process of drafting the Provincial Strategy, remained “outside-in.”

Ernstson et al. (2010) highlight the need for strong cross-scale networks in places like Central Kalimantan. As we have seen, these connections are difficult to achieve in areas with low governance capacity, limited transportation infrastructure, perverse political incentives, and geographically uneven challenges and capabilities. We find that not only are the activities of organizations most involved in REDD+ policy in Central Kalimantan geographically uneven, nearly constant meetings in the capital have yet to produce an integrated policy network. Organizations appear to sort by opinion, extent of operation, and organizational type, and more geographically active organizations (outside the provincial government) appear to be less central to REDD+ activities in the provincial capital.

Connections, however, do not always signify power. Some of the organizations with representatives on the team drafting the Provincial Strategy are not particularly well connected in the policy network.
If provincewide connections are not improved, REDD+ policy will not be fully participatory, and this will make it more difficult for REDD+ to escape the failures of past transnational conservation efforts. In addition, this could undermine the ability to address concerns with leakage, make optimal decisions about how to allocate resources across space, and understand how to adapt abstract policy models to the complex particularities of the places where policy is to be implemented. At present, the division between external and provincial actors suggests a lack of local ownership, an arrangement that could be in the interest of some organizations that might be reluctant to change.¹⁸

Efforts to develop more effective integration have been ongoing since the time of the fieldwork. The moratorium and audit of resource use permits is one example – the audit serves as a way for the provincial government to acquire more complete information regarding economic activities in the districts, which have had considerable autonomy in resource management decisions as a consequence of decentralization. Civil society efforts are growing, as well. A coalition of NGOs use the open-source Web 2.0 platform Mitra 1,⁰¹⁹ to operate BorneoClimate.Info, a website that uses text messaging for microblogging about forest issues in the province. The site operators make extensive use of Twitter and update regularly in an effort to provide information about consultations, stakeholder meetings, and news related to REDD+. Many

¹⁸This may not be the case in Central Kalimantan, however. Despite that the process of drafting the Provincial Strategy was not fully participatory, the document itself places a high value on local engagement and ownership and finding ways to make REDD+ accessible for smallholders, a position advocated in particular by faculty members at Unpar’s Center for International Cooperation in Sustainable Management of Tropical Peatland (CIMTROP), who played a key role in the drafting process. In this case, the organizations that might have an interest in a “top-down” approach have been quite vocal in advocating more advanced and effective participation. On the other hand, however, these ideas dovetail with a racialized view of Dayak land management practices as inherently forest-friendly that is not borne out by recent studies (see Resosudarmo et al. (2013)).

¹⁹Literally, Partners 1.0.
member organizations also use Facebook for similar purposes. In addition, several organizations mentioned during interviews that they were interested in developing a multi-stakeholder forum to share information and perspectives on REDD+ and forest issues more generally outside the context of the Provincial REDD+ Committee.\textsuperscript{20}

Events in Central Kalimantan have relevance beyond REDD+ itself. While perhaps uniquely popular, REDD+ is not uniquely complex in the world of climate policy. Not only is it necessary to develop a clearer understanding of what \textit{kinds} of network structure are desirable – itself a challenging task, given the contextual effects of centralization, density, and so on – but also to begin a study of the processes giving rise to particular network structures. Given the path-dependence of such patterns, understanding the processes that can generate more desirable patterns can be an important way to avoid lock-in of insufficiently democratic governance systems.

\textsuperscript{20}Such a forum should not be taken to imply that voice is the only element of effective participation, though an open stakeholder forum might be a more effective and participatory hub than KOMDA, which is staffed primarily by government officials.
Chapter 5: Reaching Forward? The Structure of the International REDD+ Policy Network

As was noted in Chapters 1 though 3, there have been suggestions that REDD+ has moved from a market-based to a sustainable development enterprise. While REDD+ was at first intended to quickly produce offsets for sale on carbon markets, the challenges of implementation have resulted in continued reliance on traditional sources of aid for funding. The resulting “aidification of REDD,” Seymour & Angelsen (2012) and Angelsen & McNeil (2012) suggest, has slowly turned the approach into a sustainable development initiative with an emphasis on forests.

A decentralized, market-based approach and an aid-based sustainable development model imply different geographies of policy creation. The decentralized approach suggests that, ideally, innovation should come from diverse sources, while the sustainable development approach is traditionally “top-down.” Due to its formal decentralization and the fuzziness of exactly what counts as “doing REDD+,” however, our understanding of what REDD+ activities look like as a whole remains somewhat impressionistic. We lack a systematic understanding of the spatial structure of REDD+.

This chapter is an early version of an article intended to be submitted for review and co-authored by myself and Professor Darla K. Munroe, so the pronoun “we” is retained here.
In this chapter, we return to the question of who produces REDD+, understood in a geographic sense. We draw upon a range of indicators of organizational involvement in REDD+ to develop a low-resolution geography of transnational activities and address this important gap in our knowledge. We study where organizations are engaging in REDD+, whether giving advice for formal government policies, producing “gray” literature, or directly implementing pilot projects. This requires understanding the geography of the various relationships discussed in Chapters 2 and 3. Here we focus in particular on transnational relationships, though we should note the complex political and social process of translating abstract policy discourses and practices to the conditions of specific sites is a crucial part of REDD+’s geography, unfortunately too complex for the limited scope of this chapter (Peck & Theodore, 2010; Peck, 2012).

While REDD+ is interesting both on its own terms and because of its significant scope, we hope our analysis here may be relevant to those interested in geographies of climate policy more broadly. In addition to studying the spatial unevenness of transnational activities, we utilize sources and methods applicable to the geography of other global governance projects that allow us to distinguish between the spatial patterns that might be expected given a range of understandings of global governance. We present data on networks formed by organizations’ transnational activities related to REDD+ policy, using a combination of network analysis techniques to adjudicate between the spatial patterns that might be expected were REDD+ a decentralized, market-based system, a traditional form of bilateral development policy, or a product of more diffuse but structured forces theorized in the literature on world-systems.
theory and and polycentricity. Based on the results of a structural blockmodel incorporating data on five interstate relations related to REDD+, we suggest the concentrated polycentric interpretation discussed in Chapter 3, in which a few core regions dominate the network, while some select regions in both core and peripheral areas can play prominent – if secondary – roles, provides the description most consistent with our data. We conclude our discussion by reflecting on the potential implications of these findings for the continued development of transnational REDD+ policy.

5.1 The Uneven Patterns of Transnational Governance

Students of global environmental governance have observed that informal, quasi-formal, or voluntary relationships spanning state borders are increasingly important for transnational environmental politics (Bulkeley, 2005; Bulkeley et al., 2012; Pattberg & Stripple, 2008). Recent literature by members of the Earth System Governance (ESG) Project (ESGP) (Frank Biermann et al., 2009), as well was work in geography on issues ranging from neoliberalization (Peck & Theodore, 2010; Peck, 2012) to NGO activities (Bebbington, 2004, 2005) and transnational justice movements (Cumbers et al., 2008; Routledge, 2009) have noted both the importance of transnational connections in contentious politics and the significance of inequalities in the resources and connections held by organizations operating in different places for intra-network politics.

As several geographers and others have noted, and as argued in Chapters 2 and 3, the structure of transnational networks can be very uneven. Economic and infrastructural inequalities, geopolitical legacies, and physical geography mean that networks, while formally decentralized in the sense that they lack overarching control
mechanisms, can nevertheless be centralized in spatial terms. These different spatial patterns within transnational networks have very different implications for how policies can be made within those networks, by whom, and with what effects.

Drawing from several perspectives, we could imagine at least four ideal-type spatial signatures characterizing the transnational dimension of REDD+, with each one having different implications for policy development (see Table 5.1). From the policy literature, we could derive two possible claims. In the decentralized, market-based world, we might expect a relatively “flat” network, with no clear hubs but considerable collaboration, a view consistent with the traditional notion of polycentricity.\(^{21}\)

From the “aidification” perspective (Seymour & Angelsen, 2012; Angelsen & McNeil, 2012), we might expect a spatial pattern in which just a few donor countries dominate connections but are not necessarily well-connected to one another, pursuing REDD+ as part of other development activities.

A third model comes from the world-systems tradition. Work in this school often utilizes network concepts, characterizing patterns of international trade using formal measurements of coreness and peripherality (D. A. Smith & White, 1992; Snyder & Kick, 1979; Fagiolo et al., 2009; Reyes et al., 2010; Schiavo et al., 2010). These authors frequently use blockmodeling (see below) of international trade and similar relational data to derive clusters of countries exhibiting common positions in the network, adopting a three-cluster model in which states are grouped into core, periphery, and semi-periphery. These studies suggest advanced capitalist countries occupy a particularly central and dominant position in networks of global flows, while areas with lower per capita income tend to be less well-connected. Within the core there

\(^{21}\)This is, essentially, a “null” hypothesis. It is highly unlikely that anyone in the academic or policy communities thinks this is what REDD+ actually looks like, but it does exist as a sort of regulative ideal and is therefore included in our discussion in part to see how close or far from this ideal REDD+ might be at present.
are high levels of interconnection, and there are important connections between the core and periphery and semi-periphery, but few connections within the periphery. If the REDD+ network fit this description, we might expect high levels of cooperation between developed countries, which would form a “hub” in a network whose “spokes” would connect peripheral countries to the core.

Though similar to the pattern we might expect on the basis of the world-systems literature, the concentrated polycentricity perspective outlined in Chapter 5 is distinct. While we might expect the most prominent centers of transnational governance to be located in core regions, concentrated polycentricity does not imply a clear core ⇒ periphery ⇒ semi-periphery ranking. We might easily find prominent – if not dominant – players in transnational REDD+ politics that are not traditionally understood as members of the core.

Research on world cities provides some support to the polycentric perspective. This literature studies the continuing development of a hierarchy of cities serving as hubs in various types of international connections, which may generate informal influence over transnational economics (Beaverstock et al., 2000; Taylor, 2004b, 2005a) and political life (Taylor, 2004a, 2005b, 2000; Wusten, 2007). Taylor (2004a, 2005b) notes that networks formed by diplomatic exchange, the United Nations system, and civil society organizations do not necessarily follow traditional economic hierarchies. Instead, cities like Nairobi, Bangkok, and New Delhi rank highly in networks defined by NGO activities (Taylor, 2004b). However, as Taylor (2005b, p. 720) notes, the most prominent cities in clusters identified through principal components analysis tend to be in the core, suggesting that “global civil society’s power structure is clearly more top-down than bottom-up,” despite bridging the “North-South divide.”
<table>
<thead>
<tr>
<th>Perspective</th>
<th>Expected spatial/network structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market-based</td>
<td>No prominent hubs; long-distance and local connections</td>
</tr>
<tr>
<td>“Aidification”</td>
<td>Links between donors and recipients; few connections between donors</td>
</tr>
<tr>
<td>World-systems</td>
<td>Links between core countries and the core and non-core</td>
</tr>
<tr>
<td>C. Polycentric</td>
<td>Dominant core; some prominent peripheral countries</td>
</tr>
</tbody>
</table>

Table 5.1: Summary of the key spatial structures of REDD+ implied by policy and theoretical literatures.

These distinctions are not just academic. While there is considerable interest in decentralized, “bottom-up” policy creation in UNFCCC circles (and amongst global policy actors more broadly), network structures centered on the global North, which place organizations based in cities like Washington, DC, London, and Geneva in the most central positions in the production and exchange of policy knowledge and ideas, may not support the forms of participatory policy innovation that proponents of approaches like REDD+ envision, as these long-distance, attenuated links are likely to suffer from bandwidth problems. Understanding the spatial patterns of global networks, therefore, provides information about the nature of political activities that might take place within them.

5.2 A Network Perspective on Transnational Governance

Many discussions of the unevenness of transnational relations utilize network analysis (Wasserman & Faust, 1994; Prell, 2012). Encompassing work in fields like sociology (Granovetter, 1973, 1985), physics (Barabási, 2002), economics (Jackson, 2008), and organizational behavior (Burt, 1995, 2005; Kilduff & Krackhardt, 2008),
amongst many others, network techniques have been used in geography for the above-mentioned purposes, as well as in the vast literature on transportation (Xu & Harriss, 2008; Choi et al., 2006), scientometrics (Liu & Zhan, 2012; Sun & Manson, 2011), and relational and evolutionary economic geography (O’Hagan & Rice, 2012; Ter Wal & Boschma, 2009).

Outside literature on world-city networks, formal network analysis in geography has only seldom been applied to traditionally political questions (Radil et al., 2010), in part because network analysis techniques tend to be spatially inexplicit. Radil et al. (2010), however, demonstrate how network analysis can be productively combined with a spatial perspective. They use blockmodeling to derive clusters of Los Angeles gangs positioned similarly within networks of enmity. Mapping these clusters on gang territories, they find strong visual evidence of spatial clustering of network positions and show that network positions provide statistically significant explanations of differences in crime levels across territories.

Network analysis is designed to provide a means of formally assessing patterns of quantitative or qualitative relationships between sets of entities. It provides a flexible ontology, composed of nodes connected by edges representing relationships. While this flexibility can be an asset, it is also important always to keep in mind the kind of network being analyzed, the abstractions made from the actual processes of interest, and the assumptions of different network measures that may not make sense when applied to particular domains.

Both nodes and the relations defined between them can have qualitative or quantitative attributes that provide additional information (Wasserman & Faust, 1994). Like considerable research in the world cities and world-systems theory tradition, we
utilize weighted networks – that is, networks in which the relations between nodes have a “strength.”

In addition to the strength of a given relation, it is important also to have information about whether or not the relation implies a directed flow. We can think of a directed relation as somehow involving one node “sending” something to another. Interpersonal social relations such as “liking,” or international trade relations like exporting provide some examples. Undirected relations, on the other hand, are inherently reciprocal and include things like friendship, coauthorship, or membership in common organizations.

Networks also can differ by the types of nodes present. One-mode networks include only a single type, while affiliation networks consist of a set of “actors” and a set of “events” though which actors are connected. Examples might include individuals connected by sitting on the same corporate board, people connected by attending the same party, or governments connected by being members of a common intergovernmental organization (Wasserman & Faust, 1994, ch. 8). There is a key shortcoming of affiliation data, however. We may frequently be interested in the affiliation network only as an indicator of underlying processes, which means several indicators should be triangulated to develop a meaningful interpretation. To provide a more direct representation of underlying patterns, affiliation data can be “projected” as an undirected, weighted, one-mode network defining relations between either actors or events, where the value of the relation between two nodes provides information about the number of times they are connected to a common node in the unprojected network (Wasserman & Faust, 1994, ch. 8).
Here, we focus on networks of relations between countries and utilize both directed, weighted, one-mode networks and undirected, weighted, one-mode projections of affiliation data. We adopt this relatively aggregated picture for two reasons. The first is that it allows us to analyze broad trends, which helps to correct for some of the inherent noisiness in our data. The second is that this approach allows us to characterize significant patterns with relatively simple measures that are more accessible to an audience from a variety of backgrounds. There are costs to this approach as well, of course, and we do lose some information in utilizing an aggregate picture, but as our purposes here are primarily expository and exploratory, we think this is a reasonable trade to make.

Because there are many ways to “do” REDD+ policy, we draw upon a broad range of indicators of organizational activity in developing our data. Particularly, we utilize data on organizational involvement in REDD+ pilot projects, consultation on major policy documents, membership on standards-setting committees, provision and receipt of funding, and publication of policy documents related to REDD+ listed on a major website that acts as a clearinghouse on forest carbon policy. These measures are chosen as a way to sample several dimensions of organizational activities on REDD+, ranging from directly implementing policy models through providing policy advice to participating in the production of discourses about REDD+ policy.

Very frequently, participation in these activities involves crossing international borders, allowing us to think of the processes leading to the emergence of transnational REDD+ governance as a network of interstate relations. Some of these relations—such as starting a pilot project in another country—can be understood as directed, while others—such as co-sponsorship of a policy document—are undirected. In addition to their direction, our relations also have a strength, defined by the number
of times an organization headquartered in one country engages in that relation in another.

In addition to the weights of various types of relations incident upon them, nodes have attributes of their own. Most important, of course, is their location. While this is not explicitly considered in most network analysis techniques, we follow Radil et al. (2010) in using mapping to visually assess spatial patterns of REDD+ governance networks. We explain the source data and detail the measures we use in the following section.

5.3 Data and Methods

5.3.1 Data Sources

To track organizational involvement in REDD+, we recorded data to generate four affiliation networks (that is, networks with two different types of nodes) showing organizations’ involvement in REDD+ pilot projects, standards creation bodies, drafting of major REDD+ policy papers, REDD-related funding, and co-sponsorship of REDD-related policy documents. These data are summarized in Table 5.2

The projects dataset was coded between Summer 2011 and Summer 2012. The data reflect public, online sources available during that period. In particular, our data draw on compilations of forest carbon projects collected by the Varming et al. (2010), Ecosystem Marketplace (2012), Forest Carbon Asia (2012b), Cenamo et al. (2009), and, especially, the Center for International Forestry Research’s Global Database of REDD+ and Other Forest Carbon Projects (Center for International Forestry Research, 2012). Projects were included only if available news reports, project documents, or datasets suggested they had begun on-the-ground activities other than
<table>
<thead>
<tr>
<th>Network</th>
<th>Explanation</th>
<th>Type</th>
<th>Weights Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects</td>
<td>Pilot projects</td>
<td>Directed</td>
<td>Organization in A sponsors project in B</td>
</tr>
<tr>
<td>FCPF Papers</td>
<td>Consulting on FCPF policy FCPF documents</td>
<td>Directed</td>
<td>An organization from A consults on a document in B</td>
</tr>
<tr>
<td>Standards</td>
<td>Membership on standards-setting bodies</td>
<td>Directed</td>
<td>An organization from A sits on a committee in B</td>
</tr>
<tr>
<td>Funding</td>
<td>Flows of funding</td>
<td>Directed</td>
<td>Monetary flows from A to B</td>
</tr>
<tr>
<td>Forest Carbon Asia</td>
<td>Co-sponsorship of documents</td>
<td>Undirected</td>
<td>An organization from each of A and B sponsor a policy document</td>
</tr>
</tbody>
</table>

Table 5.2: Description of network datasets used in the chapter.

initial research by June 2012 and involved either an avoided deforestation or sustainable forest management component. To distinguish REDD+ from the establishment of protected areas, only projects referencing REDD+ or carbon reductions as a specific goal were included. While many datasets limit REDD+ projects to the developing world, we include all projects that fit the above criteria in order to investigate connections between forest carbon projects undertaken in developed countries and REDD+ projects in the narrower sense. Recording organizations cited in documentation as having any role in funding, providing information or other support for, or directly implementing these projects produces an affiliation network of organizations connected via collaboration on pilot projects. We construct a country-level network in which countries are connected by edges when an organization headquartered in one country is involved in a pilot project sited in another, with the strength of a link denoting the number of times an organization from the sending country is involved in a pilot project in the receiving country.
The standards dataset records organizational representation on governing bodies producing standards relevant to REDD+ projects. Both voluntary and official standards for carbon reductions (such as the Verified Carbon Standard) or social and environmental co-benefits (such as the Gold Standard or the Climate, Community, and Biodiversity Standard) have become quite important for pilot projects, and there is a close connection between innovation in voluntary standards and discussions on more official approaches envisioned as part of formal REDD+ governance. Relevant standards were collected by searching the websites of standards organizations identified in Green (2011) and Peters-Stanley et al. (2012) to find those relevant for REDD+ projects and policies. With the exception of International Standards Organization and J-VER standards, standards websites identified technical committees or other bodies charged with drafting each standard. The country-level network derived from this data consists of countries linked when an organization in one country sits on a standards committee located in another, with the strength of the link denoting the number of times an organization headquartered in one country sits on a foreign committee.

The paper-drafting dataset characterizes organizational involvement in drafting planning papers written as part of the process of obtaining funding from the World Bank’s Forest Carbon Partnership Facility (FCPF). These papers, similar to the Bank’s Poverty Reduction Strategy papers, are written by governments seeking Bank funding for REDD+, generally in consultation with a number of organizations. This network dataset records organizations other than the drafting government cited as authors or consultants in these papers. The data are somewhat noisy, as the threshold for acknowledgement likely varies between countries and only some of the governments engaged in the FCPF process have completed both papers submitted in the
course of seeking funds. Nevertheless, this measure provides a useful indicator of organizational involvement in national policy discussions in states engaged in REDD+.

The country-level directed network derived from this data consists of countries linked by involvement of an organization headquartered in one country in the FCPF paper drafting process in another country, where the strength of the edge is based on the number of times an organization from the sending country is involved in FCPF drafting in the receiving country.

To capture involvement in REDD+ via funding flows, data on pledged REDD-related funding were collected from the Voluntary REDD+ Partnership (2012c). The dataset provides information on funding pledges made by state and non-state actors and includes information on both the funding and recipient organizations. Data were aggregated to show pledged REDD-related financial flows between countries in the form of a weighted, directed, one-mode network.

For the final network, metadata on important policy documents related to REDD+ were collected from Forest Carbon Asia (2012a), a website based in the Philippines and supported by a network of individuals working in multiple organizations. The extent of the website’s catalog is quite substantial, although it would certainly be ideal if there were African and Latin American analogues. The dataset was used to produce affiliation networks of organizations linked via co-sponsorship of policy documents. This network was then projected and aggregated to the country level.

Together, these networks help characterize the geography of transnational relationships supporting the emerging governance of deforestation. They include multiple ways organizations can play a role in the evolution of REDD+ as a component of the

\[^{22}\text{Data were augmented to include the$1 billion agreement between Norway and Indonesia discussed in Chapters 2 and 4.}\]
overall transnational environmental governance architecture. Using the methods outlined in the following subsection, we transform this relational data into a geography of governance.

5.3.2 Methods

Because focusing on interstate networks decreases the number of nodes we consider – and because the structure of the networks we study is relatively simple – we are able to summarize considerable information about the network with relatively straightforward measures and approaches. In this chapter, we use four primary techniques common in network analysis. These are degree, a modification of the E-I index, structural blockmodeling, and quadratic assignment procedure (QAP) regression. We describe each of these operations in detail in this section.

Degree and Outdegree

One common way to represent the network data used in these analyses is as an \( n \) by \( n \) matrix \( C \), where \( n \) is the number of nodes in the network and each cell in the matrix provides information about the relationship between the nodes denoted by the rows and columns. In binary networks, where information is only encoded about whether a relationship is present or absent, the values in the cells are all either 0 or 1. In weighted networks such as those utilized here, the cells can take on any number, which denotes the strength of the relation. In directed networks, the convention is for cells to denote the value of the relationship originating from the row node to the column node. Undirected networks are special cases of directed networks, in which \( C \) is symmetric (that is, if we have two nodes \( s \) and \( t \), and \( c \) is a cell in \( C \), \( c_{st} = c_{ts} \)).
Degree characterizes network structures by counting the number of edges incident on each node (Freeman, 1978). In weighted networks, this is simply the sum of the strength of all a node’s edges, or, in terms of matrix $C$, the sum of each row. In directed networks, it is helpful to distinguish between outward flows and inward flows, measured by outdegree and indegree, which are simply degree calculated by summing across rows (for outdegree) or down columns (for indegree).

While these measures do not consider network patterns beyond immediate connections, in networks with relatively simple structures like ours, they can serve as indicators of nodal prominence. We calculate degree for our undirected network and outdegree for directed networks.

**E-I Index Modification**

Krackhardt & Stern (1988) propose the E-I Index to measure the extent to which links within a network are confined to predefined clusters or communities. The index is defined as

\[
\frac{e - i}{e + i}
\]

(5.1)

where $e$ is the sum of edges within the cluster or community and $i$ is the sum of edges between members of that cluster and non-members. The index produces a measure between -1 (all edges are internal) and 1 (all edges are external).

For a more intuitive presentation, we reverse the measure, such that -1 denotes complete externality and 1 complete self-sufficiency, calling this the “internalization”

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23Degree is often calculated with the diagonal of $C$ set to all zeros to eliminate self-ties. We include self-ties to have a more complete measure of the involvement of organizations in each country in REDD+ activities.
index. A second modification is that we consider states to be our clusters or communities, relating all ties within states and their indegree (or degree if the network is undirected). In terms of Equation 5.3.2, all values of $i$ represent flows from nodes to themselves, which is the simply a vector $D$ that is the diagonal of matrix $C$, while all values of $e$ are given by the column sums of $C'$, a matrix produced by replacing the diagonal of $C$ with zeros. The internalization index for node $s$ is given by

$$\frac{d_s - \sum_{i=1}^{n} c'_{i,s}}{d_s + \sum_{i=1}^{n} c'_{i,s}}$$

(5.2)

where $d$ is a cell in vector $D$ and $c'$ is a cell in $C'$. This measure allows us to assess the relative levels of domestic and international involvement in REDD-related activities in each country.

**Structural Blockmodeling**

Burt (1976) argues the matrix $C$ denoting networks of relationships between nodes can be used to derive more general patterns of social roles, clustering nodes that are “structurally equivalent” – that is, nodes that have the same relationships with the same nodes. In a strict sense, two nodes $s$ and $t$ are structurally equivalent if and only if $C_{s,i} = C_{t,i}$ and $C_{i,s} = C_{i,t}$ for $i = 1, ..., n$. As this condition is unlikely to hold in empirical networks, Burt relaxes the definition by operationalizing structural equivalence in terms of the euclidean distance between the profile of edges incident on each node. Using this approach, the distance between nodes $s$ and $t$ is given by

$$\sum_{i=1}^{n} \sqrt{(c_{s,i} - c_{t,i})^2} + \sum_{i=1}^{n} \sqrt{(c_{i,t} - c_{i,s})^2} - c_{s,t}^2 - c_{t,s}^2$$

(5.3)
whether the edges are directed or undirected. The resulting value provides information on the structural distance between nodes. Using this technique, it is possible to produce an \( n \) by \( n \) symmetric matrix \( R \) where cells \( r_{s,t} \) and \( r_{t,s} \) denote the distance between nodes \( s \) and \( t \). The method has the additional advantage of being able to utilize information on multiple relations simultaneously, an approach we adopt in this chapter.\(^2\)

Of course, this matrix is only marginally more transparent than \( C \). To develop a more succinct view of the social positions suggested by the relational data, Burt (1976) suggests applying a hierarchical clustering approach, which allows us to generate a set of clusters, known as a blockmodel (Breiger et al., 1975; Wasserman & Faust, 1994), in which clusters of nodes are similarly positioned within the network in the sense that they are similarly distant from the same sets of nodes.

We choose the Ward method (Ward, 1963) as a compromise between simplicity and comprehensiveness. Unlike the CONCOR algorithm developed by Breiger et al. (1975) and utilized in Radil et al. (2010), which breaks the initial set of nodes into two parts, continuing to split clusters until the desired numbers of clusters are reached, the Ward method begins with nodes all in their own one-member grouping and iteratively combines groups. In each step, two groups are combined such that the sum of the variance of all groups about their mean increases by the smallest possible number. The process is repeated until every node is placed in a single group, and a desired number of groups is then selected.

\(^2\)To ensure comparability across networks, we utilize matrix \( C' \), ignoring self-ties. The values of the cells of \( C' \) for each network are divided by the sum of all cells in \( C' \) and multiplied by 100 prior to calculating distances, scaling all edges between 0 and 100.
Quadratic Assignment Procedure Regression

While combining Burt’s method of structural equivalence with Ward’s method of hierarchical clustering allows us to derive clusters, it does not provide us with the necessarily tools to select appropriate divisions. To test the significance of clusters, it would be helpful to have a means to assess their adequacy in explaining the variance of important nodal attributes.

We use Quadratic Assignment Procedure (QAP) regression for this purpose, regressing degree (in undirected networks) and outdegree (in directed networks) on network positions. Proposed as a network analysis method by Krackhardt (1987, 1988), QAP regression is an approach for performing regression-based tests of statistical significance when data cannot be assumed to be independently distributed (generally the case with network data – see Chapter 4). We use a permutation-based version of this test (Kilduff & Krackhardt, 2008, ch. 3), which involves estimating a regression equation, saving the coefficients and $R^2$ values and then estimating an arbitrarily large number of regressions (we use 10,000) with random permutations of the dependent variable. The observed coefficients and $R^2$ are then compared against the distribution of estimated values from simulated samples, with one minus the proportion of values from this distribution less extreme than observed providing an estimate of the probability the observed coefficients are different from zero.

This approach allows us to estimate the statistical significance of a relationship, in this case between the different network positions and degree/outdegree, conditional on the distribution of dependent variable values and collinearity among the explanatory variables. Though the dependent variable permutation test is of low power (Dekker et al., 2007), this can be an advantage in our case because it provides a high bar for
significance. We can also correct for this problem by explicitly reporting estimated p-values for both coefficients and $R^2$. We present our results in the following section.

5.4 Results

5.4.1 Internalization

The internationalization measure provides a general picture of patterns in the five networks we described in the data sources section. Figures 5.1 through 5.5 present visualizations of internationalization and network structure across all five networks. The distribution of connections is similar across networks, with organizations headquartered in the United States (which, it should be noted, includes the United Nations and World Bank) occupying prominent roles in all networks.

While there is some evidence of a core-periphery structure in the world-systems sense, with the US and Western European countries accounting for a large number of transnational connections, the networks presented here tend to deviate from the traditional core-periphery model in that members of the core are not particularly strongly connected to one another. In the directed networks, this is in part by construction, as Western European countries do not host large numbers of forest carbon projects that fit the definition used in this analysis, and by definition none of these countries have FCPF paper-drafting processes. A notable exception to this pattern is found in the standards network. As most voluntary standards are based in the US, the network structure is reversed, with the US holding a relatively large number of incoming – as opposed to outgoing – edges. Here there is some evidence of intra-core activity, as can be seen by the relatively large number of connections across the Atlantic.
Because it captures direct collaboration, the undirected network shows a little more evidence of intra-core connections, with particularly strong links between US-based and UK-based organizations. Even in the case of publications, however, the number of “South-South” or intra-periphery connections are relatively sparse, and most connections involve at least one European or North American country, a pattern that would be consistent with all of the expected spatial structures except the “decentralized” perspective.

The internalization measure suggests some interesting dynamics. In the Forest Carbon Asia network, for example, there are clearly many more transnational than domestic connections, and, while there is clearly strong intra-core collaboration, as well as connections between core and peripheral areas, there are also some connections within the periphery, particularly in South and Southeast Asia. The funding network shows patterns we might expect, with funding flows moving from developed to developing countries, though, notably, there is at least some funding flowing between developed countries in addition to the amounts traveling via the FCPF and Global Environment Facility.

The most interesting internalization patterns, however, are found in the FCPF Papers and Projects networks, where there appear to be regional patterns of internalization. Andean and Amazonian countries generally show higher levels of internalization than East and Central African and Southeast Asian countries (with the notable exception of Indonesia). Central American countries, interestingly, have low internalization in the project network but relatively high internalization in the FCPF papers network.

This could be in part explained by selection biases in the clearinghouse used to select documents.
Figure 5.1: Internalization and edge strength for REDD+ pilot project network. Edges become darker as they approach the target node. Edge size denotes weight. Grey nodes have no incoming or internal edges, so their internalization score is undefined. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 5.2: Internalization and edge strength for FCPF paper-drafting network. Edges become darker as they approach the target node. Edge size denotes weight. Grey nodes have no incoming or internal edges, so their internalization score is undefined. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 5.3: Internalization and edge strength for standards committee membership network. Edges become darker as they approach the target node. Edge size denotes weight. Grey nodes have no incoming or internal edges, so their internalization score is undefined. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 5.4: Internalization and edge strength for funding network. Values in millions of dollars. Edges become darker as they approach the target node. Edge size denotes weight. Grey nodes have no incoming or internal edges, so their internalization score is undefined. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
Figure 5.5: Internalization and edge strength for the policy paper co-sponsorship network. Edge size denotes weight. Grey nodes have no external or internal edges, so their internalization score is undefined. Projection: Gilbert. Visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
While the US and Western Europe remain prominent in many networks, there also is a discernible difference in several networks between most developing countries with REDD+ activities and the countries like Brazil and Indonesia, which boast particularly large forest areas and have been prominent in international REDD+ debates. In several networks, the countries score higher on the internalization variable than other developing countries, and they exhibit connections with other developing countries. This may in part be explained by the active role of the countries’ governments – both national and sub-national – in REDD+ discussions, as well as the fact that they host international research centers that are particularly active on REDD+ issues. Indonesia is home to the Center for International Forestry Research, which operates Forest Day at meetings of the Conference of Parties to the UNFCCC and has been central in catalyzing debate about REDD+, particularly in Southeast Asia. The Amazon Environmental Research Institute (IPAM) in Brazil, similarly, has been a proponent of compensation for avoided deforestation since at least the early 2000s, and in 2005 the institute co-sponsored a volume with the Environmental Defense Fund making the case for the inclusion of tropical forests in the global climate regime (Moutinho & Schwartzman, 2005).

While the decentralized perspective does not fare well, distinguishing between the other three structures based on these visualizations alone is difficult. Fortunately, the three other interpretations imply distinct spatial patterns of network roles. In the following sub-section, we utilize structural blockmodeling and QAP regression to develop and test the explanatory power of a clustering of countries based on their position across all six networks, which will allow us to distinguish between these two spatial expectations.
5.4.2 Structural Blockmodeling and QAP Regression

In this section, we utilize structural blockmodeling, with cluster performance checked via QAP regression, to test the three remaining hypotheses on REDD+ governance patterns. Each perspective implies a different global network structure, allowing us to use our data to adjudicate between them.

As noted previously, based on the world-systems literature, we would expect to see a cluster of the most economically affluent countries, followed by a semi-periphery of middle-income countries, and a periphery of the poorest countries. Transnational activities on REDD+, on this hypothesis, should reflect levels of affluence and position in networks of international trade. Were REDD+ a new form of development aid, we would observe network relations to define clear clusters of donor and recipient countries, with few if any clusters including members of both classes. If the concentrated polycentricity interpretation were correct, we would see a small cluster of core countries, but also a larger cluster of secondary actors that combine both core and peripheral countries.

In developing our blockmodel, we encounter a problem in that there is no clear way to choose how many clusters is appropriate. Taking an experimental approach, we choose four because the clusters produced are reasonable given pre-existing qualitative knowledge about transnational REDD+ politics and at four clusters we already identify one cluster with a single member (the US). While at first we thought the identification of a single country went against the spirit of the blockmodeling exercise, we ultimately determined to keep the US as its own cluster because our discussion in Chapter 3 does suggest the US is in a “class of its own” when it comes to REDD+. The clusters derived from the blockmodeling exercise are presented in Figure 5.6, where countries of the same color belong to a common cluster.
This analysis produces some very interesting results. It clearly identifies the countries most active in REDD+ in the yellow cluster (the US), the purple cluster (including UK, Germany, Netherlands, France, Switzerland, Norway, Australia, Brazil, and Indonesia), and the orange cluster (tropical forest countries including Peru, Democratic Republic of Congo, and Madagascar, as well as Mexico), distinguishing these clusters from the green cluster, which contains countries more marginally involved in REDD+. These findings are broadly consistent with the discussions in Chapters 2 and 3, where we noted a concentration of on-the-ground REDD+ activities near the equator and policy and funding activities in donor countries.
Figure 5.6: Clusters identified by structural blockmodeling. Areas in gray did not appear in any network. Calculated with Statnet (Handcock et al., 2003) and visualized in ggplot2 (Wickham, 2009) in R (R Core Team, 2012).
The purple cluster is especially interesting, as it includes countries traditionally identified as both “core” and “periphery.” Developing countries in this cluster are home to organizations that are highly active on REDD+ issues globally, regionally, and domestically. As noted above, Brazil and Indonesia host prominent forest research organizations, and Nairobi is home to the World Agroforestry Center, another institution that has been active in the debate about the definition of forests and the provision of benefits to smallholders, in particular. Nepal is an interesting exception to this general trend. While the Nepalese government has had a somewhat limited engagement with REDD+, the debate has been pressed by forest user groups (Di Gregorio et al., 2012), some of whom have partnered with organizations based in other countries. These countries are grouped with all the key donor country players with the exception of the US. The government of Norway, for example, has devoted considerable funds to REDD+ policy. The Australian development agency AusAID, similarly, has sponsored REDD+ in Southeast Asia, and several Australian firms have provided funding to pilot projects. Switzerland is home to both the World Wide Fund for Nature (WWF) and the International Union for the Conservation of Nature (IUCN), among other prominent organizations.

If these clusters provide an adequate summary of the network data, the grouping of countries in the purple cluster provides evidence against both the world-systems and “aidification” interpretations of REDD+. To test the significance of these clusters, we use them as explanatory variables in five QAP regression models, with the degree/outdegree of nodes in each network as the dependent variable. Results from these estimations are presented in Table 5.3, where we are able to reject the hypothesis that the clusters provide no empirical information. Across all models, the $R^2$ values
Table 5.3: QAP regression analysis to test significance of clusters derived from structural blockmodel. Values in parentheses indicate the proportion of coefficient or $R^2$ estimates more extreme than observed values across 10,000 permutations. Green category excluded as reference. N=122. Estimated in UCINET 6 (Borgatti et al., 2002).

<table>
<thead>
<tr>
<th>Partition</th>
<th>Projects</th>
<th>FCPF</th>
<th>Standards</th>
<th>F. C. Asia</th>
<th>Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple</td>
<td>44.3</td>
<td>9.29</td>
<td>8.92</td>
<td>52.9</td>
<td>515.18</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.09)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Orange</td>
<td>19.0</td>
<td>6.45</td>
<td>1.49</td>
<td>2.50</td>
<td>58.7</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(0.01)</td>
<td>(0.71)</td>
<td>(0.89)</td>
<td>(0.65)</td>
</tr>
<tr>
<td>US</td>
<td>761</td>
<td>84.3</td>
<td>185</td>
<td>618</td>
<td>2560</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Intercept</td>
<td>1</td>
<td>0.711</td>
<td>0.377</td>
<td>0.632</td>
<td>2.94</td>
</tr>
<tr>
<td></td>
<td>(1.00)</td>
<td>(1.00)</td>
<td>(1.00)</td>
<td>(1.00)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.90</td>
<td>0.60</td>
<td>0.92</td>
<td>0.83</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
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<td>(0.01)</td>
</tr>
</tbody>
</table>

are significantly greater than what would be expected based on permutation.\(^\text{26}\) The purple and yellow clusters both have coefficients significantly above expected values from the permutation tests in all but one of the networks, suggesting they are useful simplifications of network patterns.

The orange cluster does not do as well as the others and only once reaches the standard 0.05 level of statistical significance. Across all the networks, it has systematically lower coefficients than the other clusters. This finding is interesting given that this cluster picks out many countries in Africa and Latin America where pilot

\(^\text{26}\)It is important to remember that with this model the $R^2$ should be interpreted only relative to the distribution of $R^2$ values from simulated data and not as an absolute value, as $R^2$ values are likely inflated due to the use of network data.
projects and other REDD+ activities are numerous. In other words, the level of activity by organizations headquartered in these countries, as reflected in the network datasets reported here, is statistically indistinguishable from countries in which there is any level of activity on REDD+ at all.

While we should be careful in substantively interpreting the individual coefficients, as there are not clear standard errors for these estimations, it is noteworthy that the ranking of coefficients for the different partitions is consistent across all the models, with the US always being highest, followed by purple and then orange. These rankings are generally consistent with qualitative knowledge about levels of transnational activity related to REDD+ and may not be particularly surprising in light of discussions in Chapters 2 and 3.

The concentrated polycentric understanding of global governance, in which a few dominant regions in the core are supplemented by emerging centers of policymaking in select peripheral and semi-peripheral areas, performs the best of the three remaining hypotheses in explaining network patterns as analyzed through structural blockmodeling. While a considerable amount of the funding for REDD+ is certainly passing through development channels, considering multiple modes of policy engagement suggests that “aidification” is not the only story, and while core countries are clearly dominant in these networks, organizations in other places can play active roles. REDD+ has also raised the prominence of policy communities active in at least some of the countries where interventions are envisaged, a phenomenon noted in Chapter 4, and the intersection of these transnational and local political networks can be a point at which organizations can turn global policy discourses to specific local ends.

At the same time, this analysis strongly suggests that the US is “in a class of its own” when it comes to REDD+. The coefficient values of the US indicator variable
are much higher than those for the other two clusters across all networks.\textsuperscript{27} The distinctiveness of the US (as opposed to donor or developed countries as a whole) would not be consistent with any of the competing spatial structures other than concentrated polycentricity.

5.5 Discussion

While certainly not the decentralized, “flat” world hoped for by proponents of decentralized approaches to climate change mitigation, the exploratory findings of this chapter are less bleak than the world-systems view. That even at this very aggregate level of analysis some peripheral and semi-peripheral countries emerge on par with some core countries is promising, though there are clearly many parts of the world where national ownership of REDD+ – at least outside the state – is very weak, and US organizations are clearly dominant in the network of REDD-related activities.

Based on the fieldwork in Central Kalimantan reported in Chapter 4, it seems certainly possible for local civil society members to engage with the transnational REDD+ agenda and find ways to make it their own. Encouraging further localization of REDD+ policy creation, in part by supporting policy communities emerging in countries like Brazil, Kenya, Indonesia, and Nepal, could be an important way to move closer to the ideal of inclusion imagined by deliberative democratic theorists.

\textsuperscript{27}This is, in part, because the US gets “credit” for the connections held by organizations like the United Nations and World Bank, whose headquarters are located in the US, but the presence of these organizations, combined with the historical interest in forest carbon offsets in the country discussed in Chapter 3, gives US-based organizations an advantage in promoting REDD+.
Yet this analysis should also raise some concerns. Countries classified in the orange group are important sites of REDD+ activity, but network involvement of organizations in these countries (including activities within those countries themselves) is indistinguishable from what would be expected at random chance given the structure of the network data. This could be because organizational activities in these places were missed in the data collection, but the strength of the findings should give us pause, as it suggests that these are places where there may be a significant lack of local ownership of REDD+. If REDD+ is to be successful – or even ethical – it likely will be necessary to find ways to make the REDD+ process in these places more inclusive.

While this chapter has been specifically focused on REDD+ policy, the basic questions involved could be asked of a range of global policy interests. While the geography of REDD+ clearly reflects the distribution of tropical forests, the general patterns observed here could obtain for many other networks. Comparative analysis of other policy domains is necessary to provide sufficient data to develop theories to account for the emergence, dynamics, and geography of new forms of governance in a changing social world.
Chapter 6: Conclusion

Reducing Emissions from Deforestation and Degradation (REDD+) has been a prominent feature of international climate change policy since the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Montreal in 2005 and particularly since the Bali COP in 2007. While there has been an explosive growth in REDD-related activities since that time, there is no formal global structure for REDD+ due to stagnation in UNFCCC negotiations. Even though REDD+ “remained far ahead of overall negotiations” (Zwick, 2012) at the most recent COP in Doha, a confrontation between Norwegian and Brazilian negotiators over requirements for third-party emissions verification resulted in a failure to issue any substantive guidance – the first time this has happened since REDD+ formally entered debate at Bali (World Wide Fund for Nature, 2012). Continued disappointments at the UNFCCC are taking their toll. Zwick (2012) reports that at Doha delegates unofficially confirmed that for many governments, the UNFCCC is becoming a framework for coordinating national or regional efforts, rather than the basis for global action.28

As noted in Chapter 2, however, REDD+ is more of an adjective than a noun, and its moderate autonomy from the UNFCCC process may be an asset for proponents.  

28That said, if there is to be global action, it is highly likely that REDD+ or something like it will be involved, as there is still a high level of general support for forest protection among both developed and developing country governments (Kovacevic, 2012).
California, for example, is continuing with a bilateral offsetting program with the states of Acre, Brazil, and Chiapas, Mexico, which grew out of discussions under the Governors’ Climate and Forests Task Force (GCF) (REDD Offsets Working Group, 2013a). A similar offsetting mechanism is also a subject of negotiations between Japan and Indonesia (Climate Connect Newsdesk, 2011).

As these efforts demonstrate, climate policy and REDD+ do not go away in the absence of agreement under the UNFCCC. Rather, they continue in the much messier world of transnational networks forming the skeletal structure of global climate policy. Getting these networks “right” is a central challenge for those concerned with climate change, whether or not global agreement can be achieved.

I began this dissertation by asking a series of broad questions about global climate policy. Specifically, I said we need to know both how climate policy is produced – that is, what types of actions count as doing policy – and who produces it, understood in both an organizational and a geographic sense. The key normative concern, “How can REDD+ be more democratic?” presupposes the empirical analysis undertaken to answer the first two questions. In this concluding chapter, I review answers to the empirical and normative questions before reflecting on key insights for future research.

6.1 Reviewing the Key Questions

This dissertation began with a normative justification, based in deliberative democratic theory, for foregrounding communicative action in the study of the geography of transnational policy networks. The operative concept of communication used in this dissertation is drawn from work by theorists of deliberative democracy. For these writers, political acts are justified only inasmuch as they can be assented to by all
those affected in the process of uncoerced, reasoned debate (Habermas, 1996, p. 107). Though in a sense utopian, this basic principle provides an aspirational criterion for judging social and political systems.

On the basis of deliberative democratic theory, I began by asking a normative question: “**How can global climate policy become more democratic?**” This question is of course both too broad and too empirically vague to be answered in a whole dissertation or even a research trajectory, but it can motivate a series of more detailed empirical questions which can then be investigated in particular issue areas of global climate policy.

My empirical questions are subordinated to the broader objective of understanding “blockages” in deliberative democratic participation in the governance of climate change. The first question is quite basic: “**How is global climate policy produced?**” This was understood to refer to the processes by which particular forms of climate governance are created. Answering this question adequately requires detailing the types of actors involved in global climate policymaking, the modes under which involvement takes places, and the types of decisions or political strategies that are adopted through these processes.

The second key question is more specific: “**Who produces global climate policy?**” As I have noted, this *who* is understood in both a traditional and a geographic sense. By *who* I intend, first, those types of organizations that become most central in directing the transnational development of REDD+ policy and, second, the *places* that become most important for policy development. The *who* question also has a negative sense, which is the source of its normative interest: “**Who is not a part of climate policymaking?**” In other words, the empirical analysis of the geography of informal networks engaged in the development of REDD+ policy is intended to
provide the basis for an initial assessment of whether and how these informal policy processes might be made more inclusive. I review the answers to these questions developed in this dissertation in the following section.

6.2 Review of Findings

Empirically, the dissertation provides evidence that REDD+ policy is spatially centralized and identifies key hubs of policymaking in Washington, DC, and Geneva, as well as secondary hubs in the San Francisco Bay Area, New York, London, and Jakarta. Some of these spatial patterns – and the prominent actors within them – have been quite surprising, and I review the empirical findings and surprises here before moving on to the normative question.

6.2.1 How is transnational REDD+ policy produced?

Throughout the background and substantive chapters, I have suggested a diverse range of organizations fulfill many different roles in the creation of REDD+ policy. Lacking a formal institutional framework, REDD+ is more of an adjective than a noun, describing a set of activities ranging from pilot projects to REDD-readiness capacity building, all aimed to link forest conservation to the mitigation of greenhouse gas emissions.

Perhaps the most surprising finding in this regard is that REDD+ experienced massive growth in interest and in actual impact (measured in terms of pilot projects and funding flows) in the absence of any centralized institutional authority. Instead, REDD+ has grown on the basis of an expected future institution that may never solidify. In the effort to prepare for a future in which avoided deforestation offsets could
compose a sizable portion of carbon market portfolios, organizations have engaged in strategies that could help bring that outcome about — that is, organizations engaged in REDD+ are constructing the very future to which they are responding. Of course, that these actions are being taken does not itself imply that they will be successful, as Chapter 4 indicates.

In addition to the transnational flows and widespread expectations underpinning the growth of REDD+, Chapter 4 identifies a process of “reaching in” — that is, a process of translating abstract policy models produced in large part in the centers of REDD+ policymaking into concrete regulations for protecting forests in particular places. This process, most crucial if REDD+ is to actually fulfill its proponents’ promises, is quite challenging. Lack of institutional capacity, as well as the legacies of more authoritarian political systems and conservation approaches, limit the potential democratic participation that would be necessary to legitimize and — in principle — effectively translate abstract policy models into concrete circumstances.

Here, too, there were surprises. While REDD+ was politically contentious in Central Kalimantan, it was contentious only among a relatively limited group of people. Outside a few people in government agencies, some interested NGOs, and various international agencies, REDD+ was relatively unknown. In part this signified a failure of consultation and awareness-raising, but it also suggests a lack of interest. That is, at the time of the fieldwork REDD+ was so abstract and so far from actual implementation that it had yet to stoke the interest of affected parties. Even palm oil plantation firms, despite REDD+’s potential threats to their interests, were disengaged.29

29 Although it should be noted that this was perhaps because they anticipated being able to use bribery to avoid any regulative hurdles.
6.2.2 Who produces REDD+ policy?

This second question is already implicated in the previous one. As I noted above, a range of organizations (the datasets used in this dissertation identify over 1,500) have become involved in REDD+ policymaking in a variety of ways. While there is definitely a difference in organizational involvement in different kinds of activities, there does seem to be a core set of organizations that are highly involved in a variety of ways. Many of these were identified in Table 3.1.

Not surprisingly, international organizations like the United Nations and the World Bank are prominent in REDD+, acting as a source of expertise, standards, and funds. Also notable is the significance of development agencies, particularly in Europe, which perform similar functions. Transnational conservation organizations like The Nature Conservancy, World Wide Fund for Nature, and the Wildlife Conservation Society are active in pilot projects, providing policy advice, and producing publications related to REDD+. Discourses about REDD+ are also likely affected by research organizations like the Center for International Forestry Research, the World Agroforestry Center, and the Rights and Resources Initiative.

One surprising result here is the relative insignificance of firms in REDD+. While firms are dominant in numerical terms in the pilot project network, Chapter 3 indicates they do not necessarily occupy key roles (with the possible exception of McKinsey). Despite that REDD+ is understood as an emerging neoliberal policy, the private sector may not be particularly prominent in directing its development at present.

Answering the who question in the geographic sense was also informative. Chapters 3 and 5 highlight the importance of US-based organizations in the global REDD+ network – a surprising finding, given that the US government has itself been relatively lukewarm on REDD+ (which helps explain its limited activities outside of
pilot project sponsorship, seen in Table 3.1). This finding is explicable, however, given that many of the organizations that were first involved in avoided deforestation activities in the 1990s are based in Washington, DC.

The who question also encompasses who is not involved in REDD+ policymaking. This issue was the particular focus of Chapter 4. Corroborating claims that REDD+ policymaking can be insufficiently inclusive, the fieldwork suggests the spatially centralized patterns of transnational REDD+ policy, coupled with low institutional capacity and the legacies of authoritarianism, severely limit deliberative participation in REDD+.

At the same time, the fieldwork revealed some surprising innovations and work to boost deliberative participation. The efforts of organizations sponsoring BorneoClimate.info and disseminating press releases via websites like REDD-Monitor demonstrate creative ways to promote deliberation based in deep familiarity with conditions in the province. The use of text-message-based micro-blogging, while nascent, is particularly intriguing. While these initiatives certainly do not approximate an ideal speech situation, they are good examples of reformist steps that could push REDD+ in that direction. In the following section, I consider some of these normative implications more clearly.

6.2.3 How can REDD+ be more deliberatively democratic?

Di Gregorio et al. (2012) note variation across countries in the degree to which REDD+ is led by state governments, civil society, or transnational organizations. In many of the cases they survey, they note that REDD+ policy creation remains “top-down.” From the perspective of people in Central Kalimantan, as well, REDD+ seemed to come from the outside, as an intervention. While REDD+ has created
opportunities for organizations based in the province to bring traditional land rights, the destructive effects of palm oil plantations, and other long-standing concerns to a broader audience, it has also reinforced the influence of organizations with strong transnational connections and general technical abilities. This is evidence that the democratic promises of polycentric governance are not being delivered. The question, then, is what can be done about this.

Detailed policy prescriptions unfortunately cannot be rigorously underpinned by the evidence presented in this dissertation, so my discussion here should be understood as offering some modest rules of thumb. The first is that funding decisions should be devolved. While it is unlikely donor governments, funds, and foundations will give up oversight to third parties, bringing funding decisions physically closer to the places where they are implemented can lower barriers for organizations in those areas. Access to funding from organizations based in the global North is likely a key driver of centralization in the REDD+ network. As noted in Chapter 3, large conservation organizations seem much more likely to be able to partner with donors or foundations than other organizations, which could reflect advantages in access and name recognition. Some organizations working in Central Kalimantan, such as the Clinton Foundation and USAID, already seem to be adopting a version of this approach.

Second, it is not a problem for REDD+ to be an adjective. While the lack of formal institutionalization places limits on available funding and possible scope, it also lends the concept of REDD+ sufficient flexibility to be adapted to specific situations. Although, as one person in Central Kalimantan put it, REDD+ could become like a plane too full to get off the ground, conceptual vagueness allows it to
be appropriated to address longstanding issues that in any case must be faced if forest conservation efforts are to be successful.

Finally, for REDD+ to be effective, we should move from a concept of “stakeholders” to “rightsholders,” a move advocated by many civil society organizations in Central Kalimantan and elsewhere. In that context, the idea means moving from a view of people living near forests as stakeholders affected by forest policies who should be consulted to a view of them as residents holding rights to affected lands. This perspective would be backed up by ongoing efforts to map and more effectively and formally recognize traditional land tenure.

While analogs of this approach could be envisioned for other tropical forest areas, I intend a more expansive interpretation of the move from stakeholders to rightsholders. The discourse principle essentially implies a “right to deliberation” in cases where one’s well being is affected by a political act. Dryzek (2009)’s three criteria for deliberation (non-coercion, inclusiveness, and consequence) could be understood as foundational rights for those affected by REDD+ and other climate projects. While participation is certainly included as a goal in many REDD+ project standards, it is often part of general guidelines, rather than strict requirements. A more robust conception of a “right to consequential deliberation” at the heart of public and private standards could be a way to improve the quality of stakeholder engagement and empower people affected by REDD+ to participate in climate governance more fully.

6.3 Orienting Future Research

While unique in many ways, REDD+ can still tell us a great deal about global climate policy if the general network patterns discussed here hold for other issue areas. There is some evidence that this is the case. In a survey of 60 transnational
climate governance initiatives, Bulkeley et al. (2012) find that 87% were initiated by actors in the global North, despite involvement of countries in the global South in 46 cases. In addition, the funding control that is a source of considerable influence over REDD+ for governments like Norway is the same across issue areas. Market-based environmental policies, for example, require financial flows from the global North to South that may generate patterns similar to those observed in the case of REDD+. These considerations suggest a few general lessons from REDD+ might have broader applicability in future research.

The first is that climate policy is not just about governments (despite often being driven by them), and even when it is, it is not just about governments acting within their territorial boundaries. Many of the organizations involved in REDD+ are also active in other domains of climate policy, engaging in analogous activities. Policy papers, pilot projects, lobbying, and awareness raising are not activities unique to forests. In the global South, the support of non-state and development organizations is a crucial component of climate policy, and this messy skeletal structure must be capable of delivering whether a global agreement is concluded or not.

The second lesson is that institutionally decentralized and practically decentralized are two very different things. While it may be the case that decentralization in global climate policy can be successful in convincing governments to take more meaningful actions in the climate arena, if funding, policy debates, and technical knowledges retain the structures found in the case of REDD+, climate policy will not be meaningfully decentralized, and many challenges associated with centralized systems – particularly the bandwidth problem with its implications for deliberation – are likely to persist.
The third lesson, following from this, is that spatial relations matter. The easy accessibility of Palangkaraya from Jakarta but not Murung Raya, for example, has important political implications. Barriers to travel, whether in the form of costs or visa restrictions, can make it very difficult for organizations in the global South to engage decisions taken and debates held in places like New York or Washington. This dynamic was visible even within Central Kalimantan itself. The villagers whose livelihoods were likely to be most directly affected by REDD+ could not simply walk into the plush meeting rooms in the Hotel Aquarius or Rungan Sari, where many provincial discussions were held. To the degree that global climate policy debates and proposed governance architectures proceed as if states are the only actors and exist on the head of a pin, these discussions are unlikely to lead to effective and equitable climate policy.

While these lessons are somewhat pessimistic, there is a fourth lesson that comes in particular from Central Kalimantan that is more hopeful. People living in the places where climate policy is to be implemented can adapt or challenge policy discourses to address long-standing problems. The expansion of Internet access has been particularly helpful in making this possible. In Central Kalimantan, a coalition of NGOs are using Web 2.0 technologies to broaden the discussion on forests, while other groups have used popular blogs to challenge the way REDD+ activities have unfolded in the province and bring attention to the problems posed by the expansion of palm oil plantations.

On the basis of these insights, research moving forward should both increase in detail and branch out. The use of more detailed formal surveys, which could disaggregate transnational organizations into individual branch offices, identify active

Although, notably, I could.
organizations not captured in available datasets, and provide more detail on the “micro-politics” (Deleuze & Guattari, 1987) of REDD+ would certainly be beneficial. It would also be interesting to move into other areas of climate policy, such as the Clean Development Mechanism, to develop an understanding of the degree to which the outcomes we see in REDD+ are related to specific problems of forest politics. Finally, this research would be complimented by more detailed ethnographic work on the places where REDD+ policy models are produced. Understanding informal and everyday relationships between organizations in places like Washington, DC, Geneva, or San Francisco could reveal ways spatial centralization causes problems for policy development in these hubs, as well as developing and testing explanations for why such hubs emerge.

6.4 Conclusion

REDD+ is a challenging example of current trends in global climate policy. In the absence of global agreement and waning faith in the UNFCCC process, institutionally decentralized approaches may be all that remain. Whether we are left only with piecemeal approaches or whether a grand unified treaty can be concluded, however, the informal and quasi-formal relationships that make up transnational climate policy will continue to have considerable influence on the efficacy and equity of actions to mitigate and adapt to climate change.

Studying this informal skeletal structure using REDD+ as an example, I have argued that despite its institutional decentralization or fragmentation, policymaking remains spatially centralized, a situation I characterize as concentrated polycentricity. This spatial and relational structure encounters many of the problems associated with centralization while forgoing advantages in coordination. I have argued, in particular,
that this structure is likely to exhibit a considerable “bandwidth problem” because the social and spatial distance between the places where policy is formulated and the places it is to be enacted is so great. The consequence is a barrier to participation in REDD+ governance on the part of those most directly and immediately affected, a lack of inclusive and consequential deliberation that is normatively troubling from a deliberative democratic perspective.

While these observations are disheartening, they need not be crippling. There are some rules of thumb that can help to make the most of the messiness of the policy networks supporting REDD+, and I have suggested that effective spatial decentralization, flexibility, and deliberative rights could in principle push REDD+ away from a concentrated polycentric structure to a polycentric one. Given the spatial patterns observed in Chapter 5, however, there is a long way to go.

Despite that COPs may continue to be disappointing and the democratization of projects like REDD+ may be slow in coming, those concerned with global climate policy must play the hand that they are dealt. Rather than continuing to lament the weakness of global institutions, our efforts may be better spent turning to the messier but more achievable goals of finding ways to get extant transnational networks “right.” There is certainly enough work to be done in this area to keep all students of climate policy busy for a very long time.


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Resosudarmo, I. A. P., Duchelle, A. E., Ekaputri, A. D., & Sunderlin, W. D. (2012). Local hopes and worries about REDD+ projects. In A. Angelsen, M. Brockhaus,
W. D. Sunderlin, & L. Verchot (Eds.), *Analysing redd+: Challenges and choices* (pp. 193–208). Bogor, Indonesia: Center for International Forestry Research.


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Appendix A: Working with the Center for International Forestry Research

A member of the Consultative Group on International Agricultural Research (CGIAR), the Center for International Forestry Research (CIFOR) was formed in the year after the Earth Summit in Rio de Janeiro, though plans had been ongoing for some time. Influenced by the integrative view of environment and social issues characterizing the Earth Summit, CIFOR’s leadership decided to specialize in forest policy, in contrast to the biophysical focus of several other CGIAR centers. After a competitive bidding process, Indonesia was chosen to host the Center, which has its current headquarters in Bogor, about an hour’s train ride south of Jakarta.

Due to limited funding within the CGIAR network, the Center from the beginning was designed to operate with a smaller staff and less physical plant, placing a premium on collaboration with outside researchers (Center for International Forestry Research, 2003). Through these networks, the Center engaged in large-extent, comparative projects bringing together researchers from a variety of disciplines (Center for International Forestry Research, 2000). As an institution, CIFOR was designed to undertake research that would inform policy, so collaboration could also mean working with organizations like the United Nations or the World Bank, as well as the

In the interest of full disclosure, I should note that I continue to work with CIFOR as a policy network consultant.
Forestry Research and Development Agency of the Indonesian government (Center for International Forestry Research, 2003). These efforts have borne fruit. In 2004, for example, CIFOR reported that recommendations from the institution’s research had been incorporated in forest laws in eight countries (Center for International Forestry Research, 2004).

One of the areas in which CIFOR has been active is the debate over the role of forests in climate change. The institution was a prominent participant in discussions about the role of forests under the United Nations Framework Convention on Climate Change (UNFCCC) (Center for International Forestry Research, 2000), promoting rules for the Clean Development Mechanism (CDM) designed to increase accessibility to this funding source for smallholders (Center for International Forestry Research, 2005). When Reducing Emissions from Deforestation and Degradation (REDD+) entered UNFCCC discussions, CIFOR researchers pointed to over a decade of their own work on the complexity and heterogeneity of deforestation drivers, challenging the perspective of the Stern Review that forestry offsets would be easy and cheap (Center for International Forestry Research, 2006). In 2007, CIFOR convened the first Forest Day, held at the Conference of Parties (COP) to the UNFCCC in Bali, to promote discussion of forests in global climate policy (Center for International Forestry Research, 2007). The event, which has been held at every COP since, has become an important feature of UNFCCC negotiations and a platform for CIFOR leaders and researchers to advocate the inclusion of forests in a global climate agreement under a framework that would benefit smallholders (Center for International Forestry Research, 2007, 2008b, 2010a). By 2008, CIFOR had become a supporter of

31CIFOR researchers have also been engaged in debates regarding methods for funding sustainable forest management in developing countries for over a decade (Center for International Forestry Research, 2000).
the basic idea of REDD+, and the institution’s annual report declared – albeit with certain caveats – REDD+ was “an idea whose time has come” (Center for International Forestry Research, 2008b).

The Center’s role in policy debates was backed by its activities as a research organization. During the early days of the Kyoto Protocol, CIFOR conducted research suggesting fears that inclusion of forest offsets in the climate regime would swamp the market were overblown (Center for International Forestry Research, 2001). In 2005, the Center expanded its efforts, embarking on a large comparative project to study the role of forests in climate adaptation and beginning comparative research on Payment for Ecosystem Services (PES) systems (Center for International Forestry Research, 2005). CIFOR research has sometimes pushed against popular wisdom, noting the benefits of swidden agriculture (Center for International Forestry Research, 2001), challenging the tendency of researchers to treat forest communities as homogenous units (Center for International Forestry Research, 2004), and arguing against many NGOs that timber extraction and smuggling in some Southeast Asian countries is not solely driven by Western actors (Center for International Forestry Research, 2005).

In its role as a research and advisory institution, CIFOR must walk a fine line. While officially taking no positions on policies, CIFOR’s most recent Director General characterized the institution’s role as answering a series of “if-then” questions. That is, CIFOR research is supposed to provide instrumental knowledge about how best to achieve broad policy objectives. In the case of REDD+, for example, this includes a muted support for carbon markets and advocacy of much stronger protections for the rights and involvement of forest-dwelling peoples (Lang & Seymour, 2012).

32At times, it has been alleged, this position blurs on open advocacy (Lang, 2012).
REDD+ comprises a significant part of the Center’s research agenda for 2011-2013. One of the six major projects chosen for this period – the one under which the research reported in Chapter 4 was undertaken – was devoted entirely to REDD+ (Center for International Forestry Research, 2010b), and “enhancing the role of forests in mitigating climate change” is one of CIFOR’s six priority areas for 2008-2018 (Center for International Forestry Research, 2008a).

The bulk of this research is undertaken as part of the Global Comparative Study on REDD (GCS-REDD), discussed in Chapter 4. A four year project sponsored by the governments of Norway, Australia, the UK, US, and EU, the GCS-REDD is a full-spectrum study encompassing political and institutional arrangements, effects on people’s livelihoods, and methods of carbon measurement, involving around 35 people formally working for CIFOR and over 100 researchers when all collaborators are considered (Lang & Seymour, 2012). Component 1, which encompasses research on national REDD+ policies and processes, was the umbrella under which the fieldwork reported in Chapter 4 was undertaken. The work is based on a triangulation of media, network, and discourse analysis to understand the way power relations and institutions affect the development of REDD+ policies in a variety of countries (Brockhaus & Di Gregorio, 2012).

Working with CIFOR was an engaging and challenging experience. Stepping into a large and ongoing research enterprise necessarily required the sacrifice of some of the academic autonomy that I might have enjoyed in another situation. This was not because CIFOR in some way dictated results but rather due to the necessity of adapting research plans to already established methodologies. This determined the sort of questions to be asked and the means of asking them but also provided a
Figure A.1: The author at CIFOR headquarters in Bogor, Indonesia. Photograph by Moira Moeliono.

research methodology that had already been tested and could be compared across a variety of national contexts.

Stepping into a large project midway through, however, also meant adopting the conceptual framework for the methods adopted. Component 1 of the GCS-REDD is based on “the four I’s”: institutions, information, ideas, and interests. An eclectic vision, Brockhaus & Angelsen (2012) characterize the “4Is” as a political economy approach that posits agents acting according their interests in the context of established institutional “rules of the game” (North, 1990) which are themselves formed as a result of ideas and ideologies. Information or knowledge can challenge institutional arrangements or ideological presuppositions and encourage actors to reflect on
their interests, though knowledge is itself a product and instrument of power. As an institutionalist myself, I found this framework sufficiently flexible for my purposes, and while I have not referred to the 4Is by name in this dissertation, the complex interplay of institutions, ideas/ideologies, interests, and information are clearly core concerns of my discussions of the challenges of concentrated polycentricity.

Working with CIFOR has some other implications for my research that may not have been so positive, however. Working for a well-known Indonesian research institution closely associated with REDD+ almost certainly opened doors in Central Kalimantan but also emphasized my subject position as a Western researcher, which certainly affected both who wanted to talk with me and what they would say about REDD+. My experience would certainly have been different if instead of working with CIFOR I had partnered with a local environmental group such as Wahli Kalteng. To some extent, these problems may have been mitigated thanks to the assistance of Ms. Rut Dini Prasti, who knew many of our interviewees and was very helpful in ensuring a relaxed and open discussion (as much as possible, that is, within the constraints of a fixed-item questionnaire).

Overall, the experience working with CIFOR was highly positive, though it should be noted that this might in part be because I share the broadly institutionalist view of the world held by my fellow researchers. The comparative method, while imposing certain methodological constraints, still allows considerable scope for the researcher’s own initiatives, interests, and autonomy. Despite being a “Big Science” project, the research is assembled piecemeal, with careful attention to the specificities of local context. Comparison becomes possible only because CIFOR has the resources and
connections to undertake detailed – even ethnographic – studies across a “Big Science” extent. While the GCS-REDD has only now reached the point at which broad comparisons might be made, I believe that interesting findings will be possible.
Appendix B: R Code

B.1 Chapter 2 Code

```r
# VOLUNTARY REDD+ PARTNERSHIP
partner <- read.csv("VRPFundData.csv", sep="","
partner$Recipient <- as.character(partner$Recipient)
partner$Funder <- as.character(partner$Funder)
partner$Recipient[partner$Recipient=="LLEE-Live and Learn Environmental Education"] <- "LLEE-Live and Learn Environmental Education"
partner$Funder[partner$Funder=="LLEE-Live and Learn Environmental Education"] <- "LLEE-Live and Learn Environmental Education"
partner$Recipient[partner$Recipient=="RIFFEAC"] <- "RIFFEAC-R sea des Institutions de Formations Forestiere et Environnementale de l???TAfrique Centrale"
partner$Funder[partner$Funder=="RIFFEAC"] <- "RIFFEAC-R sea des Institutions de Formations Forestiere et Environnementale de l???TAfrique Centrale"
partner$Recipient[partner$Recipient=="Sangha Tri-National Trust Fund Limited (Fondation TNSF-TNS Foundation)"] <- "TNSF-TNS Sangha Tri-National Foundation"
partner$Funder[partner$Funder=="Sangha Tri-National Trust Fund Limited (Fondation TNSF-TNS Foundation)"] <- "TNSF-TNS Sangha Tri-National Foundation"
```
nodes <- sort(unique(c(as.character(partner$Recipient),
                     as.character(partner$Funder))))
write.csv(nodes, "VRPnodes.csv")

#CREATE FLOW MAP
library(ggplot2)
library(reshape)
library(rgdal)
library(maptools)
library(gpclib)
gpclibPermit()

countries <- read.csv("VRPnodesCountries.csv")
partner$Out <- as.character(countries[match(partner$Funder, as.character(countries[,1])),2])
partner$In <- as.character(countries[match(partner$Recipient, as.character(countries[,1])),2])

edges <- partner[,c(5,18,19)]
names(edges) <- c("Funding","Source","Target")
edges <- rbind(edges, c(1000, "Norway", "Indonesia"))
edges <- edges[complete.cases(edges),]
edges$Funding <- as.numeric(as.character(edges$Funding))
edges <- aggregate(edges$Funding, by=list(edges[,2],
                                          edges[,3]), FUN = sum)

names(edges) <- c("Source","Target", "Funding")
edges$Source <- as.character(edges$Source)
edges$Target <- as.character(edges$Target)
self <- edges[edges$Source==edges$Target,]
edges <- edges[edges$Source!=edges$Target,]

setwd("~/Documents/Dissertation\_Prep/carbon\_markets/REDD/
       Global\_Chapter")
world <- readOGR(".", "world")
setwd("~/Documents/Dissertation\_Prep/carbon\_markets/REDD/
       Introduction")
world.plot <- fortify(world, region="NAME")
cents <- as.data.frame(coordinates(world))
cents$name <- as.character(world$NAME)
cents$name[cents$name=="Brunei Darussalam"] <- "Brunei"
cents$name[cents$name=="Korea, Republic of"] <- "South Korea"
cents$name[cents$name=="Democratic Republic of the Congo"] <- "Democratic Republic of Congo"
cents$name[cents$name=="Congo"] <- "Republic of Congo"
cents$name[cents$name=="United States"] <- "US"
cents$name[cents$name=="United Kingdom"] <- "UK"
cents$name[cents$name=="Iran (Islamic Republic of)"] <- "Iran"
cents$name[cents$name=="Cote d'Ivoire"] <- "Ivory Coast"
cents$name[cents$name=="Burma"] <- "Myanmar"
cents$name[cents$name=="Syrian Arab Republic"] <- "Syria"
cents$name[cents$name=="United Republic of Tanzania"] <- "Tanzania"

# JOIN UP THE LAT AND LONG DATA
dedges$Longout <- cents[match(as.character(edges$Source), cents$name),1]
dedges$Latout <- cents[match(as.character(edges$Source), cents$name),2]
dedges$Longin <- cents[match(as.character(edges$Target), cents$name),1]
dedges$Latin <- cents[match(as.character(edges$Target), cents$name),2]
dself$Long <- cents[match(as.character(self$Target), cents$name),1]
dself$Lat <- cents[match(as.character(self$Target), cents$name),2]

units <- as.data.frame(unique(cbind(c(edges$Longout,edges$Longin),c(edges$Latout,edges$Latin))))
names(units) <- c("Long", "Lat")

# Empty ggplot2 theme (Sparks, 2012)
new_theme_empty <- theme_bw()
new_theme_empty$line <- element_blank()
new_theme_empty$rect <- element_blank()
new_theme_empty$strip.text <- element_blank()
new_theme_empty$axis.text <- element_blank()
new_theme_empty$plot.title <- element_blank()
new_theme_empty$axis.title <- element_blank()
new_theme_empty$plot.margin <- structure(c(0, 0, -1, -1),
        unit = "lines",
        valid.unit = 3L,
        class = "unit")

# Function to generate paths between each connected node
(Sparks, 2012)
library(Hmisc)
library(reshape2)

draw_edges <- function(x, len = 100, curved = TRUE){
    fromC <- x[4,5] # Origin
    toC <- x[6,7] # Terminus
    # Add curve:
    bezierMid <- (unlist(fromC) + unlist(toC) + bezierMid) / 3 # Moderate the Bezier midpoint
    if(curved == FALSE){bezierMid <- (fromC + toC) / 2} # Remove the curve
    edge <- draw_frame(bezier(list(cbind(fromC, bezierMid, toC)), # X & y
        evaluation = len)) # Bezier path coordinates
    edge$Sequence <- (1:len)[order(1:len, decreasing=TRUE)]
        # For size and colour weighting in plot
    edge$Links <- as.numeric(as.character(x[3]))
    edge$Group <- paste(x[2], x[1], collapse = ">")
    return(edge)
}

# Generate a (curved) edge path for each pair of
connected nodes (Sparks, 2012)
plot.edges <- list()
for(i in 1:ncol(edges)){
    plot.edges[[i]] <- edgeMaker(edges[i,], len=300, curved = TRUE)
    print(i)
}
allEdges <- do.call(rbind, plot.edges) # a fine-grained path ^, with bend ^ (Sparks, 2012)

#SIZED LINKS

g <- ggplot() +
geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group), fill="grey") +
geom_path(data=world.plot, aes(long,lat,group=world.plot$group),color="white") +
geom_path(data=allEdges, aes(x = x, y = y, group = Group, # Edges with gradient
color = Sequence, size=
Links, alpha=Links)) +
scale_color_gradient(low=gray(0.1), high=gray(1), guide ="none") +
scale_alpha_continuous(range=c(0.3,0.8), guide="none") +
scale_size(name="Funding", range=c(0.25,2.5)) +
geom_point(data=units, aes(x=Long, y=Lat), size=2.5,
color="black") +
scale_y_continuous(limits=c(-75,75))+
coord_map(projection="gilbert")+
new_theme_empty

g

#PILOT PROJECT LOCATIONS

projects <- read.csv("Projects.csv")
proj.plot <- projects[,c(21,22,25)]
names(proj.plot) <- c("Lat", "Long","Area")
proj.plot$Area <- as.numeric(as.character(proj.plot$Area))
proj.plot$Area[is.na(proj.plot$Area)] <- median(proj.plot$Area, na.rm=TRUE)
proj.plot$Area <- proj.plot$Area/1000000
p <- ggplot() +
geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group), fill="grey") +
geom_path(data=world.plot, aes(long,lat,group=world.plot$group),color="white") +
geom_point(data=proj.plot, aes(x=Long, y=Lat, size=Area
), pch=21, color="white", fill="black", alpha=I(0.5)
) +
scale_size_continuous(name="Area (HA, Millions)", range =c(2,8)) +
scale_y_continuous(limits=c(-75,75)) +
coord_map(projection="gilbert") +
new_theme_empty

#STANDARDS LOCATIONS
standards <- read.csv("Standards.Sites.csv")
standards$Committees <- 1
stands.plot <- aggregate(standards$Committees, by=list(standards$Lon, standards$Lat), FUN=sum)
names(stands.plot) <- c("Long", "Lat", "Committees")
s <- ggplot() + geom_polygon(data=world.plot, aes(long,lat,group=world.
plot$group), fill="grey") +
geom_path(data=world.plot, aes(long,lat,group=world.
plot$group), color="white") +
geom_point(data=stands.plot, aes(x=Long, y=Lat, size=Committees), pch=21, color="white", fill="black",
alpha=I(0.5)) +
scale_size_continuous(range=c(2,8)) +
scale_y_continuous(limits=c(-75,75)) +
coord_map(projection="gilbert") +
new_theme_empty

#PACKAGES
library(ggplot2)
library(reshape)

#WORKING DIRECTORY
setwd("~/Documents/Dissertation\_Prep/carbon\_markets/REDD/REDDProjNetFinal")

#READ IN DATA
projects <- read.csv("REDDProjNetProjects06262012.csv")

#GET THE DATA IN THE PROPER FORMAT
projects$Start.Date <- as.numeric(as.character(projects$Start.Date))
projects$End.Date <- as.numeric(as.character(projects$End.Date))

#SUMMARY OF PROJECT TYPES
#AGGREGATE ACTIVITIES
recode <- read.csv("activities.recode.csv", sep="\t")
projects.recode <- projects[,c("Activity1","Activity2","Activity3","Activity4")]
for (i in 1:ncol(projects.recode)) {
  projects.recode[,i] <- as.character(recode[match(as.character(projects.recode[,i]),as.character(recode [,1])),2])
}

projects[,c("Activity1","Activity2","Activity3","Activity4")] <- projects.recode

#CREATE ACTIVITY MATRIX
acts <- unique(c(unique(as.character(projects$Activity1)),
  unique(as.character(projects$Activity2)),
  unique(as.character(projects$Activity3)),
  unique(as.character(projects$Activity4))))
target <- c("Activity1","Activity2","Activity3","Activity4")

proj.acts <- matrix(0,nrow(projects),length(acts))
for (i in 1:nrow(projects)){
  for (j in 1:4){
    proj.acts[i,match(projects[i,target[j]],acts)] <- 1
  }
}

proj.acts <- as.data.frame(proj.acts)
names(proj.acts) <- as.character(acts)
# AGGREGATE TARGET GROUPS

```r
recode <- read.csv("target.group.recode.csv", sep="\t")
group.recode <- as.character(recode[match(as.character(projects[,"Target.Group"]), as.character(recode[,1])),2])
projects[,"Target.Group"] <- group.recode
```

# CREATE GROUP MATRIX

```r
groups <- unique(projects[,"Target.Group"])
proj.groups <- matrix(0, nrow(projects), length(groups))
for (i in 1:nrow(projects)){
  proj.groups[i,match(projects[i,"Target.Group"],groups)] <- 1
}
proj.groups <- as.data.frame(proj.groups)
names(proj.groups) <- as.character(groups)
```

# AGGREGATE TARGET LAND USES

```r
recode <- read.csv("target.land.use.recode.csv", sep="\t")
uses.recode <- projects[,c("Target.Land.Use.1","Target.Land.Use.2","Target.Land.Use.3")]
for (i in 1:ncol(uses.recode)) {
  uses.recode[,i] <- as.character(recode[match(as.character(uses.recode[,i]), as.character(recode[,1])),2])
}
projects[,c("Target.Land.Use.1","Target.Land.Use.2","Target.Land.Use.3")] <- uses.recode
```

# CREATE USES MATRIX

```r
uses <- unique(c(as.character(projects$Target.Land.Use.1),
  as.character(projects$Target.Land.Use.2),
  as.character(projects$Target.Land.Use.3)))
target <- c("Target.Land.Use.1","Target.Land.Use.2","Target.Land.Use.3")
proj.uses <- matrix(0,nrow(projects),length(uses))
```
for (i in 1:nrow(projects)) {
    for (j in 1:3) {
        proj.uses[i, match(projects[i, target[j]], uses)] <- 1
    }
}
proj.uses <- as.data.frame(proj.uses)
names(proj.uses) <- as.character(uses)

# CREATE A DATASET AGGREGATED BY YEAR
annual <- matrix(NA, length(1995:2011), (ncol(proj.acts) +
    ncol(proj.groups) + ncol(proj.uses) + 2))
for (i in 1995:2011) {
    annual[i-1994,] <- c(i, colSums(proj.acts[(projects$Start.Date <= i) &
        (projects$End.Date >= i),]),
        colSums(proj.groups[(projects$Start.Date <= i) &
            (projects$End.Date >= i),]),
        colSums(proj.uses[(projects$Start.Date <= i) &
            (projects$End.Date >= i),]),
        sum(projects[(projects$Start.Date <= i) &
            (projects$End.Date >= i), "Protected.Area"],
        na.rm=TRUE))
}
annual <- as.data.frame(annual)
names(annual) <- c("Year", names(proj.acts), names(proj.
    groups), names(proj.uses), "Protected")
annual <- annual[, -c(9, 10, 39, 52)]

# CONVERT TO GG PLOT FORMAT
annual.ggplot <- melt(annual, id.vars="Year")
names(annual.ggplot) <- c("Year", "Type", "Projects")
annual.ggplot$Year <- as.numeric(as.character(annual.
    ggplot$Year))
annual.ggplot$Projects <- as.numeric(as.character(annual.
    ggplot$Projects))

# PLOT OF GROWTH IN MAIN PROJECT TYPES
sub.annual <- annual.ggplot[(annual.ggplot$Type ==
    "Protected") |
(annual.ggplot$Type=="Sustainable Forest Management") | (annual.ggplot$Type=="Alternative Livelihoods") | (annual.ggplot$Type=="Agroforestry"),]
sub.annual$Type <- as.character(sub.annual$Type)
sub.annual$Type[sub.annual$Type=="Protected"] <- "Protected Area"
sub.annual$Type[sub.annual$Type=="Sustainable Forest Management"] <- "SFM"
sub.annual$Type[sub.annual$Type=="Alternative Livelihoods"] <- "Alt. Livelihood"
sub.annual <- sub.annual[complete.cases(sub.annual),]
g <- ggplot(data=sub.annual, aes(x=Year, y=Projects)) +
  geom_line(aes(colour=Type), size=1.5) +
  scale_colour_brewer(name=", type=", palette=3) +
  scale_x_continuous(limits=c(1995,2012)) +
  theme_bw() +
  theme(axis.title.x=element_text(face="bold", size=25),
        axis.text.x=element_text(size=15, colour="black", face="bold"),
        axis.title.y=element_text(face="bold", size=25, angle=90),
        axis.text.y=element_text(size=15, colour="black", face="bold"),
        legend.text=element_text(size=12, colour="black", face="bold"),
        panel.background=element_rect(colour="white"),
        panel.grid=element_line(colour="white"))
g
# PLOT OF GROWTH IN TARGET GROUPS
sub.annual <- annual.ggplot[(annual.ggplot$Type=="Landowners") |
                           (annual.ggplot$Type=="Smallholders") |
(annual.ggplot$Type=="Firm" 
   | 
   (annual.ggplot$Type==" 
   ProtectedArea"),]
sub.annual <- sub.annual[complete.cases(sub.annual),]

sub.annual <- sub.annual[complete.cases(sub.annual),]
g <- ggplot(data=sub.annual, aes(x=Year, y=Projects)) +
   geom_line(aes(colour=Type),size=1.5) +
   scale_colour_brewer(name='', type="qual", palette=3) +
   scale_x_continuous(limits=c(1995,2012)) +
   theme_bw()+
   theme(axis.title.x=element_text(face="bold",size=25),
         axis.text.x=element_text(size=15, colour="black", 
         face="bold"),
         axis.title.y=element_text(face="bold",size=25, 
         angle=90),
         axis.text.y=element_text(size=15, colour="black", 
         face="bold"),
         legend.text=element_text(size=12, colour="black", 
         face="bold"),
         panel.background=element_rect(colour="white"),
         panel.grid=element_line(colour="white"))
g

#PROGRAM INVOLVEMENT MAPS
library(rgdal)
library(maptools)
library(gpclib)

gpclibPermit()

world <- readOGR('.', "world")
membership <- read.csv("countries.membership.csv")
membership <- membership[match(as.character(world.plot$id 
   ), as.character(membership$Country)),]
world.plot <- fortify(world, region="NAME")
membership <- membership[match(as.character(world.plot$id 
   ), as.character(membership$Country)),]
world.plot[,] <- membership[,]2:5

# Empty ggplot2 theme (Sparks, 2012)
new_theme_empty <- theme_bw()
new_theme_empty$line <- element_blank()
new_theme_empty$rect <- element_blank()
new_theme_empty$strip.text <- element_blank()
new_theme_empty$axis.text <- element_blank()
new_theme_empty$plot.title <- element_blank()
new_theme_empty$axis.title <- element_blank()
new_theme_empty$plot.margin <- structure(c(0, 0, -1, -1),
  unit = "lines",
  valid.unit = 3L,
  class = "unit")

# MAP THEM

g <- ggplot() +
  geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group, fill=FIP)) +
  geom_path(data=world.plot, aes(long,lat,group=world.plot$group), color="white") +
  scale_fill_gradient(low="gray",high="black", guide="none")+
  coord_map(projection="gilbert")+
  new_theme_empty

g <- ggplot() +
  geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group, fill=UNREDD)) +
  geom_path(data=world.plot, aes(long,lat,group=world.plot$group), color="white") +
  scale_fill_gradient(low="gray",high="black", guide="none")+
  coord_map(projection="gilbert")+
  new_theme_empty

g <- ggplot() +
  geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group, fill=FCPF)) +
  geom_path(data=world.plot, aes(long,lat,group=world.plot$group), color="white") +
scale_fill_gradient(low="gray", high="black", guide="none") +
coord_map(projection="gilbert") +
new_theme_empty

g <- ggplot() +
  geom_polygon(data=world.plot, aes(long, lat, group=world.plot$group, fill=VRP)) +
  geom_path(data=world.plot, aes(long, lat, group=world.plot$group, color="white")) +
  scale_fill_gradient(low="gray", high="black", guide="none") +
  coord_map(projection="gilbert") +
  new_theme_empty

g

./Ch2.R
B.2 Chapter 3 Code

```r
#PACKAGES
library(reshape)
library(ggplot2)
library(xtable)
library(igraph)

#WORKING DIRECTORY - SET ACCORDING TO FILE PLACEMENT

#READ IN DATA
projects <- read.csv("Projects.csv")[,c(1,12:15)]
names(projects) <- c("Project", "Country", "Start", "End", "Hectares")
edges <- read.csv("Edges.csv", sep="","
orgs <- read.csv("Organizations.csv", sep="","
rpin <- read.csv("R-PINEdgeclist.csv")
rpin$Organization <- as.character(rpin$Organization)
rpp <- read.csv("R-PPEdgeclist.csv")
rpp$Organization <- as.character(rpp$Organization)

#RECODE FCPF NAMES TO AGGREGATE
rpin[rpin$Organization=="UNDP",1] <- "UN"
rpin[rpin$Organization=="FAO",1] <- "UN"
rpin[rpin$Organization=="GEF",1] <- "UN"
rpin[rpin$Organization=="UN-REDD",1] <- "UN"
rpin[rpin$Organization=="GIZ",1] <- "Government_of_Germany"
rpin[rpin$Organization=="Japan_International_Cooperation_Agency",1] <- "Government_of_Japan"
```

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rpin[rpin$Organization=="ConservationInternational",1] <- "CI"
rpin[rpin$Organization=="CooperationFrancaise",1] <- "GovernmentofFrance"
rpin[rpin$Organization=="Intercooperation",1] <- "GovernmentofSwitzerland"
rpin[rpin$Organization=="FrenchDevelopmentAgency",1] <- "GovernmentofFrance"
rpin[rpin$Organization=="WorldFoodProgram",1] <- "UN"
rpin[rpin$Organization=="WorldResourcesInstitute",1] <- "WRI"
rpin[rpin$Organization=="DANID",1] <- "GovernmentofDenmark"
rpin[rpin$Organization=="ONFI",1] <- "GovernmentofFrance"
rpin[rpin$Organization=="SNV",1] <- "GovernmentofNetherlands"
rpin <- unique(rpin)
rpp[rpp$Organization=="GTZ",1] <- "GovernmentofGermany"
rpp[rpp$Organization=="UNDP",1] <- "UN"
rpp[rpp$Organization=="FAO",1] <- "UN"
rpp[rpp$Organization=="GEF",1] <- "UN"
rpp[rpp$Organization=="UN-REDD",1] <- "UN"
rpp[rpp$Organization=="KfW",1] <- "GovernmentofGermany"
rpp[rpp$Organization=="GIZ",1] <- "GovernmentofGermany"
rpp[rpp$Organization=="JapanInternationalCooperationAgency",1] <- "GovernmentofJapan"
rpp[rpp$Organization=="JapanInternationalDevelopmentCooperationAgency",1] <- "GovernmentofJapan"
rpp[rpp$Organization=="ConservationInternational",1] <- "CI"
rpp[rpp$Organization=="CooperationFrancaise",1] <- "GovernmentofFrance"
rpp[rpp$Organization=="Intercooperation",1] <- "GovernmentofSwitzerland"
rpp[rpp$Organization=="FrenchDevelopmentAgency",1] <- "GovernmentofFrance"
rpp[rpp$Organization=="WorldFoodProgram",1] <- "UN"
rpp[rpp$Organization=="WorldResourcesInstitute",1] <- "WRI"
rpp[rpp$Organization == "DANID", 1] <- "Government of Denmark"
rpp[rpp$Organization == "ONFI", 1] <- "Government of France"
rpp[rpp$Organization == "SNV", 1] <- "Government of Netherlands"
rpp <- unique(rpp)

# COMBINE RPIN AND RPP DATASETS
fcpf <- rbind(rpin, rpp)
fcpf$Organization <- as.character(fcpf$Organization)

# SUMMARIZE - TABLE 1
ct <- count(as.character(fcpf$Organization))
ct <- ct[order(ct[, 2], decreasing = TRUE), ]
ct <- ct[ct[, 2] >= 5, ]
names(ct) <- c("Organization", "Papers")
xtable(ct[, 1:2])

# CREATE ADJACENCY MATRIX FROM PROJECTS EDGELIST
projs <- as.character(projects$Project)
orgs.edges <- sort(unique(edges[, 1]))
names(orgs.edges) <- "Organization"
adj <- matrix(0, length(orgs.edges), length(projs))
for (i in 1:nrow(edges)){
  adj[match(edges[i, 1], orgs.edges), match(edges[i, 2], projs)] <- 1
}

# REMOVE UNINCLUDED ORGANIZATIONS FROM PROJECTS DATASET
orgs.included <- unique(orgs[which(as.character(orgs[, 1]) %in% as.character(orgs.edges)), ])
orgs.included[, 1] <- as.character(orgs.included[, 1])
orgs.included <- orgs.included[order(orgs.included[, 1]), ]

# GET THE DATA IN THE PROPER FORMAT
projects$Hectares <- as.numeric(as.character(projects$Hectares))
projects$Start <- as.numeric(as.character(projects$Start))
projects$Start[is.na(projects$Start)] <- 9999
projects$End <- as.numeric(as.character(projects$End))
projects$End[is.na(projects$End)] <- 9999

#CREATE A DATASET AGGREGATED BY YEAR
for(i in 1989:2011){
  annual[i-1988,] <- c(i, sum(projects$Hectares[(projects
    $Start <= i)&(projects$End>=i)],
    na.rm=TRUE),
    nrow(projects[(projects$Start <= i) &
    (projects$End>=i)],))
}

annual <- as.data.frame(annual)
names(annual) <- c("Year", "Hectares", "Projects")
annual$Hectares <- annual$Hectares/1000000

#CONVERT TO GGPLOT FORMAT
annual.ggplot <- melt(annual,id.vars="Year")

#PLOT OF PROJECT GROWTH - FIGURE 2
sub.annual <- annual.ggplot[(annual.ggplot$variable=="Projects"),]
g <- qplot(Year,value, data=sub.annual, geom="line",
    lineend="round", linebutt="round", size=I(1.5)) +
    scale_x_continuous('Year', limits=c(1995,2012)) +
    scale_y_continuous('Projects')+
    theme_bw()+
    theme(axis.title.x=element_text(face="bold",size=25),
    axis.text.x=element_text(size=15, colour="black",
    face="bold"),
    axis.title.y=element_text(face="bold",size=25,
    angle=90),
    axis.text.y=element_text(size=15, colour="black",
    face="bold"))
tiff("ProjChart.tif",width=8000, height=8000, res=1000,
    compression="lzw")
g
dev.off()

#PLOT OF HECTARE GROWTH - FIGURE 2
```r
sub.annual <- annual.ggplot[(annual.ggplot$variable=="Hectares"),]

g <- qplot(Year,value, data=sub.annual, geom="line", lineend="round", linebutt="round", size=I(1.5)) +
scale_x_continuous('Year', limits=c(1995,2012)) +
scale_y_continuous('Total Area (Mil. HA)')+
theme_bw()+
theme(axis.title.x=element_text(face="bold",size=25),
axis.text.x=element_text(size=15, colour="black", face="bold"),
axis.title.y=element_text(face="bold",size=25, angle=90),
axis.text.y=element_text(size=15, colour="black", face="bold"))
tiff("HectChart.tif",width=8000, height=8000, res=1000, compression="lzw")
g
dev.off()

#RELATIONSHIP BETWEEN BINGOS AND FUNDER
#PREPARE DONORS VARIABLE
donors <- colSums(adj*orgs.included$DONOR)

#PREPARE BINGO VARIABLE
bingos <- c("CI", "Fauna Flora International","TNC", "WWF", "WCS")
bingo <- ifelse(orgs.included$NAME%in%bingos, 1, 0)
bingo.sum <- colSums(bingo*adj)

#Non-BINGO NGOs
ngos <- orgs.included$NGO-(orgs.included$NGO*bingo)
ngos.sum <- colSums(ngos*adj)

#FIRMS
firm.sum <- colSums(adj*orgs.included$COMPANY)

#NON-DONOR GOVERNMENTS
non <- orgs.included$GOVERNMENT-(orgs.included$GOVERNMENT *orgs.included$DONOR)
```
non.sum <- colSums(non*adj)

#NON-BINGO PROJECTS
non.b.sum <- bingo.sum - 1
non.b.sum <- non.b.sum * -1

#PERCENTAGES - CITED IN TEXT IN SECTION 4
bingo.pct <- bingo.sum
bingo.pct[bingo.pct>1] <- 1
non.b.pct <- bingo.pct - 1
non.b.pct <- non.b.pct * -1
donor.pct <- donors
donor.pct[donor.pct>1] <- 1
ngo.pct <- ngos.sum
ngo.pct[ngo.pct>1] <- 1
firm.pct <- firm.sum
firm.pct[firm.pct>1] <- 1
gov.pct <- non.sum
gov.pct[gov.pct>1] <- 1

sum(donor.pct)/ncol(adj)
sum(donor.pct*bingo.pct)/sum(donor.pct)
sum(donor.pct*non.b.pct)/sum(donor.pct)
sum(donor.pct*non.b.pct)/sum(non.b.pct)
sum(donor.pct*bingo.pct)/sum(bingo.pct)
sum(ngo.pct*bingo.pct)/sum(bingo.pct)
sum(firm.pct*bingo.pct)/sum(bingo.pct)
sum(firm.pct*ngo.pct)/sum(ngo.pct)
sum(donor.pct*ngo.pct)/sum(ngo.pct)
sum(donor.pct*firm.pct)/sum(firm.pct)
sum(donor.pct*firm.pct)/sum(donor.pct)
sum(bingo.pct*firm.pct)/sum(firm.pct)
sum(ngo.pct*firm.pct)/sum(firm.pct)
sum(gov.pct*bingo.pct)/sum(bingo.pct)
sum(gov.pct*bingo.pct)/sum(gov.pct)
sum(gov.pct*donor.pct)/sum(gov.pct)
sum(gov.pct*donor.pct)/sum(donor.pct)
sum(gov.pct*donor.pct*bingo.pct)/sum(donor.pct)
sum(gov.pct*donor.pct*bingo.pct)/sum(bingo.pct)
sum(gov.pct*donor.pct*bingo.pct)/sum(gov.pct)
#CALCULATE DC ORGANIZATION INVOLVEMENT - CITED IN TEXT, SECTION 4


dc.edges <- edges[as.character(edges[,1])%in%dc,]
dc.projs <- unique(as.character(dc.edges[,2]))

length(dc.projs)/length(projs)

#CALCULATE US ORGANIZATION INVOLVEMENT - CITED IN TEXT, SECTION 4

us <- as.character(orgs.included$NAME[as.character(orgs.included$Country) == "US"])

us.edge <- edges[as.character(edges[,1])%in%us,]
us.projs <- unique(as.character(us.edge[,2]))
not.us <- edges[!as.character(edges[,1])%in%us,]
not.us.projs <- unique(as.character(not.us[,2]))

us.for.projs <- us.projs[us.projs%in%not.us.projs]

length(us.for.projs)/length(not.us.projs)

#PRODUCE CITY PLOTS

#ATTACH LOCATION DATA

locations <- read.csv("Locations.csv")

locations$NAME <- as.character(locations$NAME)

#CALCULATE DEGREE AND BETWEENNESS

library(tnet)

plots.out <- list()

for(i in 2000:2012){
  proj.picks <- as.character(projects$Project[[(as.numeric(as.character(projects$Start))<i)&(as.numeric(as.character(projects$End))>=i))]

  edge.picks <- edges[as.character(edges[,2])%in%proj.picks[,]

  site.picks <- locations[as.character(edges[,2])%in%proj.picks[,]
#CREATE ADJACENCY MATRIX FROM EDGELIST
orgs.picks <- unique(as.character(edge.picks[,1]))
proj.picks <- unique(as.character(edge.picks[,2]))
site.picks <- locations[match(orgs.picks,locations$NAME),c("CITY","Lon","Lat")]
adj.b <- matrix(0, length(orgs.picks), length(proj.picks))
for(h in 1:nrow(edge.picks)){
  adj.b[match(edge.picks[h,1],orgs.picks),match(edge.picks[h,2],proj.picks)] <- 1
}
deg <- rowSums(adj.b)

#WEIGHTED BETWEENNESS CENTRALITY
adj.w <- adj.b%*%t(adj.b)
adj.w <- aggregate(adj.w, by=list(as.character(site.picks$CITY),site.picks$Lon,site.picks$Lat), FUN=sum)
adj.w <- aggregate(t(adj.w[,4:ncol(adj.w)]), by=list(as.character(site.picks$CITY),site.picks$Lon,site.picks$Lat), FUN=sum)
adj.w <- as.matrix(adj.w[,4:ncol(adj.w)])
diag(adj.w) <- 0
net <- as.tnet(adj.w, type="weighted one-mode tnet")

bet <- betweenness_w(net, directed=FALSE, alpha=0.5)
normbet <- 2*bet[,2]/((nrow(bet)^2)-(3*nrow(bet))+2)

#AGGREGATE BY CITIES
out <- aggregate(deg, by=list(as.character(site.picks$CITY),site.picks$Lon,site.picks$Lat), FUN=sum)
out <- cbind(out,bet[,2],normbet)
names(out) <- c("City","Longitude","Latitude","Degree","Betweenness","NBetweenness")
plots.out[[i]] <- out[complete.cases(out),]
print(i)
}

#EXPORT SELECTED YEARS FOR MAPPING - FIGURE 3
library(foreign)
write.dbf(plots.out[[2000]],"ProjNet2000.dbf")
write.dbf(plots.out[[2005]],"ProjNet2005.dbf")
write.dbf(plots.out[[2010]],"ProjNet2010.dbf")
write.dbf(plots.out[[2012]],"ProjNet2012.dbf")
# PRODUCE ORGANIZATION-TO-ORGANIZATION NETWORK

```r
bet.out <- list()
for(i in 1990:2012){
  proj.picks <- as.character(projects$Project[(as.numeric(as.character(projects$Start))<=i)&(as.numeric(as.character(projects$End))>=i))]
  edge.picks <- edges[as.character(edges[,2])%in%proj.picks,]
  # CREATE ADJACENCY MATRIX FROM EDGELIST
  orgs.picks <- unique(as.character(edge.picks[,1]))
  proj.picks <- unique(as.character(edge.picks[,2]))
  adj.b <- matrix(0, length(orgs.picks), length(proj.picks))
  for(h in 1:nrow(edge.picks)){
    adj.b[match(edge.picks[h,1],orgs.picks),match(edge.picks[h,2],proj.picks)] <- 1
  }
  net <- adj.b%*%t(adj.b)
  diag(net) <- 0
  net <- as.tnet(as.matrix(net), type="weighted one-mode tnet")
  bet <- betweenness_w(net, directed=FALSE, alpha=0.5)
  bet <- 2*bet[,2]/((nrow(bet)^2)-(3*nrow(bet))+2)
  bet.out[[i]] <- cbind(orgs.picks,bet[1:length(orgs.picks)])
  print(i)
}

# SUMMARIZE BY TYPE
types <- bet.out[[2012]]
orgs.included$NAME <- as.character(orgs.included$NAME)
types <- merge(types, orgs.included, by.x=1, by.y="NAME", all.x=TRUE, all.y=FALSE)
types$TYPE <- as.character(types$TYPE)
types$TYPE[types$TYPE=="2"] <- "Government(N=98)"
types$TYPE[types$TYPE=="3"] <- "Firm(N=287)"
types$TYPE[types$TYPE=="4"] <- "NGO(N=170)"
types$TYPE[types$TYPE=="5"] <- "Int'l Org.(N=4)"
types$TYPE[types$TYPE=="6"] <- "Academic(N=85)"
types$TYPE[types$TYPE=="7"] <- "Fund(N=83)"
```

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types <- types[(types$TYPE!="8")&(types$TYPE!="Unknown")],

#VIOLIN PLOT
p <- ggplot(types, aes(x=factor(TYPE), y=V2))+
geom_violin(scale="width")+
geom_boxplot(outlier.size=5)+
scale_x_discrete('Organization Type') +
scale_y_continuous('Normalized Betweenness')+
theme_bw()+
theme(axis.title.x=element_text(face="bold",size=25),
      axis.text.x=element_text(size=15, colour="black", face="bold"),
      axis.title.y=element_text(face="bold",size=25, angle=90),
      axis.text.y=element_text(size=15, colour="black", face="bold"))
tiff("TypeViolin.tif",width=16000, height=8000, res=1000, compression="lzw")
p
dev.off()

#FIND ORGANIZATIONS TO PLOT
picks <- bet.out[[2012]][order(as.numeric(bet.out[[2012]][[,2]],decreasing=TRUE),1]
picks.orgs <- picks[1:20]

#TRACK THEM OVER TIME
tracking <- list()
for (i in 1990:2012){
  temp <- bet.out[[i]]
  temp <- temp[match(picks.orgs, temp[,1]),,]
temp[,1] <- picks.orgs
temp <- cbind(temp, i)
temp <- as.data.frame(temp)
temp <- temp[match(temp[,1],picks.orgs),]
temp <- cbind(temp, 1:20)
 names(temp) <- c("Organization", "Betweenness", "Year", "Rank")
 tracking[[i]] <- temp
bet.orgs <- do.call("rbind",tracking)
bet.orgs$Betweenness <- as.numeric(as.character(bet.orgs$Betweenness))
bet.orgs$Organization <- as.character(bet.orgs$Organization)
bet.orgs$Betweenness[is.na(bet.orgs$Betweenness)] <- 0
bet.orgs$Organization[bet.orgs$Organization=="WWF"] <- "World Wide Fund for Nature"
bet.orgs$Organization[bet.orgs$Organization=="CI"] <- "Conservation International"
bet.orgs$Organization[bet.orgs$Organization=="TNC"] <- "The Nature Conservancy"
bet.orgs$Organization[bet.orgs$Organization=="WCS"] <- "Wildlife Conservation Society"
bet.orgs$Organization[bet.orgs$Organization=="Fauna Flora International"] <- "Fauna & Flora International"

# HEATMAP OF BETWEENNESS CENTRALITY - FIGURE 5
library(scales)
p <- ggplot(bet.orgs, aes(Year, Organization)) +
  geom_tile(aes(fill=Betweenness), low="white", high="black") +
  scale_x_discrete("") +
  scale_y_discrete(limits=rev(bet.orgs$Organization[1:20])) +
  scale_fill_gradient(name= "Normalized Betweenness", low="white", high="black") +
  theme_bw() +
  theme(axis.ticks = element_blank(),
        axis.text.x = element_text(size=15, face = "bold",
                                   angle = 315, hjust = 0,
                                   colour="black"),
        axis.title.y=element_text(face="bold",
                                   size=25,
                                   angle=90),
        axis.text.y=element_text(size=15,
```r
colour="black",
  face="bold",
  hjust=1),
legend.title=element_text(face="bold",
  size=15),
legend.text=element_text(face="bold",
  size=12))
tiff("BetHeat.tif", width=16000, height=8000, res=1000,
  compression="lzw")
p
dev.off()

# NEW AND IMPROVED TABLE 1
# FCPF PAPER NETWORKS
# READ IN DATA
setwd("~/Documents/Dissertation_PreP/Carbon_markets/REDD/Global_Chapter")

# FAC PUBLICATIONS EDGELIST TO ADJACENCY MATRIX
fac <- read.csv("FCAPubsEdgelist.csv")
orgs <- unique(as.character(fac$Organization))
adj.fac <- matrix(0, length(orgs), max(fac$Document))
for(i in 1:nrow(fac)){
  adj.fac[match(as.character(fac$Organization[i]), orgs),
    fac$Document[i]] <- 1
}
write.csv(adj.fac, "FACPubNet.csv")

# RECODE FCPF NAMES TO AGGREGATE
recode.fcpf <- read.csv("fcpfrecode.csv")
recode.fcpf$original <- as.character(recode.fcpf$original)
recode.fcpf$recode <- as.character(recode.fcpf$recode)
rpin <- read.csv("R-PINEdgelist.csv")
rpin$Organization <- as.character(rpin$Organization)
rpp <- read.csv("R-PEEdgelist.csv")
rpp$Organization <- as.character(rpp$Organization)
new.names <- recode.fcpf[match(rpin$Organization, recode.
  fcpf$original),2]
new.names <- new.names[complete.cases(new.names)]
```

rpin$Organization[rpin$Organization %in% recode.fcpf$original] <- new.names
rpin <- unique(rpin)
new.names <- recode.fcpf[match(rpp$Organization, recode.fcpf$original),2]
new.names <- new.names[complete.cases(new.names)]
rpp$Organization[rpp$Organization %in% recode.fcpf$original] <- new.names
rpp <- unique(rpp)

#COMBINE RPIN AND RPP DATASETS
fcpf <- rbind(rpin,rpp)
fcpf$Organization <- as.character(fcpf$Organization)

#EXPORT
write.csv(unique(fcpf),"FCPFOrgState.csv")

#READ IN OTHER DATA
fcpf.data <- read.csv("FCPFOrgStateCorrected.csv")
stands.data <- read.csv("OrganizationsStandards.csv")
projs.data <- read.csv("Orgs.Projs.csv")

#COORDINATE NAMES
fac$Organization <- as.character(fac$Organization)
fcpf.data$Organization <- as.character(fcpf.data$Organization)
stands.data$Organization <- as.character(stands.data$Organization)
projs.data$NAME <- as.character(projs.data$NAME)

#READ IN COMPLETE ORGANIZATION DATA
orgs.total <- read.csv("AllOrgsListFINAL.csv")
orgs.total$Organization <- as.character(orgs.total$Organization)
orgs.total$Country <- as.character(orgs.total$Country)

#CREATE ADJACENCY MATRIX FROM EDGELIST - STANDARDS
stands.data <- read.csv("StandardsNet.csv")
stands <- unique(as.character(stands.data$STANDARD))
stands.data$Organization <- as.character(stands.data$ ORGANIZATION)
stands.link <- read.csv("OrganizationsStandards.csv")
stands.link$LINK <- as.character(stands.link$LINK)
stands.link$Organization <- as.character(stands.link$ Organization)
stands.link$LINK[stands.link$LINK==''] <- stands.link$ Organization[stands.link$LINK=='']
stands.data$Organization <- stands.link$LINK[match(stands.data$Organization,stands.link$Organization)]
recode.all <- read.csv("recodeall.csv")
recode.all$original <- as.character(recode.all$original)
recode.all$recode <- as.character(recode.all$recode)
new.names <- recode.all[match(stands.data$Organization, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
stands.data$Organization[stands.data$Organization %in% recode.all$original] <- new.names
stands.net <- unique(cbind(as.character(stands.data$ Organization),as.character(stands.data$STANDARD)))
adj.stands <- matrix(0, length(orgs.total$Organization), length(stands))
for(i in 1:nrow(stands.net)){
  adj.stands[match(stands.net[i,1],orgs.total$ Organization),match(stands.net[i,2],stands)] <- 1
}
write.csv(adj.stands,"Stands.Adj.csv")
write.csv(stands,"Standards.Names.csv")
write.csv(orgs.total,"Orgs.Total.Names.csv")
#STANDARDS COUNTS
st <- unique(stands.net)
stds.count <- table(stands.net[,1])
stds.count <- as.data.frame(cbind(names(stds.count),as. vector(stds.count)))
names(stds.count) <- c("Organization","Standards")
stds.count$Organization <- as.character(stds.count$ Organization)
stds$count$Standards <- as.numeric(as.character(stds.count$Standards))

# CREATE ADJACENCY MATRIX FROM EDGELIST - FCPF

country <- unique(as.character(fcpf$State))
adj.fcpfs <- matrix(0, nrow(orgs.total), length(country))
for(i in 1:nrow(fcpf)){
  adj.fcpfs[match(fcpf[i,1],orgs.total$Organization),
             match(fcpf[i,2],country)] <- 1
}

# FCPF COUNTS
fcpf.data <- fcpf
fcpf.data$Organization <- as.character(fcpf.data$Organization)
fcpf.link <- read.csv("OrganizationsFCPF.csv")
fcpf.link$FCPF <- as.character(fcpf.link$FCPF)
fcpf.link$PROJLINK <- as.character(fcpf.link$PROJLINK)
fcpf.link$STANDLINK <- as.character(fcpf.link$STANDLINK)
fcpf.link$PROJLINK[fcpf.link$PROJLINK=="""] <- fcpf.link$STANDLINK[fcpf.link$PROJLINK=="""]
fcpf.link$PROJLINK[fcpf.link$PROJLINK=="""] <- fcpf.link$FCPF[fcpf.link$PROJLINK=="""]
fcpf.data$Organization <- fcpf.link$PROJLINK[match(fcpf.data$Organization,fcpf.link$FCPF)]
new.names <- recode.all[match(fcpf.data$Organization, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
fcpf.data$Organization[fcpf.data$Organization %in% recode.all$original] <- new.names
fcpf.count <- table(fcpf.data$Organization)
fcpf.count <- as.data.frame(cbind(names(fcpf.count),as.vector(fcpf.count)))
names(fcpf.count) <- c("Organization","FCPF")
fcpf.count$Organization <- as.character(fcpf.count$Organization)
fcpf.count$FCPF <- as.numeric(as.character(fcpf.count$FCPF))

# EXPORT NETWORK
write.csv(adj.fcpfs,"FCPF.Adj.csv")
write.csv(country,"FCPF.Names.csv")

#PROJECT COUNTS
projs.data <- read.csv("Edges.csv")
projs.data$NAME <- as.character(projs.data$Organization)
new.names <- recode.all[match(projs.data$NAME, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
projs.data$NAME[projs.data$NAME%in%recode.all$original] <- new.names
projs.count <- table(projs.data$NAME)

#FCA COUNT
fac$Organization <- as.character(fac$Organization)
new.names <- recode.all[match(fac$Organization, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
fac$Organization[fac$Organization %in% recode.all$original] <- new.names
fac.counts <- table(fac$Organization)

#PRODUCE FINAL DATASET
data.org <- merge(orgs.total,stds.count, by.x="Organization", by.y="Organization", all.x=TRUE, all.y=FALSE)
names(data.org) <- c("Organization","City","Country","Alliance","Standards")
data.org <- merge(data.org , fcpf.count, by.x = "Organization", by.y = "Organization", all.x = TRUE, all.y = FALSE)
names(data.org) <- c("Organization", "City", "Country", 
   Alliance", "Standards", "FCPF")
data.org <- merge(data.org , projs.count, by.x = "Organization", by.y = "Organization", all.x = TRUE, all.y = FALSE)
names(data.org) <- c("Organization", "City", "Country", 
   Alliance", "Standards", "FCPF", "Projects")
data.org <- merge(data.org , fac.counts, by.x = "Organization", by.y = "Organization", all.x = TRUE, all.y = FALSE)
names(data.org) <- c("Organization", "City", "Country", 
   Alliance", "Standards", "FCPF", "Projects", "FCA")

for (i in 5:8){
data.org [,i] <- as.numeric(data.org [,i])
data.org [is.na(data.org [,i]),i] <- 0
}

#NORMALIZE SCORES
data.org$NRMStandards <- data.org$Standards/sum(data.org$Standards)
data.org$NRMFCPF <- data.org$FCPF/sum(data.org$FCPF)
data.org$NRMPProj <- data.org$Projects/sum(data.org$Projects)
data.org$NRMFCA <- data.org$FCA/sum(data.org$FCA)
data.org$MNScore <- rowMeans(cbind(data.org$NRMStandards, data.org$NRMFCPF, data.org$NRMPProj, data.org$NRMFCA))

#NEW TABLE 1
data.org <- data.org[order(data.org$MNScore, decreasing=TRUE),]
xtable(data.org[1:20, c("Organization", "Standards", "FCPF", 
   "Projects", "FCA")], digits=0)

#GATEKEEPING ANALYSIS
gate <- data.org[, c("Standards", "FCPF", "Projects", "FCA")]
sfcpf <- cor(data.org$Standards, data.org$FCPF, method="spearman")
sp <- cor(data.org$Standards, data.org$Projects, method="spearman")
sfca <- cor(data.org$Standards, data.org$FCA, method="spearman")
fcpfp <- cor(data.org$FCPF, data.org$Projects, method="spearman")
fcpffca <- cor(data.org$FCPF, data.org$FCA, method="spearman")
pfca <- cor(data.org$Projects, data.org$FCA, method="spearman")
B.3 Chapter 4 Code

```r
#PACKAGES
library(ggplot2)
library(statnet)

#WORKING DIRECTORY
setwd("~/Documents/Dissertation_Prep/carbon_markets/REDD/Chapter_3")

#CENTRAL KALIMANTAN TIMELINE
event <- c("Green Government Policy",
"Norway Agreement",
"Named Pilot Province",
"Nat.REDD+ Task Force Agreement",
"Provincial Strategy Complete",
"Provincial Strategy Active")
dates <- as.data.frame(cbind(event,time))
names(dates) <- c("Event", "Date")
timeline <- ggplot(data=dates, aes(x=time,y=0,label=Event)) + geom_text(angle=65,fontface="bold",hjust=0) +
  scale_x_continuous(name="Date", limits=c(2009.5,2013.5)) +
  scale_y_continuous(name="", limits=c(0,1)) +
  theme(panel.background = element_rect(fill='white',
        colour='white'),
        axis.text.x = element_text(size = 24, lineheight = 0.9, colour = "black", vjust = 1),
        axis.title.x = element_text(size=24),
        axis.text.y = element_blank(),
        axis.ticks.y =element_blank())
timeline

#READ IN DATA
n1k <- read.csv("N1Full.csv",header=FALSE)
n2k <- read.csv("N2Full.csv",header=FALSE)
n3k <- read.csv("N3Full.csv",header=FALSE)
n4k <- read.csv("N4Full.csv",header=FALSE)
```
n5k <- read.csv("N5Full.csv",header=FALSE)
n6k <- read.csv("N6Full.csv",header=FALSE)
n7k <- read.csv("N7Full.csv",header=FALSE)
n8k <- read.csv("N8KaltengKTOnly.csv", header=FALSE)
n8k.names <- as.character(read.csv("N8Names.csv",header=TRUE)
                           [,1])
k.act <- as.character(as.matrix(read.csv("KTActors.csv"))
actors <- read.csv("Recode.csv")
actors$Actors <- as.character(actors$Actors)
actors$Recode <- as.character(actors$Recode)
attributes <- read.csv("Actors.csv")
attributes$Recode <- as.character(attributes$Recode)
t.act <- actors$Actors
n8k <- n8k[match(k.act,n8k.names),match(k.act,n8k.names)]

#SELECT KT ONLY
select <- match(as.character(k.act),t.act)
n1kalteng <- n1k[,select]
n2kalteng <- n2k[,select]
n3kalteng <- n3k[,select]
n4kalteng <- n4k[,select]
n5kalteng <- n5k[,select]
n6kalteng <- n6k[,select]
n7kalteng <- n7k[,select]
n8kalteng <- n8k

#SELECT NATIONAL ONLY
pick <- !t.act%in%as.character(k.act)
n1k <- n1k[,pick]
n2k <- n2k[,pick]
n3k <- n3k[,pick]
n4k <- n4k[,pick]
n5k <- n5k[,pick]
n6k <- n6k[,pick]
n7k <- n7k[,pick]

#MAKE COOP MATRIX
coop <- n2k + n3k + n4k + n5k + n7k

#AGGREGATE TO COOPERATION MATRIX
coop.kalteng <- n2kalteng + n3kalteng + n4kalteng +
n5kalteng +
n7kalteng + n8kalteng
coop.kalteng[coop.kalteng>1] <- 1
coop.kalteng <- coop.kalteng*t(coop.kalteng)
kt.net <- network(as.matrix(coop.kalteng), matrix.type="adjacency", directed=FALSE)

#EXPORT TO GEPHI
detach(package:statnet)
detach(package:ergm)
detach(package:networkDynamic)
detach(package:sna)
detach(package:network)
library(igraph)

#EXPORT NETWORK MAP TO UCINET FOR PLOTTING
kt.graph <- graph.adjacency(as.matrix(coop.kalteng), mode ="undirected", diag=FALSE)
V(kt.graph)$name <- as.character(actors$Recode[select])
V(kt.graph)$type <- attributes$Type[pick]
V(kt.graph)$type[V(kt.graph)$type==1] <- "N"
V(kt.graph)$type[V(kt.graph)$type==2] <- "G"
V(kt.graph)$type[V(kt.graph)$type==3] <- "A"
V(kt.graph)$type[V(kt.graph)$type==4] <- "F"
V(kt.graph)$type[V(kt.graph)$type==5] <- "D"
V(kt.graph)$type[V(kt.graph)$type==6] <- "I"
V(kt.graph)$type[V(kt.graph)$type==7] <- "B"
kt.graph.wt <- delete.vertices(kt.graph,which(degree(kt.graph)<1))
wt <- walktrap.community(kt.graph.wt)
V(kt.graph.wt)$wt <- wt$membership
write.graph(kt.graph.wt, "ktwt.gml", format="gml")
# READ IN OPINION DATA
op <- as.matrix(read.csv("KTOpinion.csv",header=FALSE))

# VALUE "0" IS MISSING DATA
op[op==0] <- NA

# MAKE AN EMPTY MATRIX TO FILL IN VALUES OF CORRELATIONS
op.cor <- matrix(NA,nrow(op),nrow(op))

# AND FOR EUCLIDEAN DISTANCE
op.dist <- op.cor

# LOOP THROUGH THE DATA, GETTING THE CORRELATION BETWEEN EACH ROW
for(i in 1:nrow(op)){
  for(j in 1:nrow(op)){
    op.cor[i,j] <- cor(op[i,],op[j,], use="pairwise.complete.obs", method="spearman")
  }
}

# AND DISTANCE
for(i in 1:nrow(op)){
  for(j in 1:nrow(op)){
    op.dist[i,j] <- sqrt(sum((op[i,]-op[j,])^2, na.rm=TRUE))
  }
}

# CHECK THE DIAGONAL OF THE MATRIX
diag(op.cor)

# READ IN ACTIVITIES DATA
acts <- as.matrix(read.csv("KTActivities.csv",header=FALSE))

# "0" IS MISSING DATA
acts[acts==0] <- NA
#EMPTY MATRIX TO FILL IN VALUES OF CORRELATIONS
acts.cor <- matrix(NA, nrow(acts), nrow(acts))

#AND FOR EUCLIDEAN DISTANCE
acts.dist <- acts.cor

#AND DISTANCE
for (i in 1:nrow(acts)){
  for (j in 1:nrow(acts)){
    acts.dist[i,j] <- sqrt(sum((acts[i,]-acts[j,])^2, na.rm=TRUE))
  }
}

#LOOP AGAIN
for (i in 1:nrow(acts)){
  for (j in 1:nrow(acts)){
    acts.cor[i,j] <- cor(acts[i,],acts[j,], use="pairwise.complete.obs", method="spearman")
  }
}

#CHECK THE DIAGONAL
diag(acts.cor)

#AND CROSS-SCALE INTERACTIONS
#AND FOR EUCLIDEAN DISTANCE
scale.dist <- acts.cor

#AND SCALE DISTANCE
for (i in 1:nrow(coop)){
  for (j in 1:nrow(coop)){
    scale.dist[i,j] <- sqrt(sum((coop[i,]-coop[j,])^2, na.rm=TRUE))
  }
}

#CHECK THE DIAGONAL
diag(scale.dist)

#COMMON GEOGRAPHICAL SPECIALIZATION
sites <- read.csv("KTSites.csv", sep="\t")[,1:2]
sites <- sites[complete.cases(sites),]
spots <- unique(as.character(sites$Kabupaten))
geo.special <- matrix(0, length(k.act), length(spots))
site.match <- sites
site.match[,1] <- match(as.character(sites$Organization), k.act)
site.match[,2] <- match(as.character(sites$Kabupaten), spots)
for (i in 1:nrow(site.match)){
  geo.special[site.match[i,1],site.match[i,2]] <-1
}
geo.sites <- geo.special
geo.keep <- geo.sites
geo.special <- geo.special%*%t(geo.special)
#NEWMAN APPROACH
geo.focus <- geo.sites
geo.sites <- sqrt(t(t(geo.sites)/colSums(geo.sites)))
geo.sites <- geo.sites%*%t(geo.sites)
#FOCUS OF ORGANIZATIONAL INTERESTS
write.csv(cbind(spots, colSums(geo.focus)), "GeoFocus.csv")
#ERGM
#PREPARE DATA
detach(package:igraph)
library(statnet)
inst <- read.csv("institutions.csv")
names <- actors$Recode[select]
pick <- match(names, attributes$Recode)
kt.net %v% "Acts" <- rowMeans(acts, na.rm=TRUE)
kt.net %v% "Type" <- attributes$Type[pick]
kt.net %v% "Place" <- attributes$Place[pick]
north <- ifelse(attributes$Place[pick]==3,1,0)
north[34] <- 0
kt.net %v% "North" <- north
kt.net %v% "infl" <- rowSums(t(n1kalteng))
disagree <- as.network(as.matrix(n6kalteng), directed= TRUE)
```r
pilots <- read.csv("KT.Pilots.csv")
gov <- ifelse(attributes$Type[pick]==2,1,0)
gov <- gov*2
kt.net %v% "Pilot" <- pilots[match(as.character(pilots$ORGANIZATION),names),2]
kt.net %v% "Pilot.Gov" <- pilots[match(as.character(pilots$ORGANIZATION),names),2] + gov
kt.net %v% "organization" <- inst$organization
kt.net %v% "penulis" <- inst$penulis
kt.net %v% "ngov" <- ifelse(kt.net%v"Type"==2,0,1)

#ERGM - KABUPATEN
set.seed(4351)
kt.net.ergm <- ergm(kt.net~
   nodematch("Place")
   +nodecov("infl")
   +nodecov("komda")
   +nodecov("penulis")
   +nodefactor("Pilot")
   +dyadcov(op.dist)
   +dyadcov(geo.special)
   +dsp(1)
   +esp(1)
   +edges,
   control=control.ergm(MCMC.interval =1000,MCMC.samplesize=100000,MCMLE .maxit=30))
summary(kt.net.ergm)
fits.kt.net.ergm <- gof(kt.net.ergm)

#ERGM - KABUPATEN COMP 2
set.seed(4351)
kt.net.ergm3 <- ergm(kt.net~
   nodematch("Place")
   +nodecov("infl")
   +nodecov("komda")
   +nodecov("penulis")
   +dyadcov(op.dist)
   +dyadcov(geo.special)
   +dsp(1)
   +esp(1)
```
+edges,
control=control.ergm(MCMC.interval =1000,MCMC.samplesize=100000, MCMLE.maxit=30))

summary(kt.net.ergm3)
fits.kt.net.ergm3 <- gof(kt.net.ergm3)

#ERGM - KABUPATEN COMP 3
set.seed(4351)
kt.net.ergm4 <- ergm(kt.net~
  nodematch("Place")
  +nodecov("infl")
  +nodecov("komda")
  +nodecov("penulis")
  +dyadcov(op.dist)
  +dyadcov(geo.special)
  +dsp(1)
  +edges,
control=control.ergm(MCMC.interval =1000,MCMC.samplesize=100000, MCMLE.maxit=30))

summary(kt.net.ergm4)
fits.kt.net.ergm4 <- gof(kt.net.ergm4)

#ERGM KABUPATEN COMP 4 - INTERACTION TERMS FOR GEOGRAPHIC EFFECTS
kt.net %v% "geo" <- rowSums(geo.keep)
geo.together <- geo.special
geo.together[geo.together>1] <- 1
geo <- rowSums(geo.keep)
geo[16:22] <- ncol(geo.keep)
kt.net %v% "geo2" <- geo
set.seed(4351)
kt.net.ergm5 <- ergm(kt.net~
  nodefactor("ngov")
  +nodematch("Place")
  +nodecov("infl")
  +nodecov("komda")
  +nodecov("penulis")
  +dyadcov(op.dist)
  +nodecov("geo")
+nodecov("geo2")
+dsp(1)
+edges,
control=control.ergm(MCMC.interval=
1000,MCMC.samplesize=100000,
MCMLE.maxit=30))

summary(kt.net.ergm5)
fits.kt.net.ergm5 <- gof(kt.net.ergm5)

#PREDICTED PROBABILITY PLOTS
library(clusterPower)
pp.plot <- function(x){
  expit(sum(x*cf))
}
rep.row<-function(x,n){
  matrix(rep(x,each=n),nrow=n)
}
cf <- kt.net.ergm5$coef
const <- c(1,0,17,0,0,7,1,3,0,1)
pp.plot(const)
const.t <- const
const.t[1] <- 0
pp.plot(const.t)

const.pl <- const
const.pl[2] <- 1
pp.plot(const.pl)

const.i <- rep.row(const,63)
const.i[,3] <- 0:62
i.plot <- as.data.frame(cbind(const.i[,3], apply(const.i
,1,pp.plot)))
i.p <- ggplot(data=i.plot, aes(x=i.plot[,1],y=i.plot[,2])
  ) +
  geom_line(size=1(2))+
  scale_x_continuous(name="Influence")+
  scale_y_continuous(name="Probability")+
  theme_bw()+
  theme(axis.text.x=element_text(face=2,size=20),
    axis.text.y=element_text(face=2,size=20),
```r
i.p

const.k <- rep.row(const, 101)
const.k[, 4] <- seq(0, 12, 12/100)
k.plot <- as.data.frame(cbind(const.k[, 4], apply(const.k
1, pp.plot)))
k.p <- ggplot(data=k.plot, aes(x=k.plot[, 1], y=k.plot[, 2])
+ geom_line(size=I(2)) +
  scale_x_continuous(name="Seats on Provincial Committee"
) +
  scale_y_continuous(name="Probability") +
  theme_bw() +
  theme(axis.text.x=element_text(face=2, size=20),
    axis.text.y=element_text(face=2, size=20),
    axis.title.x=element_text(face=2, size=35),
    axis.title.y=element_text(face=2, size=35),
    legend.title=element_text(face=2, size=35),
    legend.text=element_text(face=2, size=20))
k.p

const.p <- rep.row(const, 101)
const.p[, 5] <- seq(0, 6, 6/100)
p.plot <- as.data.frame(cbind(const.p[, 5], apply(const.p
1, pp.plot)))
p.p <- ggplot(data=p.plot, aes(x=p.plot[, 1], y=p.plot[, 2])
+ geom_line(size=I(2)) +
  scale_x_continuous(name="Membership in Writing Team") +
  scale_y_continuous(name="Probability") +
  theme_bw() +
  theme(axis.text.x=element_text(face=2, size=20),
    axis.text.y=element_text(face=2, size=20),
    axis.title.x=element_text(face=2, size=35),
    axis.title.y=element_text(face=2, size=35),
    legend.title=element_text(face=2, size=35),
    legend.text=element_text(face=2, size=35),
)```
const.o <- rep.row(const,101)
const.o[,6] <- seq(0,13,13/100)
o.plot <- as.data.frame(cbind(const.o[,6], apply(const.o
,1,pp.plot)))
o.p <- ggplot(data=o.plot, aes(x=o.plot[,1],y=o.plot[,2])
     ) +
     geom_line(size=I(2)) +
     scale_x_continuous(name="Opinion␣Distance") +
     scale_y_continuous(name="Probability") +
     theme_bw()+
     theme(axis.text.x=element_text(face=2,size=20),
          axis.text.y=element_text(face=2,size=20),
          axis.title.x=element_text(face=2,size=35),
          axis.title.y=element_text(face=2,size=35),
          legend.title=element_text(face=2,size=35),
          legend.text=element_text(face=2,size=20))
o.p

const.g1 <- rep.row(const,101)
const.g1[,1] <- 0
const.g1[,8] <- seq(0,13,13/100)
g1.plot <- as.data.frame(cbind(const.g1[,8], apply(const.
g1,1,pp.plot)))
g1.p <- ggplot(data=g1.plot, aes(x=g1.plot[,1],y=g1.plot
[,2])) +
     geom_line(size=I(2)) +
     scale_x_continuous(name="Geographic␣Extent␣(Government)
" ) +
     scale_y_continuous(name="Probability") +
     theme_bw()+
     theme(axis.text.x=element_text(face=2,size=20),
          axis.text.y=element_text(face=2,size=20),
          axis.title.x=element_text(face=2,size=35),
          axis.title.y=element_text(face=2,size=35),
          legend.title=element_text(face=2,size=35),
          legend.text=element_text(face=2,size=20),
const.g2 <- rep.row(const, 101)
const.g2[,7] <- seq(0,13,13/100)
const.g2[,8] <- seq(0,13,13/100)
g2.plot <- as.data.frame(cbind(const.g2[,8], apply(const.
  g2,1,pp.plot)))
g2.p <- ggplot(data=g1.plot, aes(x=g2.plot[,1],y=g2.plot
  [,2])) +
geom_line(size=I(2)) +
scale_x_continuous(name="Geographic Extent (Other)") +
scale_y_continuous(name="Probability") +
theme_bw() +
  theme(axis.text.x=element_text(face=2,size=20),
  axis.text.y=element_text(face=2,size=20),
  axis.title.x=element_text(face=2,size=35),
  axis.title.y=element_text(face=2,size=35),
  legend.title=element_text(face=2,size=35),
  legend.text=element_text(face=2,size=20))
g2.p

cost.d <- rep.row(const, 101)
const.d[,9] <- seq(0,35,35/100)
d.plot <- as.data.frame(cbind(const.d[,9], apply(const.
  d,1,pp.plot)))
d.p <- ggplot(data=d.plot, aes(x=d.plot[,1],y=d.plot[,2])
  ) +
geom_line(size=I(2)) +
scale_x_continuous(name="Dyadwise Shared Partners") +
scale_y_continuous(name="Probability") +
theme_bw() +
  theme(axis.text.x=element_text(face=2,size=20),
  axis.text.y=element_text(face=2,size=20),
  axis.title.x=element_text(face=2,size=35),
  axis.title.y=element_text(face=2,size=35),
  legend.title=element_text(face=2,size=35),
  legend.text=element_text(face=2,size=20))
d.p
B.4 Chapter 5 Code

```r
# FCPF PAPER NETWORKS
# READ IN DATA
setwd("~/Documents/Dissertation Prep/carbon markets/REDD/Global/Chapter")

# FAC PUBLICATIONS EDGELIST TO ADJACENCY MATRIX
fac <- read.csv("FCAPubsEdgelist.csv")
orgs <- unique(as.character(fac$Organization))
adj.fac <- matrix(0, length(orgs), max(fac$Document))
for(i in 1:nrow(fac)){
    adj.fac[match(as.character(fac$Organization[i]), orgs), fac$Document[i]] <- 1
}
write.csv(adj.fac, "FACPubNet.csv")

# RECODE FCPF NAMES TO AGGREGATE
recode.fcpf <- read.csv("fcpfrecode.csv")
recode.fcpf$original <- as.character(recode.fcpf$original)
recode.fcpf$recode <- as.character(recode.fcpf$recode)

rpin <- read.csv("R-PINEdgelist.csv")
rpp <- read.csv("R-PPEdgelist.csv")
new.names <- recode.fcpf[match(rpin$Organization, recode.fcpf$original), 2]
new.names <- new.names[complete.cases(new.names)]
rpin$Organization[rpin$Organization %in% recode.fcpf$original] <- new.names
rpin <- unique(rpin)

new.names <- recode.fcpf[match(rpp$Organization, recode.fcpf$original), 2]
new.names <- new.names[complete.cases(new.names)]
rpp$Organization[rpp$Organization %in% recode.fcpf$original] <- new.names
rpp <- unique(rpp)
```
#COMBINE RPIN AND RPP DATASETS
fcpf <- rbind(rpin,rpp)
ccpf$Organization <- as.character(fcpf$Organization)

#EXPORT
write.csv(unique(fcpf),"FCPF0rgState.csv")

#READ IN OTHER DATA
fcpf.data <- read.csv("FCPF0rgStateCorrected.csv")
stands.data <- read.csv("OrganizationsStandards.csv")
projs.data <- read.csv("Orgs.Projs.csv")

#COORDINATE NAMES
fac$Organization <- as.character(fac$Organization)
ccpf.data$Organization <- as.character(fcpf.data$Organization)
stands.data$Organization <- as.character(stands.data$Organization)
projs.data$NAME <- as.character(projs.data$NAME)

#READ IN COMPLETE ORGANIZATION DATA
orgs.total <- read.csv("AllOrgsListFINAL.csv")
orcs.total$Organization <- as.character(orgs.total$Organization)
orcs.total$Country <- as.character(orgs.total$Country)

#CREATE ADJACENCY MATRIX FROM EDGELIST - STANDARDS
stands.data <- read.csv("StandardsNet.csv")
stands <- unique(as.character(stands.data$STANDARD))
stands.data$Organization <- as.character(stands.data$ORGANIZATION)
stands.link <- read.csv("OrganizationsStandards.csv")
stands.link$LINK <- as.character(stands.link$LINK)
stands.link$Organization <- as.character(stands.link$Organization)
stands.link$LINK[stands.link$LINK=="""] <- stands.link$Organization[stands.link$LINK=="""]
stands.data$Organization <- stands.link$LINK[match(stands.data$Organization,stands.link$Organization)]
recode.all <- read.csv("recodeall.csv")
```r
recode.all$original <- as.character(recode.all$original)
recode.all$recode <- as.character(recode.all$recode)
new.names <- recode.all[match(stands.data$Organization, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
stands.data$Organization[stands.data$Organization %in% recode.all$original] <- new.names

stands.net <- unique(cbind(as.character(stands.data$Organization),as.character(stands.data$STANDARD)))
adj.stands <- matrix(0, length(orgs.total$Organization), length(stands))
for(i in 1:nrow(stands.net)){
  adj.stands[match(stands.net[i,1],orgs.total$Organization),match(stands.net[i,2],stands)] <- 1
}

write.csv(adj.stands,"Stands.Adj.csv")
write.csv(stands,"Standards.Names.csv")
write.csv(orgs.total,"Orgs.Total.Names.csv")

#STANDARDS COUNTS
st <- unique(stands.net)
stds.count <- table(stands.net[,1])
stds.count <- as.data.frame(cbind(names(stds.count),as.vector(stds.count)))
names(stds.count) <- c("Organization","Standards")
stds.count$Organization <- as.character(stds.count$Organization)
stds.count$Standards <- as.numeric(as.character(stds.count$Standards))

#CREATE ADJACENCY MATRIX FROM EDGELIST - FCPF

country <- unique(as.character(fcpf$State))
adj.fcps <- matrix(0, nrow(orgs.total), length(country))
for(i in 1:nrow(fcpf)){
  adj.fcps[match(fcpf[i,1],orgs.total$Organization),
           match(fcpf[i,2],country)] <- 1
}

#FCPF COUNTS
```
fcpf.data <- fcpf
fcpf.data$Organization <- as.character(fcpf.data$ Organization)
fcpf.link <- read.csv("OrganizationsFCPF.csv")
fcpf.link$FCPF <- as.character(fcpf.link$FCPF)
fcpf.link$PROJLINK <- as.character(fcpf.link$PROJLINK)
fcpf.link$STANDLINK <- as.character(fcpf.link$STANDLINK)
fcpf.link$PROJLINK[fcpf.link$PROJLINK=="""] <- fcpf.link$ STANDLINK[fcpf.link$PROJLINK=="""]
fcpf.link$PROJLINK[fcpf.link$PROJLINK=="""] <- fcpf.link$ FCPF[fcpf.link$PROJLINK==""]
fcpf.data$Organization <- fcpf.link$PROJLINK[match(fcpf. data$Organization,fcpf.link$FCPF)]
new.names <- recode.all[match(fcpf.data$Organization, recode.all$original),2]
new.names <- new.names[complete.cases(new.names)]
fcpf.data$Organization[fcpf.data$Organization %in%recode. all$original] <- new.names
fcpf.count <- table(fcpf.data$Organization)
fcpf.count <- as.data.frame(cbind(names(fcpf.count),as. vector(fcpf.count)))
names(fcpf.count) <- c("Organization","FCPF")
fcpf.count$Organization <- as.character(fcpf.count$ Organization)
fcpf.count$FCPF <- as.numeric(as.character(fcpf.count$ FCPF))

#EXPORT NETWORK
write.csv(adj.fcpfs,"FCPF.Adj.csv")
write.csv(country,"FCPF.Names.csv")

#PROJECT COUNTS
projs.data <- read.csv("Edges.csv")
projs.data$NAME <- as.character(projs.data$Organization)
new.names <- recode.all[match(projs.data$NAME, recode.all $original),2]
new.names <- new.names[complete.cases(new.names)]
projs.data$NAME[projs.data$NAME%in%recode.all$original] <- new.names
projs.count <- table(projs.data$NAME)
projs.count <- as.data.frame(cbind(names(projs.count),as.
vector(projs.count)))

names(projs.count) <- c("Organization","Projects")

projs.count$Organization <- as.character(projs.count$Organization)

projs.count$Projects <- as.numeric(as.character(projs.count$Projects))

#FCA COUNT

fac$Organization <- as.character(fac$Organization)

new.names <- recode.all[match(fac$Organization, recode.
all$original),2]

new.names <- new.names[complete.cases(new.names)]

fac$Organization[fac$Organization %in% recode.all$original ] <- new.names

fac.counts <- table(fac$Organization)

fac.counts <- as.data.frame(cbind(names(fac.counts),as.
vector(fac.counts)))

names(fac.counts) <- c("Organization","FCA")

fac.counts$Organization <- as.character(fac.counts$Organization)

fac.counts$FCA <- as.numeric(as.character(fac.counts$FCA))

#VRP DATASET

partner <- read.csv("VRPFundData.csv", sep=",")

partner$Recipient <- as.character(partner$Recipient)

partner$Funder <- as.character(partner$Funder)

partner$Recipient[partner$Recipient=="LLEE- Live and Learn Environment Education"] <- "LLEE - Live and Learn Environmental Education"

partner$Funder[partner$Funder=="LLEE- Live and Learn Environment Education"] <- "LLEE - Live and Learn Environmental Education"

partner$Recipient[partner$Recipient=="RIFFEAC"] <- "RIFFEAC - R seau des Institutions de Formations Forestiere et Environnementale de l ????TAfrique Centrale"

partner$Funder[partner$Funder=="RIFFEAC"] <- "RIFFEAC - R seau des Institutions de Formations Forestiere et Environnementale de l ????TAfrique Centrale"
nodes <- sort(unique(c(as.character(partner$Recipient),
as.character(partner$Funder))))
countries <- read.csv("VRPnodesCountries.csv")
countries$Country <- as.character(countries$Country)
countries$Country[countries$Country=="Viet Nam"] <- "Vietnam"
partner$Out <- as.character(countries[match(partner$Funder, as.character(countries[,1])),2])
partner$In <- as.character(countries[match(partner$Recipient, as.character(countries[,1])),2])
edges <- partner[,c(5,18,19)]
names(edges) <- c("Funding","Source","Target")
edges <- rbind(edges, c(1000, "Norway", "Indonesia"))
edges <- edges[complete.cases(edges),]
edges$Funding <- as.numeric(as.character(edges$Funding))
edges <- aggregate(edges$Funding, by=list(edges$Source, edges$Target), FUN = sum)
names(edges) <- c("Source","Target","Funding")
vrp.count <- aggregate(as.numeric(as.character(edges$Funding)), by=list(edges$Source), FUN=sum)
names(vrp.count) <- c("Country","Funding")

#PRODUCE FINAL DATASET
data.org <- merge(orgs.total,stds.count, by.x="Organization", by.y=1, all.x=TRUE, all.y=FALSE)
names(data.org ) <- c("Organization","City","Country","Alliance","Standards")
data.org <- merge(data.org ,fcpf.count, by.x="Organization", by.y=1, all.x=TRUE, all.y=FALSE)
names(data.org ) <- c("Organization","City","Country","Alliance","Standards","FCPF")
data.org <- merge(data.org ,projs.count, by.x="Organization", by.y=1, all.x=TRUE, all.y=FALSE)
names(data.org ) <- c("Organization","City","Country","Alliance","Standards","FCPF", "Projects")
data.org <- merge(data.org, fac.counts, by.x="Organization", by.y=1, all.x=TRUE, all.y=FALSE)

names(data.org) <- c("Organization","City","Country","Alliance","Standards","FCPF","Projects","FCA")

for (i in 5:8)
{
  data.org [,i] <- as.numeric(data.org [,i])
  data.org [is.na(data.org [,i]),i] <- 0
}

#AGGREGATE BY STATE

data.state <- aggregate(data.org[,5:8], by=list(as.character(data.org$Country)), FUN=sum)
names(data.state)[1] <- "Country"
data.state <- merge(data.state, vrp.count, by.x="Country", by.y="Country", all=TRUE)
data.state[is.na(data.state)] <- 0

write.csv(data.state,"GlobalDataStateFINAL.csv")

#PRODUCE DATASET FOR QAP REGRESSION

library(reshape)

wdi <- read.csv("WDIData.csv")

wdi$Country.Name <- as.character(wdi$Country.Name)

wdi <- wdi[,c(1,3,5:9)]

wdi2 <- melt(wdi, id.vars=c("Country.Name","Indicator.Name"))

wdi2 <- cast(wdi2, Country.Name ~ Indicator.Name, mean, na.rm=TRUE)
data.state.reg <- merge(data.state, wdi2, by.x="Country", by.y="Country.Name", all.x=TRUE, all.y=TRUE)
data.state.out <- data.state.reg[,c(1:6,17,18,19,21,22,24)]

for(i in 2:7)
{
  data.state.out[is.na(data.state.out[,i]),i] <- 0
}

data.state.out$LNPOP <- log(data.state.out[,12])
data.state.out$LNFAPCT <- log(data.state.out[,8])
data.state.out$LNFA <- log(data.state.out[,9])
data.state.out$LNGDP <- log(data.state.out[,10])
write.csv(data.state.out, "GlobalRegressionData.csv")

# MAPPING INTERSTATE NETWORKS
library(ggplot2)
library(reshape)
library(rgdal)
library(maptools)
library(gpclib)
gpclipPermit()

world <- readOGR(".", "world")
world.plot <- fortify(world, region="NAME")
cents <- as.data.frame(coordinates(world))
cents$name <- as.character(world$NAME)
names(cents) <- c("Long", "Lat", "name")
cents$name[cents$name=="VietNam"] <- "Vietnam"
cents$name[cents$name=="UnitedRepublicofTanzania"] <- "Tanzania"
cents$name[cents$name=="DemocraticRepublicoftheCongo"] <- "DemocraticRepublicofCongo"
cents$name[cents$name=="Congo"] <- "RepublicofCongo"
cents$name[cents$name=="UnitedStates"] <- "US"
cents$name[cents$name=="UnitedKingdom"] <- "UK"
cents$name[cents$name=="BruneiDarussalam"] <- "Brunei"
cents$name[cents$name=="KoreaRepublicof"] <- "SouthKorea"
cents$name[cents$name=="IranIslamicRepublicof"] <- "Iran"
cents$name[cents$name=="CotedIvoire"] <- "IvoryCoast"
cents$name[cents$name=="Burma"] <- "Myanmar"
cents$name[cents$name=="SyrianArabRepublic"] <- "Syria"

# EMPTY ggplot2 THEME (Sparks, 2012)
new_theme_empty <- theme_bw()
new_theme_empty$line <- element_blank()
new_theme_empty$rect <- element_blank()
new_theme_empty$strip.text <- element_blank()
new_theme_empty$axis.text <- element_blank()
new_theme_empty$plot.title <- element_blank()
new_theme_empty$axis.title <- element_blank()
new_theme_empty$plot.margin <- structure(c(0, 0, -1, -1),
  unit = "lines",
  valid.unit = 3L,
  class = "
  unit")

#MAKE LEGEND
dat <- as.data.frame(cbind(c(-1,1),c(1,-1), c(1,-1)))
names(dat) <- c("One", "Two", "Three")
leg <- ggplot(data=dat, aes(x=One, y=Two, colour=Three)) +
  geom_point() +
  scale_colour_gradient2(name="", low="Red", high="Blue") +
  new_theme_empty +
  theme(legend.text=element_text(face=2, size = 36),
  legend.direction="horizontal",
  legend.key.size=unit(2.65, "cm"))
leg

#FCPF
fccpf.data$Source <- orgs.total[match(fcpf.data$Organization,orgs.total$Organization),"Country"]
fccpf.data$State <- as.character(fcpf.data$State)
states <- unique(c(fcpf.data$State, fcpf.data$Source))
fccpf.states <- matrix(0, length(states),length(states))
for(i in 1:nrow(fcpf.data)){
  fcpf.states[match(fcpf.data$Source[i],states),match(fcpf.data$State[i],states)] <- fcpf.states[match(fcpf.data$Source[i],states),match(fcpf.data$State[i],states)] +1
}
fccpf.inout <- as.data.frame(cbind(states,rowSums(fcpf.states),colSums(fcpf.states),diag(fcpf.states)))
names(fcpf.inout) <- c("Country","Outdegree","Indegree","Self")
fccpf.inout$Outdegree <- as.numeric(as.character(fcpf.inout$Outdegree))
fccpf.inout$Indegree <- as.numeric(as.character(fcpf.inout$Indegree))
fccpf.inout$Self <- as.numeric(as.character(fcpf.inout$Self))
fcpf.inout$Outdegree <- fcpf.inout$Outdegree - fcpf.inout$Self
fcpf.inout$Indegree <- fcpf.inout$Indegree - fcpf.inout$Self
fcpf.inout$External <- (fcpf.inout$Self - fcpf.inout$Indegree)/(fcpf.inout$Indegree + fcpf.inout$Self)

cents.f <- merge(cents, fcpf.inout, by.x="name", by.y="Country", all.x=TRUE, all.y=FALSE)
names(cents.f) <- c("name","Long","Lat","Outdegree", "Indegree", "Self", "External")
fcpf.data$Links <- 1
fcpf.plot <- aggregate(fcpf.data$Links, by=list(fcpf.data$State,fcpf.data$Source), FUN=sum)
names(fcpf.plot) <- c("State","Source", "Links")
fcpf.plot$Source <- as.character(fcpf.plot$Source)
fcpf.plot$State <- as.character(fcpf.plot$State)
fcpf.plot$LongOut <- cents.f[match(fcpf.plot$Source,cents.f$name),"Long"]
fcpf.plot$LatOut <- cents.f[match(fcpf.plot$Source,cents.f$name),"Lat"]
fcpf.plot$Longin <- cents.f[match(fcpf.plot$State,cents.f$name),"Long"]
fcpf.plot$Latin <- cents.f[match(fcpf.plot$State,cents.f$name),"Lat"]
cents.f <- cents.f[!is.na(cents.f$Outdegree),]

#GENERATE PATHS BETWEEN NODES - FCPF
fcpf.plot <- fcpf.plot[complete.cases(fcpf.plot),]
fcpf.plot <- fcpf.plot[fcpf.plot$State!=fcpf.plot$Source ,]
fcpf.plot$Links <- as.numeric(as.character(fcpf.plot$Links))
fcpf.plot <- fcpf.plot[order(fcpf.plot$Links, decreasing=TRUE),]
fcpf.edges <- list()

n <- 200
for (i in 1:nrow(fcpf.plot)){
  lat.out <- fcpf.plot[i,"LatOut"]
  lat.in <- fcpf.plot[i,"Latin"]
  long.out <- fcpf.plot[i,"LongOut"]
long.in <- fcpf.plot[i,"Longin"]
if(lat.out >= lat.in){
lats <- seq(lat.in, lat.out, by=abs(lat.out-lat.in)/n)
lats <- lats[order(lats,decreasing=TRUE)]
}
else{
lats <- seq(lat.out, lat.in, by=abs(lat.out-lat.in)/n)
}
if(long.out >= long.in){
longs <- seq(long.in, long.out, by=abs(long.out-long.in)/n)
longs <- longs[order(longs,decreasing=TRUE)]
}
else{
longs <- seq(long.out, long.in, by=abs(long.out-long.in)/n)
}
sequence <- 1:(n+1)
fcpf.edges[[i]] <- cbind(longs,lats,fcpf.plot[i,"Links"],sequence, paste(fcpf.plot$Source[i], ">", fcpf.plot$State[i], sep=""))
print(paste(i, "of", nrow(fcpf.plot), sep="\n"))
}
allEdges <- as.data.frame(do.call(rbind, fcpf.edges))
names(allEdges) <- c("Long", "Lat", "Links", "Sequence", "Group")
allEdges$Long <- as.numeric(as.character(allEdges$Long))
allEdges$Lat <- as.numeric(as.character(allEdges$Lat))
allEdges$Links <- as.numeric(as.character(allEdges$Links))
allEdges$Sequence <- as.numeric(as.character(allEdges$Sequence))
g <- ggplot() +
geom_polygon(data=world.plot, aes(long, lat, group=world.plot$group), fill="grey") +
geom_path(data=world.plot, aes(long, lat, group=world.plot$group), color="white") +
```R
geom_path(data=allEdges, aes(x = Long, y = Lat, group = Group,
                          alpha = Sequence, size=Links), color="black") +
geom_point(data=cents.f, aes(x=Long, y=Lat, fill=External), size=4, pch=21, color="black") +
scale_fill_gradient2(name="Internalization",low="red", high="blue", na.value="grey50", guide="none")+
scale_size(name="", range=c(0.5,4)) +
scale_alpha_continuous(range=c(0.1,1), guide = "none") +
scale_y_continuous(limits=c(-75,75)) +
coord_map(projection="gilbert") +
new_theme_empty
g

#PROJECTS
proj.site <- read.csv("Projects.csv")
projs.data$Target <- as.character(proj.site[match(as.
                          character(projs.data$Project),as.character(proj.site$Project)),"Country"])
projs.data$Target[projs.data$Target == "Laos"] <- "Lao People’s Democratic Republic"
projs.data$Source <- as.character(orgs.total[match(as.
                          character(projs.data$NAME), as.character(orgs.total$Organization)),"Country"])
states <- unique(c(projs.data$Target, projs.data$Source))
projs.states <- matrix(0, length(states),length(states))
for(i in 1:nrow(projs.data)){
  projs.states[match(projs.data$Source[i],states),match(
              projs.data$Target[i],states)] <- projs.states[match(
              projs.data$Source[i],states),match(projs.data$Target[i],states)] +1
}
proj.inout <- as.data.frame(cbind(states,rowSums(projs.
                          states),colSums(projs.states),diag(projs.states)))
names(proj.inout) <- c("Country","Outdegree","Indegree","Self")
proj.inout$Outdegree <- as.numeric(as.character(proj.
                          inout$Outdegree))
```
proj.inout$Indegree <- as.numeric(as.character(proj.inout$Indegree))
proj.inout$Self <- as.numeric(as.character(proj.inout$Self))
proj.inout$Outdegree <- proj.inout$Outdegree - proj.inout$Self
proj.inout$Indegree <- proj.inout$Indegree - proj.inout$Self
proj.inout$External <- (proj.inout$Self - proj.inout$Indegree)/(proj.inout$Indegree + proj.inout$Self)

cents.p <- as.data.frame(coordinates(world))
cents.p$name <- as.character(world$NAME)
names(cents.p) <- c("Long", "Lat", "name")
cents.p$name[cents.p$name=="VietNam"] <- "Vietnam"
cents.p$name[cents.p$name=="United Republic of Tanzania"] <- "Tanzania"
cents.p$name[cents.p$name=="Democratic Republic of the Congo"] <- "Democratic Republic of Congo"
cents.p$name[cents.p$name=="United States"] <- "US"
cents.p$name[cents.p$name=="United Kingdom"] <- "UK"
cents.p$name[cents.p$name=="Korea, Republic of"] <- "South Korea"

projs.data$Links <- 1
proj.plot <- aggregate(projs.data$Links, by=list(projs.data$Target,projs.data$Source), FUN=sum)
names(proj.plot) <- c("Target","Source", "Links")
proj.plot$Source <- as.character(proj.plot$Source)
proj.plot$Target <- as.character(proj.plot$Target)
proj.plot$LongOut <- cents.p[match(proj.plot$Source,cents.p$name),"Long"]
proj.plot$LatOut <- cents.p[match(proj.plot$Source,cents.p$name),"Lat"]
proj.plot$Longin <- cents.p[match(proj.plot$Target,cents.p$name),"Long"]
proj.plot$Latin <- cents.p[match(proj.plot$Target,cents.p$name),"Lat"]

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cents.p <- merge(cents.p, proj.inout, by.x="name", by.y="Country", all.x=TRUE, all.y=FALSE)
names(cents.p) <- c("name","Long","Lat","Outdegree", "Indegree", "Self", "External")
cents.p <- cents.p[!is.na(cents.p$Outdegree),]

#GENERATE PATHS BETWEEN NODES - PROJECTS
proj.plot <- proj.plot[complete.cases(proj.plot),]
proj.plot <- proj.plot[proj.plot$Target!=proj.plot$Source ,]
proj.plot$Links <- as.numeric(as.character(proj.plot$Links))
proj.plot <- proj.plot[order(proj.plot$Links, decreasing=TRUE),]
proj.edges <- list()

n <- 200
for (i in 1:nrow(proj.plot)){
  lat.out <- proj.plot[i,"LatOut"]
  lat.in <- proj.plot[i,"Latin"]
  long.out <- proj.plot[i,"LongOut"]
  long.in <- proj.plot[i,"Longin"]
  if(lat.out >= lat.in){
    lats <- seq(lat.in, lat.out, by=abs(lat.out-lat.in)/n)
    lats <- lats[order(lats,decreasing=TRUE)]
  } else{
    lats <- seq(lat.out, lat.in, by=abs(lat.out-lat.in)/n)
  }
  if(long.out >= long.in){
    longs <- seq(long.in, long.out, by=abs(long.out-long.in)/n)
    longs <- longs[order(longs,decreasing=TRUE)]
  } else{
    longs <- seq(long.out, long.in, by=abs(long.out-long.in)/n)
  }
  sequence <- 1:(n+1)
proj.edges[[i]] <- cbind(longs,lats,proj.plot[i,"Links"],sequence, paste(proj.plot$Source[i], ">", proj.plot$Target[i],sep=""))
print(paste(i, "of", nrow(proj.plot),sep="\n"))
}

allEdges <- as.data.frame(do.call(rbind, proj.edges))
names(allEdges) <- c("Long", "Lat", "Links", "Sequence", "Group")
allEdges$Long <- as.numeric(as.character(allEdges$Long))
allEdges$Lat <- as.numeric(as.character(allEdges$Lat))
allEdges$Links <- as.numeric(as.character(allEdges$Links))
allEdges$Sequence <- as.numeric(as.character(allEdges$Sequence))

p <- ggplot() + geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group), fill="grey") + geom_path(data=world.plot, aes(long,lat,group=world.plot$group),color="white") + geom_path(data=allEdges, aes(x = Long, y = Lat, group = Group,
           alpha = Sequence, size=Links), color="black") + geom_point(data=cents.p, aes(x=Long, y=Lat, fill="External"), size=4, pch=21, color="black") + scale_fill_gradient2(name="Internalization",low="red", high="blue", na.value="grey50", guide="none")+ scale_size(name="", range=c(0.5,4)) + scale_alpha_continuous(range=c(0.1,1), guide = "none")+ scale_y_continuous(limits=c(-75,75))+ coord_map(projection="gilbert")+
new_theme_empty

p

#STANDARDS
stands.sites <- read.csv("Standards.Sites.csv")
stands.sites$Standard <- as.character(stands.sites$Standard)
stands.data$STANDARD <- as.character(stands.data$STANDARD)
stands.sites$State <- as.character(stands.sites$State)
stands.data$Target <- as.character(stands.sites$State[
  match(stands.data$STANDARD, stands.sites$Standard)])
stands.data$Source <- orgs.total$Country[match(stands.
  data$Organization, orgs.total$Organization)]
cents.s <- as.data.frame(coordinates(world))
cents.s$name <- as.character(world$NAME)
names(cents.s) <- c("Long", "Lat", "name")
cents.s$name[cents.s$name=="VietNam"] <- "Vietnam"
cents.s$name[cents.s$name=="UnitedRepublicofTanzania"] <- "Tanzania"
cents.s$name[cents.s$name=="DemocraticRepublicofthe
  Congo"] <- "DemocraticRepublicofCongo"
cents.s$name[cents.s$name=="Congo"] <- "RepublicofCongo"
cents.s$name[cents.s$name=="UnitedStates"] <- "US"
cents.s$name[cents.s$name=="UnitedKingdom"] <- "UK"
cents.s$name[cents.s$name=="Korea,Republicof"] <- "SouthKorea"
states <- unique(c(stands.data$Target, stands.data$Source))
stands.states <- matrix(0, length(states), length(states))
for(i in 1:nrow(stands.data)){
  stands.states[match(stands.data$Source[i],states),match
    (stands.data$Target[i],states)] <- stands.states[
    match(stands.data$Source[i],states),match(stands.
    data$Target[i],states)] +1
}
stands.inout <- as.data.frame(cbind(states,rowSums(stands.
  states),colSums(stands.states),diag(stands.states)))
names(stands.inout) <- c("Country","Outdegree","Indegree",
  "Self")
stands.inout$Outdegree <- as.numeric(as.character(stands.
  inout$Outdegree))
stands.inout$Indegree <- as.numeric(as.character(stands.
  inout$Indegree))
stands.inout$Self <- as.numeric(as.character(stands.inout
$Self))
stands.inout$Outdegree <- stands.inout$Outdegree - stands.inout$Self
stands.inout$Indegree <- stands.inout$Indegree - stands.inout$Self
stands.inout$External <- (stands.inout$Self - stands.inout$Indegree)/(stands.inout$Indegree + stands.inout$Self)
cents.s <- merge(cents.s, stands.inout, by.x="name", by.y="Country", all.x=TRUE, all.y=FALSE)
stands.data$Links <- 1
stands.plot <- aggregate(stands.data$Links, by=list(stands.data$Target, stands.data$Source), FUN=sum)
names(stands.plot) <- c("Target","Source", "Links")
stands.plot$Longout <- cents.s[match(stands.plot$Source, cents.s$name),"Long"]
stands.plot$Latout <- cents.s[match(stands.plot$Source, cents.s$name),"Lat"]
stands.plot$Longin <- cents.s[match(stands.plot$Target, cents.s$name),"Long"]
stands.plot$Latin <- cents.s[match(stands.plot$Target, cents.s$name),"Lat"]
stands.plot <- stands.plot[complete.cases(stands.plot),]
stands.plot <- stands.plot[stands.plot$Target!=stands.plot$Source,]
stands.plot$Links <- as.numeric(as.character(stands.plot$Links))
stands.plot <- stands.plot[order(stands.plot$Links, decreasing=TRUE),]
stands.edges <- list()
cents.s <- cents.s[!is.na(cents.s$Outdegree),]

#GENERATE PATHS BETWEEN NODES - STANDARDS
n <- 500
for (i in 1:nrow(stands.plot)){
  lat.out <- stands.plot[i,"Latout"]
  lat.in <- stands.plot[i,"Latin"]
  long.out <- stands.plot[i,"Longout"]
  long.in <- stands.plot[i,"Longin"]
  if(lat.out >= lat.in){
    # code continues here...
lats <- seq(lat.in, lat.out, by=abs(lat.out-lat.in)/n)
}
lats <- lats[order(lats,decreasing=TRUE)]
else{
lats <- seq(lat.out, lat.in, by=abs(lat.out-lat.in)/n)
}
if(long.out >= long.in){
  longs <- seq(long.in, long.out, by=abs(long.out-long.in)/n)
  longs <- longs[order(longs,decreasing=TRUE)]
} else{
  longs <- seq(long.out, long.in, by=abs(long.out-long.in)/n)
}
sequence <- 1:(n+1)
stands.edges[[i]] <- cbind(longs,lats,stands.plot[i,"Links"],sequence, paste(stands.plot$Source[i], ">", stands.plot$Target[i],sep=" "))
print(paste(i, "of", nrow(stands.plot),sep=" "))
}

allEdges <- as.data.frame(do.call(rbind, stands.edges))
names(allEdges) <- c("Long", "Lat", "Links", "Sequence", "Group")
allEdges$Long <- as.numeric(as.character(allEdges$Long))
allEdges$Lat <- as.numeric(as.character(allEdges$Lat))
allEdges$Links <- as.numeric(as.character(allEdges$Links))
allEdges$Sequence <- as.numeric(as.character(allEdges$Sequence))

s <- ggplot() +
  geom_polygon(data=world.plot, aes(long,lat,group=world.plot$group), fill="grey") +
  geom_path(data=world.plot, aes(long,lat,group=world.plot$group), color="white") +
  geom_path(data=allEdges, aes(x = Long, y = Lat, group = 
    Group),
alpha = Sequence, size=
Links), color="black")
+ geom_point(data=cents.s, aes(x=Long, y=Lat, fill=
External), size=4, pch=21, color="black") +
scale_fill_gradient2(name="Internalization", low="red",
high="blue", na.value="grey50", guide="none") +
scale_size(name="", range=c(0.5,4)) +
scale_y_continuous(range=c(0.5,1), guide = "none") +
coord_map(projection="gilbert") +
new_theme_empty

#FUNDING
vrp.plot <- partner[,c(5,18,19)]
names(vrp.plot) <- c("Funding","Source","Target")
states <- unique(c(vrp.plot$Target, vrp.plot$Source))
vrp.states <- matrix(0, length(states),length(states))
for(i in 1:nrow(vrp.plot)){
  vrp.states[match(vrp.plot$Source[i],states),match(vrp.
  plot$Target[i],states)] <- vrp.states[match(vrp.plot
  $Source[i],states),match(vrp.plot$Target[i],states)]
  + vrp.plot$Funding[i]
}
vrp.inout <- as.data.frame(cbind(states,rowSums(vrp.
  states),colSums(vrp.states),diag(vrp.states)))
names(vrp.inout) <- c("Country","Outdegree","Indegree", "Self")
vrp.inout$Outdegree <- as.numeric(as.character(vrp.inout$
  Outdegree))
vrp.inout$Indegree <- as.numeric(as.character(vrp.inout$
  Indegree))
vrp.inout$Self <- as.numeric(as.character(vrp.inout$Self)
  )
vrp.inout$Outdegree <- vrp.inout$Outdegree - vrp.inout$
  Self
vrp.inout$Indegree <- vrp.inout$Indegree - vrp.inout$Self
vrp.inout$External <- (vrp.inout$Self - vrp.inout$
  Indegree)/(vrp.inout$Indegree + vrp.inout$Self)
cents.v <- as.data.frame(coordinates(world))
cents.v$name <- as.character(world$NAME)
names(cents.v) <- c("Long", "Lat", "name")
cents.v$name[cents.v$name=="Brunei Darussalam"] <- "Brunei"
cents.v$name[cents.v$name=="Korea, Republic of"] <- "South Korea"
cents.v$name[cents.v$name=="Democratic Republic of the Congo"] <- "Democratic Republic of Congo"
cents.v$name[cents.v$name=="Congo"] <- "Republic of Congo"
cents.v$name[cents.v$name=="United States"] <- "US"
cents.v$name[cents.v$name=="United Kingdom"] <- "UK"
cents.v$name[cents.v$name=="Iran (Islamic Republic of)"] <- "Iran"
cents.v$name[cents.v$name=="Cote d'Ivoire"] <- "Ivory Coast"
cents.v$name[cents.v$name=="Burma"] <- "Myanmar"
cents.v$name[cents.v$name=="Syrian Arab Republic"] <- "Syria"
cents.v$name[cents.v$name=="United Republic of Tanzania"] <- "Tanzania"
cents.v <- merge(cents.v, vrp.inout, by.x="name", by.y="Country", all.x=TRUE, all.y=FALSE)

vrp.plot <- aggregate(vrp.plot$Funding, by=list(vrp.plot$Source, vrp.plot$Target), FUN=sum)
names(vrp.plot) <- c("Source", "Target", "Funding")
vrp.plot$Longout <- cents.v[match(vrp.plot$Source, cents.v$name),"Long"]
vrp.plot$Latout <- cents.v[match(vrp.plot$Source, cents.v$name),"Lat"]
vrp.plot$Longin <- cents.v[match(vrp.plot$Target, cents.v$name),"Long"]
vrp.plot$Latin <- cents.v[match(vrp.plot$Target, cents.v$name),"Lat"]
vrp.plot <- vrp.plot[complete.cases(vrp.plot),]
vrp.plot <- vrp.plot[vrp.plot$Target!=vrp.plot$Source,]
vrp.plot$Funding <- as.numeric(as.character(vrp.plot$Funding))
vrp.plot <- vrp.plot[order(vrp.plot$Funding, decreasing=TRUE),]
vrp.edges <- list()
cents.v <- cents.v[!is.na(cents.v$Outdegree),]

# GENERATE PATHS BETWEEN NODES - FUNDING
n <- 500
for (i in 1:nrow(vrp.plot)){
  lat.out <- vrp.plot[i,"Latout"]
  lat.in <- vrp.plot[i,"Latin"]
  long.out <- vrp.plot[i,"Longout"]
  long.in <- vrp.plot[i,"Longin"]
  if(lat.out >= lat.in){
    lats <- seq(lat.in, lat.out, by=abs(lat.out-lat.in)/n)
    lats <- lats[order(lats, decreasing=TRUE)]
  } else{
    lats <- seq(lat.out, lat.in, by=abs(lat.out-lat.in)/n)
  }
  if(long.out >= long.in){
    longs <- seq(long.in, long.out, by=abs(long.out-long.in)/n)
    longs <- longs[order(longs, decreasing=TRUE)]
  } else{
    longs <- seq(long.out, long.in, by=abs(long.out-long.in)/n)
  }
  sequence <- 1:(n+1)
  vrp.edges[[i]] <- cbind(longs, lats, vrp.plot[i,"Funding"], sequence, paste(vrp.plot$Source[i], ">", vrp.plot$Target[i], sep=""))
  print(paste(i, "of", nrow(vrp.plot), sep="\n"))
}

allEdges <- as.data.frame(do.call(rbind, vrp.edges))
names(allEdges) <- c("Long", "Lat", "Funding", "Sequence", "Group")
allEdges$Long <- as.numeric(as.character(allEdges$Long))
allEdges$Lat <- as.numeric(as.character(allEdges$Lat))
allEdges$Funding <- as.numeric(as.character(allEdges$Funding))
allEdges$Sequence <- as.numeric(as.character(allEdges$Sequence))

v <- ggplot() +
  geom_polygon(data=world.plot, aes(long, lat, group=world.plot$group), fill="grey") +
  geom_path(data=world.plot, aes(long, lat, group=world.plot$group), color="white") +
  geom_path(data=allEdges, aes(x = Long, y = Lat, group = Group,
                              alpha = Sequence, size= Funding), color="black") +
  geom_point(data=cents.v, aes(x=Long, y=Lat, fill="External"), size=4, pch=21, color="black") +
  scale_fill_gradient2(name="Internalization", low="red", high="blue", na.value="grey50", guide="none")+
  scale_size(name="", range=c(0.1,4)) +
  scale_alpha(name="", range=c(0.1,4)) +
  scale_y_continuous(limits=c(-75,75)) +
  coord_map(projection="gilbert") +
  new_theme_empty
v

#EXPORT DATA FOR NETWORK CORRELATIONS
#CONVERT DIRECTED NETWORKS TO COMPARABLE ADJACENCY MATRICES
#GET ALL STATES IN ONE OBJECT
states <- unique(c(as.character(orgs.total$Country), vrp.plot$Source, vrp.plot$Target))
states <- states[complete.cases(states)]

#FCPF
fcpf.export <- matrix(0, length(states), length(states))
fcpf.data$Source <- as.character(fcpf.data$Source)
fcpf.data$State <- as.character(fcpf.data$State)
for (i in 1:nrow(fcpf.data)){
  # Code continues here
fcpf.export[match(fcpf.data$Source[i], states), match(fcpf.data$State[i], states)] <- fcpf.export[match(fcpf.data$Source[i], states), match(fcpf.data$State[i], states)] +1

diag(fcpf.export) <- 0
write.csv(fcpf.export,"FCPFUcinet.csv")

#PROJECTS
projs.export <- matrix(0, length(states), length(states))
projs.data$Source <- as.character(projs.data$Source)
projs.data$Target <- as.character(projs.data$Target)
for (i in 1:nrow(projs.data)){
    projs.export[match(projs.data$Source[i], states), match(projs.data$Target[i], states)] <- projs.export[match(projs.data$Source[i], states), match(projs.data$Target[i], states)] +1
}
diag(projs.export) <- 0
write.csv(projs.export,"ProjUcinet.csv")

#STANDARDS
stands.export <- matrix(0, length(states), length(states))
stands.data$Source <- as.character(stands.data$Source)
stands.data$Target <- as.character(stands.data$Target)
for (i in 1:nrow(stands.data)){
    stands.export[match(stands.data$Source[i], states), match(stands.data$Target[i], states)] <- stands.export[match(stands.data$Source[i], states), match(stands.data$Target[i], states)] +1
}
diag(stands.export) <- 0
write.csv(stands.export,"StandsUcinet.csv")

#FUNDING
vrp.export <- matrix(0, length(states), length(states))
for (i in 1:nrow(vrp.plot)){

vrp.export[match(vrp.plot$Source[i], states), match(vrp.plot$Target[i], states)] <- vrp.export[match(vrp.plot$Source[i], states), match(vrp.plot$Target[i], states)] + vrp.plot$Funding[i]

diag(vrp.export) <- 0
write.csv(vrp.export, "FundsUcinet.csv")

#GENERATE ONE-MODE NETWORKS FROM BIPARTITE FCA NETWORK
fac$Organization <- as.character(fac$Organization)
sorgs <- unique(fac$Organization)
fac.adj <- matrix(0, length(sorgs), max(fac$Document))
for(i in 1:nrow(fac)){
  fac.adj[[match(fac$Organization[i], sorgs),fac$Document[i]]] <- fac.adj[[match(fac$Organization[i], sorgs),fac$Document[i]]] + 1
}
fac.om <- fac.adj%*%t(fac.adj)
countries <- as.character(sorgs.total$Country[match(sort(unique(fac$Organization)), as.character(sorgs.total$Organization))])
fac.om <- aggregate(fac.om, by=list(countries),FUN=sum)
fac.om <- t(fac.om[,2:ncol(fac.om)])
fac.om <- aggregate(fac.om, by=list(countries),FUN=sum)
fac.om <- t(as.matrix(fac.om[complete.cases(sort(unique(countries)))]))
fac.om <- fac.om[complete.cases(sort(unique(countries)))]
sum(fac.om[upper.tri(fac.om, diag=FALSE)])/sum(fac.om[upper.tri(fac.om, diag=TRUE)]) #74% of links int'l

fac.om.export <- matrix(0, length(states), length(states))
fac.om.export[match(sort(unique(countries[complete.cases(countries)])), states), match(sort(unique(countries[complete.cases(countries)])), states)] <- fac.om
fac.om.diag <- diag(fac.om.export)
fac.om.degree <- rowSums(fac.om.export)
diag(fac.om.export) <- 0
write.csv(fac.om.export, "FCAUcinetOM.csv")

# FCA MAP
cents <- as.data.frame(coordinates(world))
cents$name <- as.character(world$NAME)
cents$name[cents$name=="Viet\_Nam"] <- "Vietnam"
cents$name[cents$name=="United\_Republic\_of\_Tanzania"] <- "Tanzania"
cents$name[cents$name=="Democratic\_Republic\_of\_the\_Congo"] <- "Democratic\_Republic\_of\_Congo"
cents$name[cents$name=="Congo"] <- "Republic\_of\_Congo"
cents$name[cents$name=="United\_States"] <- "US"
cents$name[cents$name=="United\_Kingdom"] <- "UK"
cents$name[cents$name=="Korea,\_Republic\_of\_" ] <- "South\_Korea"

cfa.edgelist <- list()
for(i in 1:nrow(fac.om.export)){
  temp <- fac.om.export[i,]
  temp[1:i] <- 0
  if(sum(temp)>0){
    fca.edgelist[[i]] <- cbind(states[i],states[temp>0],
                              temp[temp>0])
  }
}

fca.edgelist <- as.data.frame(do.call(rbind,fca.edgelist))
names(fca.edgelist) <- c("Node1", "Node2", "Links")
fca.edgelist$Node1 <- as.character(fca.edgelist$Node1)
fca.edgelist$Node2 <- as.character(fca.edgelist$Node2)
fca.edgelist$Links <- as.numeric(as.character(fca.edgelist$Links))
fca.deg.plot <- as.data.frame(cbind(fac.om.degree, states))
names(fca.deg.plot) <- c("Degree", "Country")
fca.deg.plot$Country <- as.character(fca.deg.plot$Country)
fca.deg.plot$Degree <- as.numeric(as.character(fca.deg.plot$Degree))
fca.deg.plot$Internationalization <- (fac.om.diag-fca.deg.plot$Degree)/(fac.om.diag+fca.deg.plot$Degree)
fca.deg.plot <- fca.deg.plot[fca.deg.plot[,1]>0,]
fca.deg.plot[,c("Long","Lat")]<-cents[match(fca.deg.
plot$Country, cents$name),1:2]
fca.edgelist[,c("Longout","Latout")]<-cents[match(fca.
edgelist$Node1,cents$name),1:2]
fca.edgelist[,c("Longin","Latin")]<-cents[match(fca.
edgelist$Node2,cents$name),1:2]
fca.edgelist <- fca.edgelist[order(fca.edgelist$Links),]

fom <- ggplot() +
  geom_polygon(data=world.plot, aes(long,lat,group=world.
plot$group), fill="grey") +
  geom_path(data=world.plot, aes(long,lat,group=world.
plot$group),color="white") +
  geom_segment(data=fca.edgelist, aes(x=Longout, xend=
    Longin, y=Latout, yend=Latin, alpha=Links, size=
    Links)) +
  scale_size_continuous(name="", range=c(0.25,4)) +
  geom_point(data=fca.deg.plot, aes(x=Long, y=Lat, color=
    Internationalization), size=4) +
  scale_color_gradient2(name="Internalization", low="red",
    high="blue", guide="none") +
  scale_alpha_continuous(name="Tie Strength", range=c
    (0.2,1), guide="none") +
  scale_y_continuous(limits=c(-75,75)) +
  coord_map(projection="gilbert") +
  new_theme_empty

#EQUIVALENCE CLUSTERING
library(sna)
library(network)
fcpf.export <- fcpf.export/sum(fcpf.export)*100
fcpf.net <- network(fcpf.export, directed=TRUE)
projs.export <- projs.export/sum(projs.export)*100
proj.net <- network(projs.export, directed=TRUE)
stands.export <- stands.export/sum(stands.export)*100
stands.net <- network(stands.export, directed=TRUE)
vrp.export <- vrp.export/sum(vrp.export)*100
vrp.net <- network(vrp.export, directed=TRUE)
fac.om.export <- fac.om.export/sum(fac.om.export)*100
fca.om.net <- network(fac.om.export, directed=TRUE)
alld <- list(fcpf.net, proj.net, stands.net, vrp.net, fca.
om.net)
all.ev <- equiv.clust(all, method="euclidean", cluster.
method="ward")
all.bm <- blockmodel(all, all.ev, k=4, block.content="
median")
alld.part <- cbind(states[all.bm$order.vector],all.bm$block.membership)

#EXPORT FOR QAP REGRESSION ANALYSIS
data.state.out$Partition <- alld.part[match(as.character(
data.state.out$Country),all.part[,1]),2]
data.state.part <- data.state.out[!is.na(data.state.out$Partition),]
data.state.part$Partition1 <- ifelse(data.state.part$Partition=="1",1,0)
data.state.part$Partition2 <- ifelse(data.state.part$Partition=="2",1,0)
data.state.part$Partition3 <- ifelse(data.state.part$Partition=="3",1,0)
data.state.part$Partition4 <- ifelse(data.state.part$Partition=="4",1,0)
write.csv(data.state.part, "PartitionRegUCINET.csv")

#MAP THE CLUSTERS
world.plot$id <- as.character(world.plot$id)
world.plot$id[world.plot$id=="VietNam"] <- "Vietnam"
world.plot$id[world.plot$id=="United Republic of Tanzania"] <- "Tanzania"
world.plot$id[world.plot$id=="Democratic Republic of the Congo"] <- "Democratic Republic of Congo"
world.plot$id[world.plot$id=="Congo"] <- "Republic of Congo"
world.plot$id[world.plot$id=="United States"] <- "US"
world.plot$id[world.plot$id=="United Kingdom"] <- "UK"
world.plot$id[world.plot$id=="Korea, Republic of"] <- "South Korea"
world.plot$id[world.plot$id=="Cote d’Ivoire"] <- "Ivory Coast"
world.plot$id[world.plot$id=="Iran (Islamic Republic of)"] <- "Iran"
world.plot$id[world.plot$id=="Burma"] <- "Myanmar"
world.plot$id[world.plot$id=="Brunei Darussalam"] <- "Brunei"
world.plot$id[world.plot$id=="Syrian Arab Republic"] <- "Syria"
world.plot$Partition <- all.part[match(world.plot$id, all.part[,1]),2]

map <- ggplot(data=world.plot) +
  geom_polygon(aes(long,lat,group=world.plot$group, fill=Partition)) +
  scale_fill_brewer(type="qual", guide="none", na.value=gray(0.85))+
  geom_path(data=world.plot, aes(long,lat,group=world.plot$group),color="black", size=0.5) +
  scale_y_continuous(limits=c(-55,100)) +
  coord_map(projection="gilbert")+
  new_theme_empty
map

./Ch5.R