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Institutional Determinants of Success among Forestry-Based Carbon Sequestration Projects in Sub-Saharan Africa

Travis W. Reynolds[1]
Ph.D. Student
Daniel J. Evans School of Public Affairs
University of Washington
twreynol@u.washington.edu

Abstract

This paper examines the structure and implementation of international afforestation and reforestation efforts that use payments for carbon sequestration to finance some or all of their tree-planting activities. Such projects may be usefully conceptualized as attempts to overcome common pool resource dilemmas: growing trees for carbon offsets requires incentive structures to discourage premature harvesting by private actors, and institutional structures to monitor forest management, administer sanctions for infractions, distribute benefits from carbon offset sales, and communicate project results to international funding sources. Neoclassical economics and institutional theories provide some initial predictions of which project types, in terms of contextual characteristics and management approaches, are most likely to result in reliable, low-cost carbon sequestration in tropical forests. The paper examines these theoretical projections using an original dataset based on online documentation and phone interviews detailing the institutional structure and social/environmental context of 38 carbon-sequestration related forestry programs across sub-Saharan Africa. Some findings are consistent with theoretical expectations: larger projects, for example, consistently appear to realize economies of scale, resulting in lower per-ton costs of carbon sequestration (in spite of higher verification and monitoring costs). However, other findings contradict expectations: projects undertaken in relatively harsh climates (low rainfall, poor quality soils), for example, appear *more* likely to durably and cost-effectively sequester carbon than projects in areas more conducive to growth of vegetation. Meanwhile, private carbon sequestration initiatives by for-profit companies perform the worst out of all programs studied, casting doubt on initial expectations that a "free market" approach to carbon forestry will result in efficient outcomes.

[1] Daniel J. Evans School of Public Affairs, University of Washington, Box 353550, Seattle, WA 98195.
E-mail: twreynol@u.washington.edu. Phone: (802) 363-3074. Fax: (206) 221-6873.

1. INTRODUCTION

Over the past two decades it has become increasingly common for communities in low-income countries to participate in international markets for ecosystem services, including the sale of carbon dioxide emissions offsets generated through forestry initiatives (Jindal 2008; Landell-Mills & Porras 2002). Growing forests sequester – that is, durably store – carbon in the form of biomass in wood, leaves, and soil organic matter (SOM). Forests therefore have the potential to mitigate global warming by serving as "sinks" that remove carbon dioxide (CO_2) from the atmosphere (IPCC, 2001). Current estimates suggest major tropical and subtropical regions in developing countries in particular have the potential to reduce the atmospheric carbon burden by as much as 2.3 billion metric tons of carbon (Niles *et al.* 2002). This fact, combined with scientific and economic arguments that "it doesn't matter from the perspective of the atmosphere where carbon is removed, so it makes sense to remove it where costs are lowest" has led countries, industries, and individuals to sponsor a variety of projects to "offset" their carbon emissions through reforestation in the developing world (Fenhann 2005; UNFCCC 2003). Today there are dozens of such projects in operation all over the globe, funded and operated by sponsors ranging from the World Bank BioCarbon Fund to national governments seeking to meet Kyoto Targets, to non-profit and for-profit organizations seeking to generate revenues from carbon offset sales.

The basic notion of forestry-based carbon sequestration projects in the developing world is relatively straightforward. Within any given project, a state, industry, or other implementing party will contract with land users (either individually or as a collective) in a low-income country to engage in land use practices scientifically shown to increase net carbon storage in trees and soils. These project activities allow the implementing party to claim carbon offsets, the number of which may vary depending on the carbon accounting method used and the kinds of forest activities undertaken.[2] Once claimed (and sometimes certified by a third party) the offsets can be used by the implementing party to meet mandated greenhouse gas reduction targets under the Kyoto Protocol, or for "green" public relations purposes (as in the case of industries in non-Kyoto compliant countries like the U.S.). Alternatively, the implementing agency may also choose to sell the carbon offsets to another party, either for monetary gain or to fund further project activities, or both.

From an economic perspective, such market mechanisms effectively reduce the global costs of sequestering a given amount of carbon, as the relatively low cost of land and labor makes forestry-based carbon sequestration in low-income nations a far more cost-effective solution than equivalent projects in developed countries (UNFCC 2003; de Jong *et al.* 2003; Stavins 1999). Payments for forestry-based carbon sequestration is also seen to be economically efficient (at least in theory), because like all payments for ecosystem services (PES) schemes (Wunder 2005), carbon offset payments seek to internalize the positive externalities generated by intact forests, thereby increasing the market supply of such forests to a level closer to societal demand (Sedjo & Sampson 1997). At the same time, from a social and environmental perspective the opportunity to engage in global carbon offset markets allows developing nations to increase rural incomes through the sale of carbon sequestration offsets (Katoomba Group 2005; Holden *et al.* 2003; Smith & Scherr 2003)

[2] There is now an extensive scientific literature on methods for assessing carbon storage in different trees species and different soil types under different management regimes. For example, a 1,000 hectare Eucalyptus camaldulensis plantation (a fast growing species) that is managed for timber (meaning some trees will eventually be harvested, releasing their stored carbon back into the atmosphere) may generate fewer offsets, but generate them sooner, than a 1,000 hectare planting of native species (usually slower growing) that is managed as a permanent reforestation effort (where no harvesting will be permitted). Importantly, however, it should also be noted that the latter project might prove very costly to implement, thus leading to higher-cost offsets.

while engaging in (potentially) ecologically beneficial forestry and agro-forestry projects (Montagnini & Nair 2004). Niles *et al.* (2002) estimated that, given a central price of $10 per ton of carbon sequestered and using a discount rate of 3%, taking full advantage of reforestation opportunities in the developing world could generate a net present value of $16.8 billion for some of the world's poorest nations, in addition to social and environmental benefits to local communities from increased fuel wood availability, water filtration and other ecosystem services.

However in practice capturing these economic and social benefits has proven to be an extraordinary challenge. This challenge stems from the fact that historically many of the benefits from tropical forests, including carbon sequestration, have been public goods – enjoyed by the global community and yet paid for by no one. The trees themselves, meanwhile, have historically been managed as common pool resources – used by individuals and communities in low-income countries to satisfy immediate needs, without regard for the regional and global implications of deforestation. In this historical context, the explosion of forestry-based carbon sequestration projects in the developing world has thus necessitated the creation of an extensive set of institutional structures for the production, verification, and sale of carbon sequestration offsets (Boyd 2006). At the community level, carbon sequestration projects must provide strong and contextually appropriate incentives for individuals and communities in low-income countries to plant and protect trees (Gibson *et al.* 2005*;* 2000). At the project level, project managers must develop organizational structures for project implementation, monitoring and rule enforcement that are both cost-effective and function within economic, social, and environmental resource constraints (Rinaudo *et al*. 2008; Jindal 2008; 2006; Michaelowa & Jotzo 2005). Finally, at the macro (or national/international) level carbon sequestration projects must ultimately "sell" their offsets – both figuratively and literally - to their international clientele. The sale of carbon dioxide emissions offsets thus entails a major communications challenge, particularly in the face of changing international norms and expectations surrounding what forestry-based initiatives in the developing world can and should deliver (Katoomba Group 2005).

This paper examines the structure and implementation of 38 afforestation and reforestation efforts in sub-Saharan Africa that use payments for carbon sequestration to finance some or all of their project activities. Neoclassical economics and institutional theories provide some initial suggestions of which project "types," in terms of contextual characteristics and management approaches, are most likely to result in reliable, low-cost carbon sequestration in tropical forests. While previous studies have provided descriptive or case study data on forestry-based carbon sequestration initiatives (Jindal 2008; 2006; Landell-Mills & Porras 2002), none to date have systematically sought to develop a deductive framework that can be applied across programs to explore questions about program design and effectiveness. This paper takes a first step in this direction by attempting to derive a conceptual framework that can be applied across diverse programs, drawing on neoclassical economics, institutional choice theory, and game theory. Carbon sequestration payments and the associated institutional structures for managing the production and sale of carbon offsets are described as simultaneous efforts to (1) alter individual-level incentive structures (facilitating collective action for protecting forests), (2) reduce project-level transaction costs (making forestry-based carbon offsets less costly, more secure, and more attractive to investors), and (3) take advantage of emerging trends of global-level interest in combating global climate change and reducing poverty in the developing world in order to "sell" carbon forestry. Successful carbon sequestration projects – defined simply as those projects able to generate and sell reliable, low-cost carbon offsets – are expected to satisfy all three of these

requirements. The implications of this theory are tested using an original dataset on forestry-based carbon sequestration programs in sub-Saharan Africa.

The paper is organized as follows. Sections 2 and 3 focus on explaining the nature of forest management challenges in the developing world and outlining how economic and institutional theories contribute to our understanding of forestry-based carbon sequestration projects at the community, project, and national/international levels. Section 4 then develops a set of hypotheses from the theory, and Section 5 examines these hypotheses using data on 38 forestry-based carbon sequestration projects. Section 6 summarizes the research findings and outlines an agenda for future inquiry.

2. PUBLIC GOODS PROBLEMS, COMMON POOL RESOURCE DILEMMAS, AND "SUCCESSFUL" CARBON SEQUESTRATION PROJECTS

For the purposes of this article the following simplified definition of "project success" will be used. A "successful project" is one that sequesters carbon durably (that is, the project does not collapse) and that has sold its product to at least one consumer.[3] Economic and institutional factors conceivably influencing project success at each of three levels of analysis – community-level, project-level, and national/international-level – are discussed in greater detail in the ensuing sections. First, however, it is worthwhile to emphasize the nature of deforestation and consequent loss of carbon sinks in low income countries, as the problem is understood through both economic and institutional theoretical lenses.

2.1. Tropical Forestry as a Global Public Goods Problem

In economic terms, payments for carbon sequestration aim to overcome a global public goods problem – failures in the global market for carbon storage capacity – by internalizing the positive externalities associated with planting trees and managing forests (Wunder 2005). Carbon sequestration payments are used to provide incentives for land owners and land users to engage in land-use practices that provide broader regional and global benefits – namely, reductions in global greenhouse gas emissions responsible for climate change. Under standard neoclassical economic assumptions, c*eteris paribus*, carbon payments should increase the rewards of forests over other possible land uses in low-income countries, thus leading to more forests, and more carbon storage.

However upon closer inspection this is clearly not the whole story. A key remaining issue is the capacity of institutional structures within the low-income country to govern the distribution of payments, along with access to other forest-related benefits. Local forest benefits might include access to firewood, timber rights, and land access for agriculture and grazing, in addition to any carbon payments themselves. Even in the presence of substantial carbon offset payments to local leaders and political elites, poor households might still exploit Distribution matters. Indeed, it is conceivable that even if all positive externalities of tropical forests were "internalized" – in the sense that all wealthy countries paid an annual dividend to all low-income countries for the forest ecosystem services they provided – one might still observe deforestation in the developing world, so

[3] One additional criteria that would be reasonable for assessing project "success" would be that the offsets are produced at low cost – certainly projects generating carbon offsets at prices greater than $35 per ton of sequestered CO_2 would suffer as this value approaches the approximate cost of sequestering vast quantities of carbon in forests in the industrialized world (Stavins 1999). However the difficulty in determining actual costs of carbon sequestration from the published data on many projects (which often conflate sequestration costs and other project activity costs) renders this criterion problematic, at least until better data become available.

long as local resource access and distribution issues remained unresolved. It thus appears that "internalizing" the global benefits of tropical forests through offset payments may be insufficient for ensuring sustainable management of forest carbon sinks. Local institutional capacity to overcome local failures in markets for forest benefits is also necessary.

2.2. Tropical Forestry as a Local Common Pool Resource Problem

Thus from an institutional perspective, forestry-based carbon sequestration projects can be at least in part understood as efforts to overcome collective action dilemmas facing communities living in and near forests. Collective action is needed because forests are, in many developing nations, a common pool resource (CPR). Also known as an "impure" public good, a CPR is a good which can be jointly consumed but in which increasing group size tend to diminish the marginal benefit to all consumers (that is, there is a crowding effect) (Isaac *et al.* 1988). Growing forests provide a range of consumption goods in the form of timber, firewood, and other non-timber forestry products (NTFPs) including food, animal fodder, traditional medicines, and other cultural goods. When human populations are small, forests may well produce timber and NTFPs faster than humans can extract them – this is typical of the so-called "empty world" in Ecological Economics (Daly & Farley 2004). However when human populations are larger, forest resources become rival goods – as a simple example, by cutting down the last African Mahogany tree in the forest, an individual robs all others in his or her community of the opportunity to consume African Mahogany. When access to forests is unrestricted, the well-known theorized outcome of the forest CPR problem is over-harvesting and ultimate depletion of the forest resource; the now-famous "tragedy of the commons" (Hardin 1968). Indeed, research has shown that theory accurately predicts behavior (and resulting environmental outcomes) in many cases: local-level actors will tend to overharvest and exhaust forest resources (Dietz *et al.* 2003; Angelsen 2001; Ostrom *et al.* 1994), particularly when the forests are owned by national governments (as opposed to private or even community ownership).

Intuitively, forestry-based carbon sequestration projects could overcome CPR dilemmas in several different ways. One option would be to adopt the paradigmatic neoclassical approach to the resolution of CPR problems: eliminate the CPR, by privatizing forest resources through secure land tenure policies. In theory, with secure property rights, low transaction costs and sufficient payments, PES schemes should "work" as predicted by neoclassical economic theory, resulting in sustained carbon sequestration. However in practice changing property rights regimes is likely to be politically infeasible; though one alternative is to establish secure individual rights to individual trees (World Bank 2008), thus contributing to the resolution of local CPR dilemmas without the need to address often politically contentious national land tenure policies. Finally, yet other possibility, rooted in institutional theory, is for carbon sequestration projects to attempt to strengthen existing local governance structures for CPR management. Such community-based CPR management is clearly far more complex than "simple" property-rights approaches, in that it allows local governments and community groups to decide for themselves how to implement and monitor carbon sequestration projects, and how to distribute forest benefits with an aim to overcome CPR dilemmas while retaining the CPR characteristic of the resource.

Broadly, research pioneered by Ostrom (1990), Gibson *et al.* (2005) and others suggests that, predictors of successful management of common pool resources include characteristics of the resource (how many trees are there? how readily do they grow? how much is the carbon sequestration payment?), characteristics of the group (is the group large or small? are there other factors, e.g. large group size or ethnic heterogeneity, that might lead to tension and conflict?), and

underlying institutional arrangements (are formal rules clear and enforced? are there established and widely enforced norms and duties? are there norms of trust and cooperative behavior?). These and other more specific theoretical predictors of project success are discussed in Section 3.

3. ECONOMIC AND INSTITUTIONAL INSIGHTS INTO FOREST MANAGEMENT IN THE DEVELOPING WORLD

Forestry-based carbon sequestration projects aim to resolve global public goods problems and local CPR dilemmas through the transfer of payments from international beneficiaries to local providers of carbon sequestration services, and through the construction (or strengthening) of local institutions for the management of forest resources. The following sections consider theoretical predictors of project success at three levels: micro (community or individual), mezzo (project design and management), and macro (national/international context).

3.1. Micro-level: Common pool resource "games" and incentives

At the micro- or individual-level, economic theory suggests that "successful" carbon sequestration projects will be those initiatives that "get the incentives right." Global public goods problems and local CPR dilemmas alike arise because individual incentives lead rational actors to engage is socially detrimental behavior: sustainable harvesting of fuel wood and timber to maximize forest yields may be a collectively desirable goal for a rural community in Africa, but at the individual level the decision "do not cut this tree" – which may mean forgoing needed fuelwood or income – might not be an *individually* rational course of action.[4] Larger populations sharing the CPR (increasing the chances that someone else will cut the tree if you don't) increases the incentive to cut down trees (Isaac & Walker 1988)[5], while PES – particularly with larger payments – might increase the incentives to plant and protect trees. Of course, a purely rational individual might seek to have both the payment and the tree – accepting an offset payment and then cutting the tree anyway. Thus another class of pertinent incentives includes sanctions for "cheating" (that is, accepting a carbon payment but not engaging in promised forest management activities). Such sanctions may include individual fines, community-level penalties, or in extreme cases project termination.[6] Finally, whatever the incentive structure, economic theory also suggests that individual decisions to participate in a forestry-based carbon sequestration project will be in part dictated by two additional factors, namely the discount rate (i.e., what is the net present value of carbon offset payments that may not be received until years in the future?), and on a related note the assessment of risk (i.e., what is the likelihood that the sequestration project will fail, resulting in few or zero carbon credits generated in the future?). Discount rates used by individuals in low-income countries are often very high, reflecting urgent and immediate fuel and food security needs, and compounded by insecure land tenure (discouraging long-term natural capital investments)

[4] As Shahi & Kant note: "in every community living close to forests, two groups of people can be found—one law abiding and the other using the forests illegally" (2007).

[5] Experimental game theory research further formalizes theoretical expectations under CPR conditions: work by Isaac & Walker (1988), for example, finds the intuition that "large" groups would have a more difficult time providing public goods than "small" groups to be strongly supported, in particular if that distinction in group size is linked to reductions in the marginal per capita return to any individual from cooperative behavior. In other words, it may not be the number of people that matters, so much as the reduction in individual benefits when "the pie" was to be divided (Isaac & Walker 1988). Such trends lend support to the notion that PES schemes, which can in effect increase individual benefits for protecting forests, might serve to re-order individual preferences in such a way as to promote long-term forest growth.

[6] Indeed, Gibson *et al.* (2005) conclude that in some cases, adequate rule enforcement may be the most important determinant of outcomes under CPR conditions. This notion is also consistent with the broad literature in behavioral economics suggesting individuals typically value losses (e.g., fines for harvesting) greater than gains (e.g., an equivalent payoff from harvesting).

(Reynolds 2009). In some cases doubts about rewards from payments in the carbon sequestration project may also increase discount rates, particularly in areas with a history of unsuccessful international development projects or volatile tenure policies (Kebede 2002). Furthermore, sanctions for rule-breaking may also be discounted, particularly if the likelihood of detection is low. Gibson *et al*. (2005) note that many rural communities in Africa have few if any resources to compensate scouts for enforcing rules against over-harvesting of commonly-owned forestland. In such cases, they argue, bribes by would-be lawbreakers might dwarf the salaries of the supposed scouts. Successful PES schemes must therefore shift this balance, both by increasing the individual rewards to *not* cutting trees (through offset payments), and by decreasing the risk-adjusted rewards to harvesting trees (by increasing scout numbers and incomes).

Meanwhile, theoretical and empirical research inspired by institutional theories suggests that in addition to formal rules and enforcement, informal institutions such as norms can also impose significant constraints on actors and thereby lead to more favorable outcomes in CPR scenarios. Coleman (1990) defines a norm to be a socially defined right by others to control an individual's action. He further argues that even in situations where individual material sanctions or rewards are not available, norms may still exist if socially derived sanctions or rewards have been internalized by an actor. Such internalization of norms, he contends, is more likely when the individual in question strongly identifies with a particular group. Fudenberg & Levine (1998) echo this sentiment by emphasizing the importance of "social arrangements and social norms that lead to common expectations of what is likely to happen from day to day." Empirical research by Shahi & Kant (2007), Ostrom (1994) and others further suggests that social incentives can lead to positive outcomes in the domain of forest CPR management. Henrich *et al.*'s (2005) multi-country study finds that group-level differences in economic organization and the structure of social interactions explain a substantial portion of the behavioral variation across societies: the higher the degree of market integration and the higher the payoffs to cooperation in everyday life, for example, the greater the level of pro-social behavior seen in experimental games. But they also conclude that individual-level economic and demographic variables do not consistently explain game behavior, either within or across groups. Rather they find that in many cultures experimental game play appears to reflect the common interactional patterns of "everyday life." In other words, people may rely on *cultural learning* to direct much of their social behavior, and as a result of such learning processes, societies with different historical trajectories might arrive at radically different social equilibria (Henrich *et al*. 2005). The authors hypothesize that different social, cultural, and physical environments might foster the development of differing generalized behavioral dispositions (regarding such norms and expectations as equity, altruism, etc.) that are applicable across many "game settings", including task performance (work versus shirk) or investment in reputation building (cooperate versus cheat).[7] As Berg *et al*. state, people are willing to reward "appropriate behavior" (1995:139).[8] All of these variables are better understood as underlying characteristics of a project's operating environment (rather than factors that are susceptible to management choices, as in the mezzo level issues described below).

[7] The notion of cooperation has received extensive attention in the game theory literature (Berg *et al*. 1995, Axelrod & Dion 1988, Axelrod 1984). Arrow (1974) refers to trust as an ubiquitous and important "lubricant of a social system," while Berg *et al*.'s research using "trust games" leads them to proclaim that "reciprocity exists as a basic element of human behavior" (1995:122).

[8] Along a similar vein, a recent study by Haile *et al.* (2008) investigated the effects of heterogeneity in income and race on cooperation in South Africa. When racial and income information was available, it significantly affected participants' trust behavior: namely low income subjects from both racial groups invested significantly less in partnerships with the high income subjects of the other racial group, a behavior the authors attribute to institutionalized "cross-racial envy." Such tacit "rules of the game" influencing individuals behavior may have implications far beyond experimental game theory research: as Haile *et al*. (2008) note, in the aggregate such selective distrust could lead to substantial underinvestment in the economy.

Gibson & Marks (1995) ultimately caution that in practice successfully re-ordering the preferences of actors can be a serious challenge. One especially important finding in their study is that community-level rewards may be largely ineffective at engendering desired behaviors. In essence, by giving quasi-public goods[9] to communities to abstain from hunting endangered species in Zambia, Gibson & Marks (1995) found that a Zambian anti-poaching program failed to sufficiently reward individual behavior. Programs were creating a new free-rider problem in which some individuals continued to hunt while receiving benefits from community projects. In this specific instance, relying on social incentives to reduce transaction costs (by pooling community benefits in the form of projects tied to biodiversity protection, and reducing project expenditures on independent monitoring and verification) ultimately resulted in greatly inferior outcomes. The authors conclude that design of projects for CPR management must therefore be tailored to local contexts and characteristics of the resource.

3.2. Mezzo-level: Project Design, Transaction Costs and Institutional Structures

At the project level, the design of a project clearly impacts that project's performance in terms of environmental (forest management) and economic (cost minimization) objectives. Neoclassical economic theory, and work in the New Institutional Economics (NIE) provides some initial intuitions in this regard (Williamson 2000). Larger projects, for example, should be able to realize economies of scale relative to small projects by reducing per-ton management and verification costs; similarly, projects that focus on the propagation of fast-growing exotic tree species might be better able to sequester carbon dioxide quickly and cheaply as compared to projects that promote slower-growing native tree plantings (Kolshus *et al*. 2001). Meanwhile projects that operate within fewer political jurisdictions – and thus face less administrative costs – might also enjoy some advantage. Finally, as mentioned previously a major argument in neoclassical economic theory is that issuing property rights – i.e. privatization of common pool resources – is a powerful way to overcome the market failures inherent in many CPR systems. Indeed, some forestry-based carbon projects to date have evaded the CPR problem altogether, by buying land from national governments for reforestation purposes, or by working exclusively with private landowners (Jindal 2008). Economic theory predicts that such projects should have a competitive edge over their CPR-type counterparts.

However private property rights are infeasible in some situations, particularly in long-shared resources where it may be enormously difficult to "fairly" allocate rights. Moreover there is some evidence to suggest that privatization is not always desirable. In a study of rangeland management in sub-Saharan Africa, Goodhue & McCarthy (2009) conclude that traditional CPR management institutions actually lead to higher yields (in terms of animal weights) than more "modern" land privatization policies.[10] These authors conclude that the relative performance of traditional systems compared to private and common property regimes depends on a number of factors, including the productivity of the resource itself: traditional grazing rights may be preferred to well-defined private property rights when the resource base is large enough for the insurance feature of traditional rights to provide real value. Some authors argue the emphasis should be more one on how to support and compensate traditional natural resource management systems for the public good values generated.

[9] Public goods are characterized by nonexcludability, i.e. their benefits are available to a group whether or not its members contribute to the provision of the good. Rational individuals would choose to receive the benefits from hunting activities while simultaneously enjoying the advantages offered by the public good.

[10] Well-defined boundaries are necessary to reduce uncertainty as to who will benefit and who will pay the costs; poorly defined boundaries should increase uncertainty and thus retard efforts to find or sustain a collective solution (Gibson *et al.* 2005).

Molnar *et al.* (2004) suggest that either secure property rights or contracts offering social services might be more effective incentive mechanisms than ones based mainly on financial payments.

From an institutional perspective, perhaps even more important in determining overall project success, however, are management and leadership characteristics – especially the ability of managers to design and implement projects in a manner appropriate for a given social and institutional context. Theory and empirical research both suggest environmental management strategies that are designed and implemented in a manner consistent with local norms and values have a greater likelihood of survival and success (Ostrom *et al.* 1999). Case studies by Ostrom (1994) suggest high levels of social capital might decrease both the uncertainty and transaction costs to individuals in their interactions and thereby increase the odds of reaching and maintaining a collective solution. At the same time, projects that tangibly benefit local and national stakeholders – for example by sharing carbon credit revenues locally, or by ensuring that projects are designed so as to increase "spillover benefits," such as access to fuel wood and other forest products - are clearly more likely to generate local and national support.[11] Such projects might therefore be more likely to "succeed" (that is, cost-effectively achieve project objectives, including carbon sequestration) than others. Finally, management and leadership are also key factors in disseminating information about project activities and outcomes to relevant stakeholders. In the absence of such communication, local stakeholders might not grasp the benefits to be realized from supporting a carbon sequestration project (e.g., by protecting trees) - and might therefore not support a potentially beneficial project. Under especially adversarial conditions local communities might even actively work to undermine the project (Smith & Scherr 2003). Other research in economics and signaling theory suggests that international organizations similar to carbon sequestration programs might engage in costly communications activities, including pursuing 3rd-party certification of project activities, as a means of assuring potential project sponsors that projects are secure and worthwhile investments (Gugerty, forthcoming).

3.3. Macro-level: International Institutions, Markets, and Values

Ultimately it appears that the conditions under which CPR management will succeed can vary widely across contexts – but in any event, "non-tragic" solutions to the CPR game can be observed. However there is one additional layer of factors that may influence carbon sequestration project success – the national and international institutions within which carbon projects operate, including both the markets within which "carbon trading" occurs, and the international norms and values that allow those very markets to exist.

At the national level, specific social variables of theoretical significance in the CPR debate include groups' interdependence, poverty levels, ethnic and linguistic homogeneity, population pressures, technology levels, and perceived predictability of the benefit flow (related to political and climate stability, among other variables, see e.g., Ostrom 2001). But more generally, the success of any PES scheme also hinges on effectively accessing markets. Such access requires strong communication with buyers of the services in question (from a managerial perspective), but it also entails alignment of project design and activities with prevailing values in the marketplace (factors which are out of the control of the project manager). Given that the number of venues for forestry-based carbon offset sales remains limited, institutional theorists might predict a high degree of homogeneity among forestry-based carbon sequestration projects. In short, a combination of

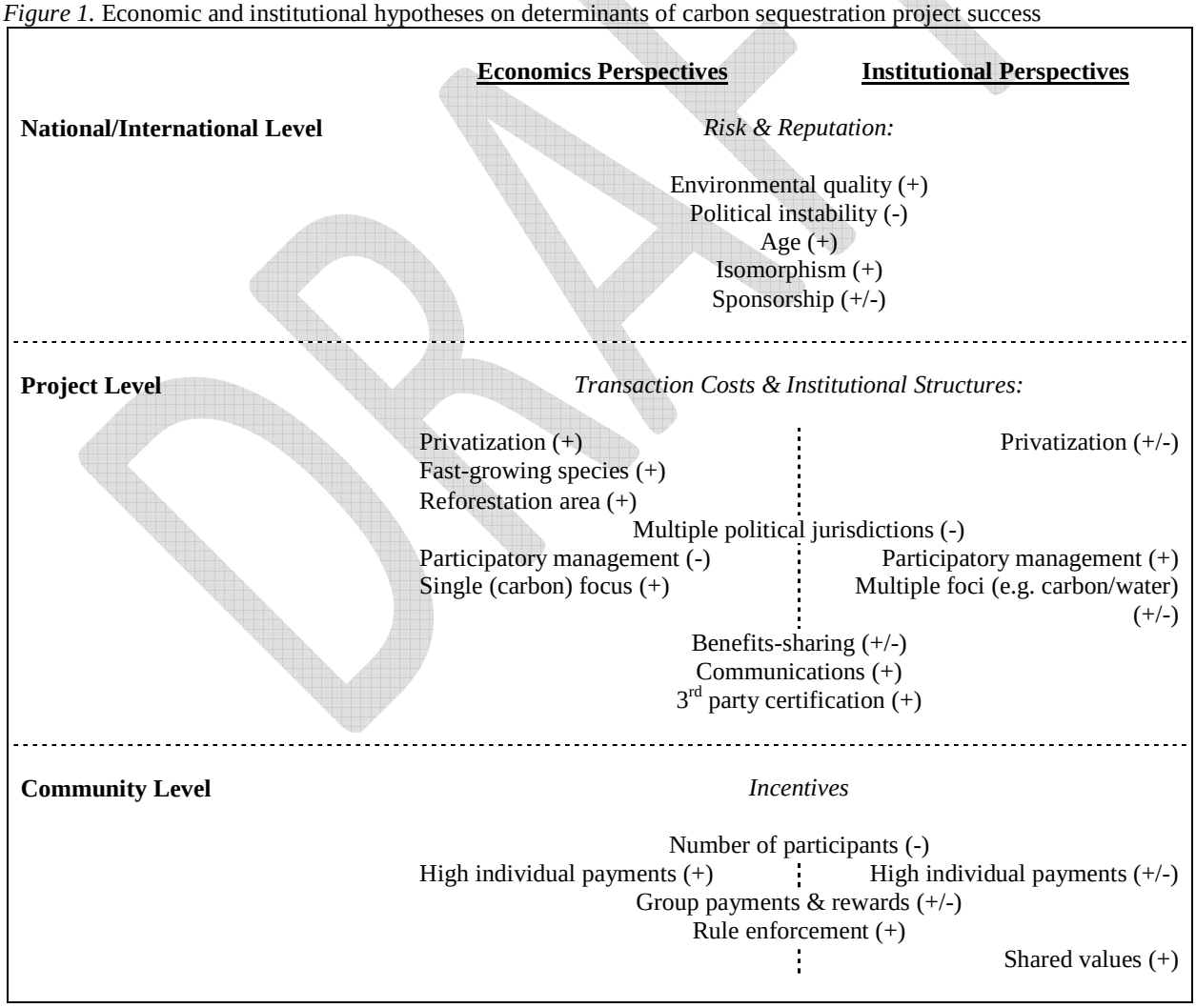
[11] In this context "local support" might take the form of protecting trees from fire and animals, and even expanding the geographic range of project activities, while "national support" might include favorable publicity of project activities and outputs.

coercive forces (as buyers seek to standardize and thus streamline carbon offset production chains) and mimetic forces (as project managers seek to emulate project designs that have proven "successful" in other venues) should result in trends of institutional isomorphism across carbon sequestration initiatives (c.f., DiMaggio and Powell 1983). Finally, recent surveys show a growing appreciation of the importance of integrating development goals into forestry-based carbon offset projects in the developing world, and an increasing international disdain for "pure" commercial carbon forestry projects (growing trees for carbon exclusively, with little community involvement). "Successful" projects will likely be those most able to undertake and communicate their compatibility with (varying) sponsor perspectives on "the right way" to sequester carbon in forests.

4. HYPOTHESES ABOUT THE STRUCTURE OF FORESTRY-BASED CARBON SEQUESTRATION PROGRAMS

The key predictions stemming from the theory, including the hypothesized direction of the effect (+ means increases likelihood of success; - means decreases likelihood of success; +/- means theorized direction is indeterminate) are summarized in Figure 1.

Figure 1. Economic and institutional hypotheses on determinants of carbon sequestration project success



As shown in the Figure, economic and institutional theories are largely in agreement with regards to the theorized determinants of project success at the macro (national/international) level. At the other levels, however, economic perspectives (on the left) often differ from institutional perspectives (on the right).

The next section of the paper examines these hypotheses and questions about the structure and success of forestry-based carbon sequestration programs based on the economic and socio-institutional framework developed above. While many case studies have examined individual carbon sequestration projects in detail, this is one of the first studies to take a systematic look at the design and performance of forestry-based carbon sequestration initiatives across a range of programs and settings.

5. EVALUATING ECONOMIC AND INSTITUTIONAL THEORIES THROUGH PROJECT DESIGN

This section evaluates whether forestry-based carbon sequestration programs are consistent with the hypotheses developed above using data on 38 forestry-based carbon sequestration projects in sub-Saharan Africa. Candidate programs were identified through a comprehensive literature and media review, including web searches, public lists of existing projects and trading platforms for carbon offset sales, and telephone interviews with project managers. Three criteria were used to identify projects for inclusion. First, projects must use carbon offset sales to finance some or all project activities. Projects sequestering carbon for purely environmental or public-relations purposes were thus excluded. Second, projects must entail the active planting and management of trees for carbon offsets – projects for prevented deforestation are excluded (as such projects are currently ineligible for carbon payments through the CDM). Finally, given the nature of the dependent variable (success or failure), projects in the planning stage were also excluded.[12]

Once the 38 programs meeting the sample criteria were identified, the structure of each project was considered in terms of key environmental characteristics (e.g., rainfall, soil quality), key socio-political characteristics (political boundaries, ethnic heterogenerity, land tenure institutions), and key management characteristics (e.g., sponsor involvement in project design and implementation, stakeholder involvement in planning and management, species selection and propagation methods, project benefits-sharing with local communities, and overall project vision and goals). Given the exploratory nature of the research a mixed qualitative-quantitative study design was adopted. Namely, the "most-similar method" of case selection is often used in the early stages of social science research, where research is exploratory (Gerring 2007). The method is a small-N technique that aims to unveil possible causal relationships by studying a limited number of cases that are as similar as possible in all respects (i.e. all independent variables, X_n) except for the outcome of interest (i.e. the dependent variable, Y), where they are expected to vary. This study seeks to explain "project success" among different forestry-based carbon sequestration projects (Y: Reliable Sequestration). A most-similar research design begins by attempting to survey all possible causes (Xs) of the outcome (Y): for example, assuming that local climate (X_1), the sponsor of the project (X_2), and whether or not local leaders were involved in project activities (X_3) are hypothetical causes of project success (Y). One can then select from the population only cases

[12] These criteria exclude many new and high-profile programs in Africa operating under new REDD guidelines. These markets are too new for any conclusions to be drawn at this time, though much of the theory discussed above may be broadly applicable to these new projects as well.

where most of the possible causes have the same value across cases, allowing one to isolate likely causes of success or failure among carbon sequestration initiatives.

5.1. General Patterns of Project Emergence

The data on program structure confirm a broad diversity of institutional structures in past and extant carbon sequestration projects. The vast majority of projects are relatively new (emerging in the past 5-10 years), and the oldest program is only 17 years old. And though there are projects in 18 African countries at present, most operate in the Southeast, possibly reflecting certain environmental and institutional characteristics relatively more amenable to carbon offset production and sales in that region (Jindal 2008). But with regards to project scope there remains a great deal of variability – though it is noteworthy that only 2 projects emphasized *only* carbon sequestration as the primary product of their activities. Finally, even though almost all projects actively incorporate local input in project design and implementation, they appear to do so with highly varied degrees of benefits-sharing with project participants and surrounding communities. Table 1 summarizes key characteristics of the projects in the sample.

Table 1. Characteristics of forestry-based carbon sequestration projects.

	Project Characteristics	**Percentage of projects in each category (n=38)**	**Number of projects in each category**
Age	Less than five years	58%	22
	6-10 years	21	8
	11-15 years	18	7
	More than 15 years	3	1
Location	Uganda	19%	8
	Ethiopia	8	3
	Kenya	8	3
	Madagascar	8	3
	Mozambique	8	3
	Tanzania	8	3
	South Africa	8	3
	Other East Africa	3	1
	Other West Africa	18	7
	Other Sub-Saharan	11	4
Geographic Scope	National	95%	36
	Transnational	5	2
Sponsorship	Private Company	45%	17
	GEF/WB	28	9
	Foreign State	16	5
	NGO	6	2
	Other (intra-state)	16	5
Project Scope (Benefits Emphasized)	Carbon Only	5%	2
	Environment	87	33
	Social/Economic	76	29
	Biodiversity	47	18
	Soil	47	18
	Other (Research)	6	2

Local Involvement in Planning	Locally Initiated Project	11%	4
	Extensive Local Consultation	40	15
	Some Local Consultation	40	15
	Private Investor Project	9	4
Local Involvement in Implementation	Locally Managed Project	25%	6
	High Local Involvement (Labor & Managing)	71	27
	Low Local Involvement (Labor Only)	16	5
	Emphasize Women	5	2
Project Benefits-Sharing	All Benefits to Locals	6%	2
	All Non-Carbon Benefits to Locals	25	6
	Specific Provisions for Locals (e.g. fuel allowance, hunting)	61	26
	None (or income only)	9	4
Institutional Development	Emphasize Institution-Building	32%	12

5.2. Patterns of Project Structure

The average project size in the sample was $2.3 million, and covered an area of nearly 60,000 hectares. Moreover the average project reportedly has or will sequester over 13.5 million metric tons of carbon dioxide, however these values varied dramatically across projects. The Kawaza Village Planting in Zambia, for example included only a small school plantation of 300 trees (with offsets sold by the private firm Flying for Carbon). Overall, the smallest offset projects accounted for well under 1,000 tons of carbon sequestration, while the largest projects represented 100 million tons or more. The costs of offsetting, however - at least for offset buyers - was much less variable. Among the 23 projects actively selling carbon offsets at the time of the study the average offset price was $9.39 (SD: 5.28) per ton CO_2, very low relative to current forestry-based carbon sequestration alternatives in the US, (see e.g., Stavins 1999 for a review). With regards to sponsorship, a surprising 45% of projects were undertaken by private companies, though many private carbon sequestration projects are very recent (average age 3.2 years). Moreover, though many projects were undertaken by private companies or local NGOs, over half of the projects were sponsored either directly (45%) or indirectly (29%) by international buyers (either the World Bank or a foreign state).

A summary of key patterns observed among projects using simple criteria for "project success" is shown in Tables 2-4 below. Statistically significant differences between successful and unsuccessful projects are in bold text (Chi-square statistic significant with p-value < 0.01).

5.3. Determinants of Success: Micro Level

At the micro-level individual financial incentives – as measured by the use of carbon payments directly to land owners or land users – do not appear to strongly influence outcomes.

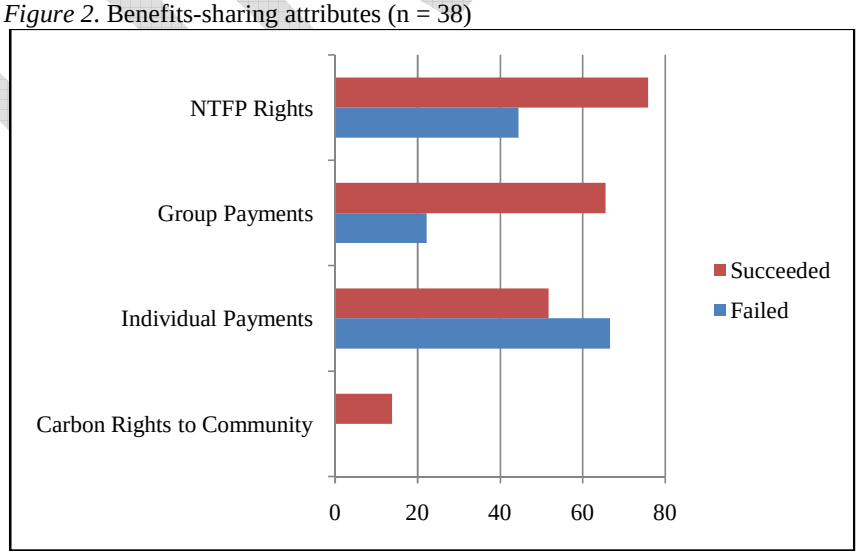
Contrary to theoretical expectations, projects involving larger numbers of participants do not appear more likely to fail than smaller projects. Also contrary to economic theory, payments directly to individuals does not appear associated with greater levels of project success – indeed, projects emphasizing group-level benefits (either carbon payments to community groups, or other development projects in communities tied to the carbon sequestration project outcomes) consistently outperform projects eschewing such group-level benefits, as summarized in Table 2 below.

Table 2. Patterns of success and failure among forestry-based carbon sequestration projects: Micro level.

	Theorized Relationships	**Observed Project Characteristics**	
		SUCCESS: *Sold Credits And Survived* N = 29	**FAILURE**: *No Sale Or Did Not Survive* N = 9
Micro Level *(individual incentives)*	Number of participants (-)	Many participants (28/29)	Many participants (7/9)
	Indiv. payments (+ or +/-)	Indiv. payments (15/29)	Indiv. payments (6/9)
	Group payments (+/-)	**Group payments (19/29)**	**Group payments (2/9)**
	Local rule enforcement (+)	*Community-implemented (11/29)*	*Community-implemented (5/9)*
	Shared values (+)	*Homogenous population (8/29)*	*Homogenous population (4/9)*

Local ethnic homogeneity (a proxy for social incentives) does not appear to predict project success, nor does local rule enforcement (as opposed to state or international oversight). That said, none of the projects initiated and implemented by local communities in the sample were classified as failures. Nevertheless it must be noted that this may be in part due to the extreme hesitance of international funding agencies to fund any but the most promising of proposed carbon sequestration projects. In other words, the success of local initiatives may not reflect the strength of a bottom-up development approach, so much as the outcome of a highly competitive international funding environment wherein only the very strongest of local initiatives survive.

Figure 2. Benefits-sharing attributes (n = 38)



Among noteworthy micro-level successes are Wangaari Maathai's Green Belt Movement and the Plan Vivo Project in Uganda. Both have resulted in widespread reforestation, and both have been mimicked by more recently emerging projects. Three projects failed due primarily to micro-level weaknesses. All were woodlot projects initiated by private companies on privately purchased land with zero local involvement. In all instances project activities were disrupted by widespread pillaging of forest resources by disenfranchised local populations. In the case of the Forests, Ltd. in Tanzania and Uganda, attempts to restrict local communities' access to forest resources even resulted in deaths due to violent enforcement of trespassing prohibitions by hired authorities. Such actions resulted in charges of "CO_2lonialism" that were picked up by the popular press and transmitted across Europe, compounding the project's micro-level incentives problems with mezzo- and macro-level communications problems, as discussed further below.

5.4. Determinants of Success: Mezzo Level

At the mezzo level several project management characteristics exerted a strong influence on project outcomes. As previously highlighted, benefits-sharing was a key determinant of project success, as was local involvement in project design and implementation: projects implemented directly by investors (as opposed to by communities themselves) were more likely to fail (Table 3). Some fairly basic predictions from neoclassical economic theory, including the desirability of privatization of land resources and the use of fast-growing species, showed no significant association with project success in the sample. Though there was some evidence of economies of scale among projects, with the largest projects (in terms of hectares and total volume carbon sequestered) offering some of the lowest-cost carbon sequestration (as little as $0.67 per ton in the case of the Benin Community Management of Woody Savannah Project), overall it appears that both large and small projects have been able to be successful. Working across a range of governance levels also does not appear to stifle projects (as transaction cost economics might suggest). The Humbo Assisted Regeneration Project, for example, successfully brings together World Vision Australia, the Ethiopian Agriculture, Rural Development & Forestry Coordination Office, and 7 local community cooperative societies to manage degraded lands for carbon, biodiversity and sustainable income-producing activities through reforestation (World Bank Carbon Finance Unit, 2008). And the 3 transnational projects in the sample were all "successes."

Table 3. Patterns of success and failure among forestry-based carbon sequestration projects: Mezzo level.

	Theorized Relationships	**Observed Project Characteristics**	
		SUCCESS: *Sold Credits And Survived* N = 29	**FAILURE**: *No Sale Or Did Not Survive* N = 9
Mezzo Level *(project structure)*	Privatization (+ or +/-)	*No investor-owned properties*	*Some investor-owned properties (2/9)*
	Fast-growing species (+)	*Primarily local species (12/29)*	*Primarily exotic species (5/9)*
	Reforestation area (+)	*Mixed*	*Mixed*
	Multiple political jurisdictions (-)	***Single project location (21/29)***	***Multiple project areas (8/9)***
	Participatory (- or +)	*Community-implemented (11/29)* ***Investor-implemented (5/29)***	*Community-implemented (5/9)* ***Investor-implemented (5/9)***
	Carbon focus (+ or -)	***Primarily non-CO_2 focus (17/29)***	***Primarily CO_2 focus (9/9)***

		Mean number of foci: 4.76	***Mean number of foci: 3.33***
	Benefits-sharing (+/-)	***Shared NTFP rights (22/29)***	***No shared NTFP rights (5/9)***
	Communications (+)	*Have website (19/29)*	*Have website (5/9)*
	3rd party certification	*Not 3rd party certified (20/29)*	*Not 3rd party certified (5/9)*

Perhaps the most influential mezzo-level variable is diversity of project goals: contrary to neoclassical economic expectations, projects that specialized in carbon sequestration alone fared far worse than those projects emphasizing a variety of benefits, often with a variety of different (and costly) activities. In Ethiopia and Benin, for example, communities have been trained in techniques to propagate native species (including farmer managed natural regeneration); and the project area currently covers over 2,500 hectares. The forested lands provide habitat for local species and enrich biodiversity, while at the same time reducing soil erosion and flooding. In both projects, income from the sale of carbon sequestration services – in the form of Certified Emissions Reductions (CERs) sold by World Vision to the World Bank over the next 3 decades - will be reinvested in project activities and in local infrastructure and food security efforts. Over 3,000 households will ultimately benefit from the project in Ethiopia, and over 10,000 in Benin, through employment and training opportunities as well as through access to sustainable food and fuel sources, and cleaner and more reliable water sources in and around the project area due to reforestation efforts.

Meanwhile two projects failed due to mezzo-level weaknesses. The Forest Rehabilitation in Mt. Elgon & Kibale National Parks project emphasized biodiversity preservation and carbon sequestration in its design. It also advertised local economic development benefits in the form of salaries for project workers and park scouts in the project area. However by working almost exclusively with national government officials in the project design and implementation, the project soon encountered resistance from local leaders and communities – the few economic benefits accruing to individuals involved in the project were insufficient to overcome community-wide perceptions that their right to forest resources was being taken by overseas project managers. The result was increases in deforestation, poaching, and other activities (increasing project costs and marring the reputation of the project founders). The TIST-Tanzania project meanwhile failed to effectively monitor project "leakage", and was therefore denied endorsement by the government of Tanzania in 2008 (therefy making the multi-year project ineligible to receive carbon sequestration payments through the CDM). This failure was astonishing in part due to the great success of past TIST efforts in Tanzania, and the ongoing success of TIST projects in neighboring Uganda. But the failure clearly emphasizes the tradeoffs inherent in minimizing transaction costs in project implementation – by actively involving local populations in the implementation, monitoring, and enforcement of project activities TIST sought to minimize project costs (while strengthening local institutions). However these efforts were determined to inadequately guarantee that forest protection by TIST would not lead to expanded deforestation elsewhere ("leakage") thus TIST-Tanzania was ultimately denied certification by the national and international institutions of the CDM.

5.5. Determinants of Success: Macro Level

Finally, though it is difficult to assess how macro-level factors have influenced project performance, some observations can be made. Most surprisingly, environmental characteristics favorable to tree growth, including good soil quality and higher rainfall, were both *negatively*

associated with project success. A closer look at failed projects suggests that the opportunity costs of foregone agricultural production on high quality sites may outweigh even relatively large project-related benefits – the high-quality sites chosen by the private, commercial plantations in the sample, for example, were also highly desired by local communities, ultimately leading to conflict. Projects on degraded sites, on the other hand, weren't "taking something away" from anyone – on degraded lands opportunity costs are lowest.

Table 4. Patterns of success and failure among forestry-based carbon sequestration projects: Macro level.

	Theorized Relationships	**Observed Project Characteristics**	
		SUCCESS: *Sold Credits And Survived* N = 29	**FAILURE**: *No Sale Or Did Not Survive* N = 9
Macro Level *(national/ international context)*	**Environmental quality (+)**[§]	***Degraded soil (20/29)*** ***Average annual rainfall: 959 mm***	***Good soil (6/9)*** ***Average annual rainfall: 1112 mm***
	Political instability (-)	*Mean HDI rank: 155* *Project in Uganda (5/29)* *Project in Tanzania (1/29)*	*Mean HDI Rank: 150* *Project in Uganda (3/9)* *Project in Tanzania (2/9)*
	Age (+)	*Mixed*	*Mixed*
	Isomorphism (+)	*Not observed*	*Not observed*
	Sponsorship (+/-)	***For-profit company (13/29)*** - ***BioCF (7/8)***	***For-profit company (6/9)***

Finally, a key component at the macro level appears to be communication. All of the failing projects suffered in some respect or another from negative international publicity regarding their projects. Particularly given the voluntary nature of many forestry-based offset trading platforms today, such negative publicity can be catastrophic for an organization. For-profit companies in the sample were particularly susceptible to negative publicity surrounding their project activities (and local conflicts resulting from those activities). Nevertheless there is some evidence of adaptation among private carbon sequestration firms - the recent re-branding of "Forests, Ltd. Norway" (with 2 failed projects) as "The Green Forests Initiative" (with one new project underway) suggests that private companies may be learning from experience that carbon-only projects, at least in the current international market and normative environment, may not be a wise business plan.

6. Discussion and Conclusions

Deforestation in low-income countries has implications at the local, regional, and global level. Communities in rural areas are highly dependent on forests for their daily needs of fuel wood, food, timber, animal fodder and other forest products. At the national and regional levels forests are critical for preventing soil erosion, regulating water supplies and providing local climate stability; in many instances forests in biodiversity-rich areas also represent important sources of tourism revenue. Finally, at the global level the issue of climate change has put tropical deforestation high on the international agenda: the clearing and burning of forests represents a substantial source of anthropogenic carbon dioxide emissions. At the same time, however, such negative trends can be reversed: degraded forests can be replanted and managed, restoring food, fuel, and water security in impoverished areas (Reynolds *et al*. 2009), and it is now widely acknowledged that the sustainable

management of forests has the potential to remove millions of tons of greenhouse gasses from the atmosphere and sequester (durably store) such pollutants in the form of living biomass. This fact has recently prompted organizations such as the World Bank BioCarbon Fund (www.biocarbonfund.org) to invest millions of dollars in reforestation and forest management activities in the developing world (Jindal 2008).

The benefits of reforestation are clear, and the disastrous consequences of inaction are apparent (Gibson *et al*. 2005). But there remains a great deal of uncertainty – and almost no theory – surrounding how to implement and manage successful reforestation projects. Institutional constraints (e.g., laws) or social constraints (e.g., norms) might provide incentives for individuals to pursue a collectively desirable strategy. However weak state institutions and widespread poverty may have an opposite effect. Existing research provides little concrete guidance on these issues – especially when an exogenous "carbon payment" is introduced.

As early as the late 1990s it was already clear that forestry-based carbon sequestration was not a universally applicable tool; as one scholar noted: "Whether and to what degree "forestry instruments" belong in individual nations' global climate policy portfolios will depend upon geographic, institutional, and economic characteristics of countries and key local characteristics of forestry and land-use practices" (Richards *et.al*. 1997). An analysis of the institutional structure and operating context of a number of afforestation and reforestation projects in Africa that use payments for carbon sequestration to finance some or all of their tree-planting activities focusing on environmental/contextual characteristics (e.g., local climate, soil quality, political boundaries) and key management characteristics (e.g., local stakeholder involvement in planning and management, species selection and propagation methods, project benefits-sharing with local communities, and overall project "vision" and goals)..

At the individual level, such projects seek to alter incentive structures such that individual landholders and land-users make choices that are consistent with the collectively beneficial goal of growing and protecting forests. Such incentives may include direct "carbon payments" to individual land-users, or alternatively community-level benefits such as education, health, and infrastructure projects may be tied to carbon sequestration outcomes. At the project-level, forestry-based carbon sequestration schemes face the same challenges as any commodity-selling organization: producing and marketing a good (in this case carbon offsets) in a reliable and efficient manner given available resources and constraints. Producing carbon offsets that are durable can incur substantial costs in planting trees, monitoring tree growth, enforcing rules to protect growing carbon stocks, and delivering carbon offset payments to project participants. But at the same time buyers will be reluctant to purchase offsets at exorbitantly high prices, thus project managers must strive to ensure the durability of carbon offsets while simultaneously minimizing program costs. Finally, at the global level carbon sequestration projects face an enormous marketing challenge. To sell offsets projects must effectively communicate the credibility of offsets to potential buyers. Moreover, projects must strive to align themselves with swiftly changing national- and global-level expectations that emphasize not only carbon sequestration as a goal of forestry projects in the developing world, but also equity, sustainability, and other concerns.

The application of economic and institutional theories to forestry-based carbon sequestration programs offers several preliminary hypotheses about predictors of program "success". All of these literatures jointly acknowledge that low-cost, reliable carbon sequestration programs will be characterized by (1) an enabling environment (from an ecological standpoint) such that trees are

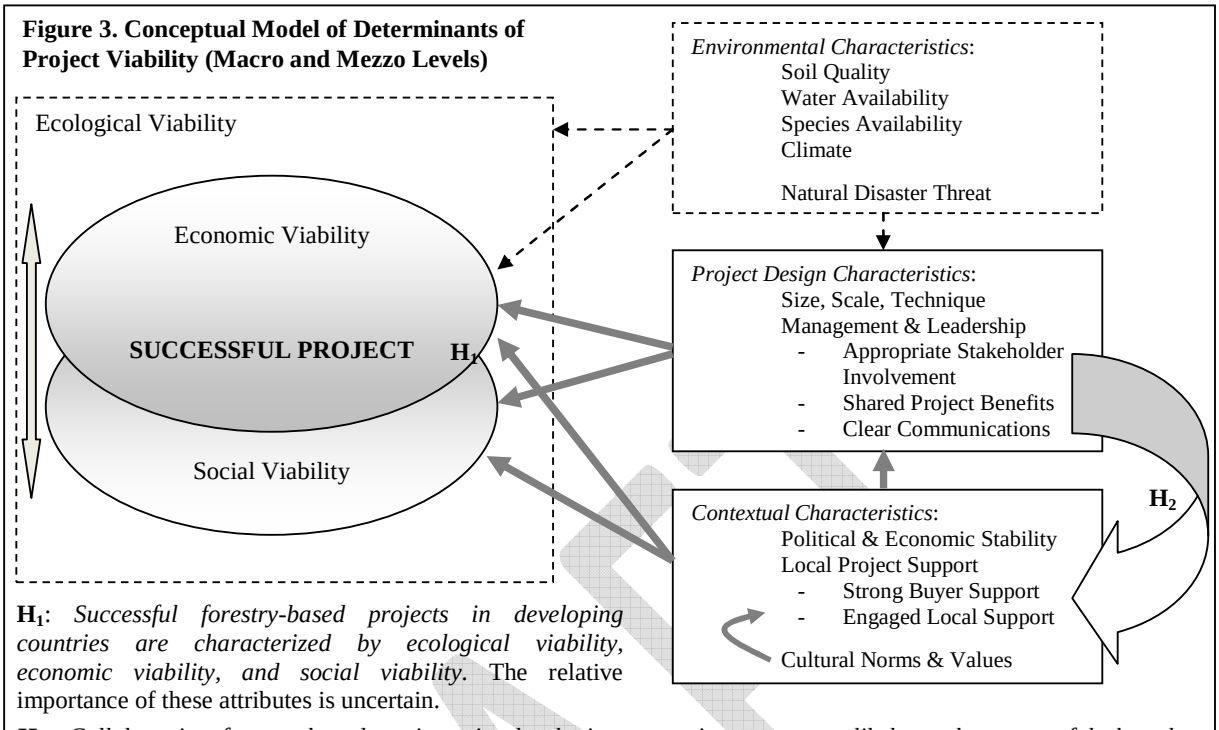
physically able to grow; (2) an enabling incentive structure (from an economic standpoint) such that local communities will choose to plant and protect growing forests throughout the carbon-crediting period; and (3) an enabling institutional structure (from a socio-institutional standpoint) such that costs and benefits are fairly allocated, transaction costs are lowered, and risk is minimized. There is a vast scientific literature on what ecological factors are most favorable to carbon storage in trees and soils. However it is not clear from current theory whether both enabling economic incentives and enabling institutions are equally necessary for successful programs in low-income countries. Research in game theory for example suggests there may be a tradeoff between economic incentives and socio-institutional structures: if individual rewards for carbon offset sales are sufficiently high, for example, formal institutions for community-level monitoring and enforcement of anti-harvesting rules may be unnecessary.[13] Alternately, in the presence of strong social norms against harvesting from the common-pool resource, it is conceivable that smaller payments may suffice for reliable carbon sequestration (in extreme cases, even in the absence of individual property rights).

This study has illustrated some of the aspects of project design (including technical factors as well as institutional arrangements) that have proven important to determining the viability of international payments for carbon sequestration to engage in small-scale forestry activities in sub-Saharan Africa. Some findings are consistent with economic theory. Namely, larger projects appear able to realize economies of scale, resulting in lower per-ton costs of carbon sequestration (though some of these gains are muted due to high verification and monitoring costs for larger projects, particularly those projects seeking to sell certified emissions reductions (CERs) through the Clean Development Mechanism). Other findings contradict theoretical expectations; for example, projects undertaken in relatively harsh climates with poorer quality soils appear more robust (that is, less likely to fail) than projects undertaken in areas with better soil and higher rainfall - areas that are clearly more conducive to the growth of vegetation. Meanwhile, private carbon sequestration initiatives by for-profit companies (European industries seeking to comply with national emissions limits under the Kyoto Protocol) perform the worst out of all programs studied, casting doubt on expectations that a free market approach to international carbon forestry will result in the most desirable outcomes. Experiences to date suggest that local participation in project implementation, and higher levels of benefits-sharing with communities in project areas may also increase the likelihood that a project will "not fail" – in spite of the fact that such project characteristics also increase per-ton costs of sequestering carbon. Finally, changing global norms about what carbon sequestration projects should aim to accomplish in the developing world suggest that even when projects do not appear to constitute economically viable carbon emissions abatement strategies, the significant ecological and economic benefits associated with forestry-based carbon sequestration may still make such projects desirable as international development strategies, at least partially financed by carbon offset sales.

A simplified conceptual model derived from the findings is presented in Figure 3.

[13] Although institutions capable of guaranteeing land tenure – or at the very least ownership over trees planted – may still be influential.

Figure 3. Conceptual Model of Determinants of Project Viability (Macro and Mezzo Levels)



H_1: *Successful forestry-based projects in developing countries are characterized by ecological viability, economic viability, and social viability*. The relative importance of these attributes is uncertain.

H_2: *Collaborative forestry-based projects in developing countries are more likely to be successful than less collaborative approaches.* Management and leadership strategies that incorporate adequate stakeholder involvement, provide substantial spillover benefits, and communicate project intentions and impacts will increase local and national support, which will improve economic and social viability, thereby increasing the likelihood of project success.

While deforestation leads to soil erosion, landslides, flooding, and other forms of devastation in countries around the globe, reforestation (the planting of trees on former woodlands) and afforestation (planting trees where there were historically no trees) have been shown to stabilize soils, increase soil water retention, and reduce incidences of violent flooding (FAO, 2004; Bekele, 2001). At the same time forests provide a whole host of other benefits in the form of ecosystem services such as biodiversity, wood for fuel and construction, and even local climate stabilization. But perhaps most importantly of all forestry activities represent a form of international development assistance where financial resources are increasingly available. Increasing global attention – and associated funding – surrounding the issue of global climate change has created an unprecedented opportunity for investments in natural capital (in the form of forests and agro-forestry projects) in the developing world (Turpie et al., 2008). Forestry activities that sequester carbon dioxide thus represent one feasible opportunity for breaking vicious cycles, and generating "virtuous" ones, in the sub-Saharan region (Reynolds 2009).

However realizing these potential benefits will require profound efforts at institution-building to allow communities living in and around forests to sustainably and equitably manage these resources for carbon and other benefits. Ultimately, there is abundant evidence to suggest that the tragedy of the commons can at times be avoided. Anthropologists, economists, game theoreticians and political scientists together have built the case that local users can and do construct institutions to use natural resources sustainably (Ostrom 1990). Since all participants benefit from the positive externalities of the forestry activities and none can be prevented from enjoying it, forest

management activities require collective action on the part of participating communities (Olson 1965).

In future research, a more nuanced understanding of "success" would refer not only to the survival of projects (as considered here), but also a number of other factors ranging from the number of trees planted and surviving, the degree to which institutions have proven to be efficient (e.g., number of trees planted per dollar of payment), equitable (e.g., to what degree payments and other benefits associated with the reforestation project are equitably shared by local stakeholders), and sustainable (e.g., what efforts are undertaken to ensure that the reforested area will remain forested after the project comes to a close). Existing research highlights further highlights a need to consider the interactions between ecological systems, political systems and other social institutions (Goodhue & McCarthy 2009). The participants in natural resource management games (CPR, Poachers & Scouts or others) are likely to vary widely across countries, across cultures, and even across time. As Henrich *et al*. (2005) emphasize, cultural processes define what behavior is both strategically sound and *socially acceptable*: "the preferences and beliefs of new members are influenced by the economic and social institutions that structure the tasks people perform to make a living and to remain in good standing in their communities."

Nevertheless the present study has provided at least a general idea of the current state of forestry-based carbon sequestration programs in sub-Saharan Africa. Ultimately, as Gibson *et al.* remark: "The challenge that policy analysts now face is to move beyond the presumption that there is one, or a very limited, set of institutions that works to solve all commons dilemmas and to sort out which factors are most important in achieving successful management of resources — at least at a local level" (2005: 274). This research constitutes a small step in that direction.

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